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CSEDU 2009

1st International Conference on Computer Supported Education

Proceedings

Volume 1

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IICREST – Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology
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FOREWORD

This volume contains the proceedings of the First International Conference on Computer Supported Education (CSEDU 2009), organized by INSTICC – the Institute for Systems and Technologies of Information, Control and Communication, technically co-sponsored by the Workflow Management Coalition (WfMC), the Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology (IICREST), the IEEE Portugal Section and the Portuguese Chapter of the IEEE Education Society.

CSEDU aims at becoming a yearly meeting place for presenting and discussing new educational environments, best practices and case studies on innovative technology-based learning strategies, institutional policies on computer supported education including open and distance education, using computers. In particular, the Web is currently a preferred medium for distance learning and the learning practice in this context is usually referred to as e-learning. CSEDU-2009 is expected to give an overview of the state of the art as well as upcoming trends, and to promote discussion about the pedagogical potential of new learning and educational technologies in the academic and corporate world.

This conference brings together researchers, engineers and practitioners interested in methodologies and applications related to the Education field. It has six main topic areas, covering different aspects of Computer Supported Education, including "Information Technologies Supporting Learning", "Learning/Teaching Methodologies and Assessment", "Social Context and Learning Environments", "Legal and Cultural Management Issues", "Domain Applications and Case Studies" and "Quality, Evaluation and Accreditation Policies". CSEDU is held back-to-back with WEBIST, the conference on Web Information Systems and Technologies, providing a synergetic environment for delegates from both conferences, as many current and future issues and applications of Computer Supported Education are clearly related to the Web. This joint conference format will be kept in future events.

CSEDU 2009 received 275 paper submissions from 59 countries in all continents. A double-blind review process was enforced, with the help of the 146 experts who are members of the conference program committee, all of them internationally recognized in one of the main conference topic areas. After reviewing, only 25 papers were selected to be published and presented as full papers, i.e. completed work (8 pages in proceedings / 30' oral presentations) and 70 papers, describing work-in-progress, were selected as short papers for 20' oral presentation. Furthermore there were also 47 papers presented as posters. The full-paper acceptance ratio was thus 9%, and the total oral paper acceptance ratio was less than 35%. These ratios denote a high level of quality, which we intend to maintain or reinforce in the next edition of this conference.

The quality level of the CSEDU 2009 technical program is reinforced by six keynote lectures, delivered by distinguished guests who are renowned experts in their fields, including (alphabetically): Mats Daniels (Uppsala University, Sweden), Itiel Dror (University College London, United Kingdom), Manuel Castro Gil (National University for Distance Education, Spain), Thao Le (Faculty of Education, University of Tasmania, Australia), Edmundo Tovar

(Madrid Polytechnic University, Spain) and Wim Veen (Delft University of Technology, The Netherlands).

Although this is the first edition of the conference, we will do our best to ensure appropriate indexing for the proceedings of CSEDU including, hopefully, DBLP, INSPEC, EI and Thomson Reuters Conference Proceedings Citation Index. Furthermore, all papers will soon be available at the INSTICC digital library.

Building an interesting and successful program for the conference required the dedicated effort of many people. Firstly, we must thank the authors, whose research and development efforts are recorded here. Secondly, we thank the members of the program committee and additional reviewers for their diligence and expert reviewing. Thirdly, we would like to thank the national and international associations who co-sponsored this event, and their representatives at the conference, especially Prof. José Metrôlho and Prof. José Salvado from the Portuguese Chapter of the IEEE Education Society. We also wish to include here a word of appreciation for the excellent organization provided by the conference secretariat, from INSTICC, who have smoothly and efficiently prepared the most appropriate environment for a productive meeting and scientific networking. Last but not least, we thank the invited speakers for their invaluable contribution and for taking the time to synthesize and deliver their talks.

Looking forward to an inspiring world-class conference and a pleasant stay in Lisboa for all delegates, we hope to meet you again next year for the 2nd CSEDU, details of which will be shortly made available at http://www.csedu.org.

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INFORMATION TECHNOLOGIES SUPPORTING LEARNING

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Keywords: e-Learning services, Technology enhanced learning, Digital objects and reusability, Digital contents and repositories, Open courses and open knowledge.

Abstract: The massive, simultaneous redesign of all degrees in European Higher Education Area presents daunting challenges but also offers unprecedented opportunities. All degrees must be simultaneously redesigned; synergies among them can be effectively exploited, thus encouraging the re-utilization oriented approaches discussed in this paper (LCMS, standards like LOM, Dublin Corem QTI, IMS, SCORM, etc.). On the other hand, shifting the unit of academic measurement to student hours (through the ECTS) facilitates the seamless combination of face-to-face, distance and blended learning in academic degrees.

1 INTRODUCTION

Higher Education in Europe has been profoundly modified since the declaration of Bologna (1999) (European Union, 2008) and their later road to start-up their implementation before 2010. The introduction of new technologies have also changed the methodology and use of technology in education itself.

The new European Area (Castro, 2007) and its convergence in education designed a model closer to what today is conducted in North America and Japan. In such systems is given greater importance to the practice load during the conduct of a subject. By providing an orientation toward more experimental tasks, and a clear direction to the working world, students develop a range of skills than in degrees with less experimentation do not have.

The idea of creating a common space of Education across Europe boosts mobility both within and outside the member countries. Member countries could move to any other continuing their studies there, just so uniformity and novelty attract the interests of other countries outside the European wishing to study in this new education plan. This mobility of people has as its immediate translation increase the economy and generates jobs uniform.

This new model is voluntary and while at first was accepted by the countries present in Bologna, there have been countries that have signed up later and others who for reasons of the countries themselves have been rejected.

Of course the adoption of this new model brings a number of negative aspects that is the view of each of the countries that are trying to adopt if it is greater than the benefits it can bring.

The clear disadvantages common in most countries are:

- Economics aspects in the change of the educational system of each country and their own interests.
- Academic aspects, this is the part most important or at least should be. Studies aimed at the more practical or vocational clashed with the design of some careers in particular with the ancient engineering.

More than these commonalities each country deals with the various obstacles that its educational system differs from the new European model. In Spain, the current model had mainly two types of degrees: “diplomaturas” and technical engineering (3-year); and “licenciatura” and engineering degree (5 or 6-year). Degree of 3-year would be a BS/BSc and degree of 5-year would be a MA/MSc. The problem these degrees are not exact equivalent. 3-year degrees are more oriented to vocational and experimentation tasks while 5-year degrees are more theoretical knowledge.

But taking a step closer to the problem within the own country, levels of similarity between universities in the curriculum of a particular degree are scarce and each of the universities could give a different importance on the same subjects, including subjects exist only in selected universities.

One could imagine that this amount of hegemony to reach a common consensus within the country itself is already a first step. However, the process goes on changing and all the universities and countries trying to adopt the new model by the deadline.

In order to understand how this "Bologna process" (the convergence towards the Common European Higher Education Area, EHEA) sets the framework within which the IT-based approaches analyzed in this paper must operate, as well as the ultimate goals they must support, it is necessary to differentiate the two major interrelated sets of changes it involves (Moon and Duran, 2008).

The most visible set of changes involves the abovementioned adoption of a US-like unified cycle structure involving graduate-master-doctoral cycles, as well as the adoption of a single unit of measurement, the ECTS (European Credit Transfer Systems) credit (which refers to 25-30 student hours of total effort, rather than being measured in hours of face-to-face lessons as before). In many countries (such as Spain), this involves the re-design and thus the (re)accreditation of all the degrees, under the quality certification system required by the EHEA.

This massive, simultaneous redesign of all degrees presents daunting challenges but also offers unprecedented opportunities. On the one hand, since all degrees must be simultaneously redesigned, synergies among them can be effectively exploited, thus encouraging the re-utilization oriented approaches discussed in this paper (LCMS, standards like LOM, Dublin Core, QTI, IMS, SCORM, etc.). On the other hand, shifting the unit of academic measurement to student hours (through the ECTS) facilitates the seamless combination of face-to-face, distance and blended learning in academic degrees.

The other, maybe even more significant but more subtle set of changes are those aimed at shifting the focus from instructor-centered “teaching” to student-centered “active learning”. It involves methodological changes such as continuous evaluation, de-emphasizing theoretical lectures to focus more on assignments and projects, higher practical focus, allowing students higher flexibility to design their own curricula. When combined with budget limitations, this methodological shift strongly supports the introduction of effective IT based approaches to alleviate the burden on the instructor’s resources. These should facilitate the educational equivalent of the current manufacturing trend towards “mass-customization”, thus allowing individually tailored learning paths with a level of resources similar to that required by standardized education.

In addition, several countries are taking this opportunity to introduce far-reaching modifications in their educational systems, which further strengthen the case for the introduction of IT based educational innovation. For example, in Spain, until now, all “official” degrees were listed in a catalogue compiled by the Education ministry (universities could also grant their own degrees on whatever they wanted, but those did not have official recognition). This catalogue included the name and the degree curriculum (structure), up to certain level of detail. The new system, however, breaks away from that closed catalogue approach and just issues some very generic guidelines to which new degrees should conform. Within this framework, universities (both private and public) are free to propose whichever degree titles and supporting curricula they want. Once the proposal is cleared from a quality criteria point of view (general quality criteria, such as the faculty CVs, cohesiveness of the proposed degree curriculum and appropriateness of the supporting IT infrastructure) the new degree is inscribed in a national registry, and the university is free to offer it (subject, again, to periodic quality evaluations).

One last aspect worth highlighting regarding the EHEA is its emphasis on promoting mobility and the

international dimension in education (through joint international degrees or through mobility in selected subjects of end term Thesis). Again, achieving this objective would be assisted by the adoption of standards-based, location independent IT-based educational solutions. These should support both distributed provision of learning services (e.g. in degrees offered by consortia of universities) and their consumption by distributed student groups, facilitating not just the interaction between students and instructors, but also the increasingly critical interaction among participants in distributed teams.

2 e-LEARNING EVOLUTION

The task of finding this convergence is present in every country. There is a clear desire for a common area of higher education. As well as seeking solutions and models to conform to European, the technology also gave a fairly noticeable change in the methodology on the side of teachers and on the side of students. Teachers can communicate synchronously with students and they can have colaboratives tools, documentation, opinion board, etc., which are renewed every day.

E-learning (EIfEL, 2008) has changed considerably during the last 15 years, when it only offered digital content (in text files, or in the best cases through hypermedia documents). Nowadays, the e-learning concept (APEL, 2008) involves an everyday wider range of technologies, table 1.

Table 1: Different Technologies in nowadays.

Technologies			
Wiki & Blogs	Discussion boards & Chats	Educational animation	e-mail
ePortfolios	Games	Hypermedia	LMS
MP3 Players	Multimedia CD-ROMs	Screencasts	Simulation
Virtual & knowledge based classrooms	Websites & Web 2.0	Podcast & videocast	Remote & vlabs, Etc.

Obviously, the backbone of this e-learning evolution is the technological revolution (BECSA, 2007) due to the fact that there is not really a new pedagogical methodology in the way of teaching. The real change is based on the new services, and the new possibilities that they offer to both students and teachers.

The concept of e-learning was used to define the online environments where students rarely came to faculties. Over time the offer distance learning courses has increased, relieving traditional courses. These courses also include doctoral programs.

E-learning is naturally suited to distance learning (Castro, 2003) and flexible learning, but can also be used in conjunction with face-to-face teaching, in which case the term Blended learning is commonly used.

In higher education especially, the increasing tendency is to create a Virtual Learning Environment (VLE) (which is sometimes combined with a Management Information System (MIS) to create a Managed Learning Environment) in which all aspects of a course are handled through a consistent user interface standard throughout the institution (Castro, 2004).

E-Learning lessons are generally designed to guide students through information or to help students perform in specific tasks.

A common standard format for e-learning content is SCORM whilst other specifications allow for the transporting of "learning objects" (Schools Interoperability Framework) or categorizing meta-data (LOM).

The way to implement the new technological resources will depend on one's own programmer or teacher of the course, that it always taking into account existing technology. So the level of involvement between student and teacher, even the content of the course may change depending on the preferences given. A course of international politics can be beneficial if there are tools that give the synchronous communication appear natural and fluid. On the other hand a course which requires a more individual study is not necessary to introduce this kind of tools.

Therefore the communication and the technology associated with a course will be asynchronous or synchronous. As asynchronous communication are blogs, wikis and discussion boards, in addition to the email for all one known. Participation requires no interaction with other users or with the programmer of that course. On the other hand the highly participatory courses where there is a need for real-time communications are those who use synchronous tools such as chat sessions or virtual classes.

In addition to e-learning that we all know, is the e-learning 2.0-inspired Web 2.0. As such, it aims to give greater impetus to all the collaborative tools and a social aspect, such as virtual communities where you can get a large amount of documentation

as a live communication with the other participants. A clear example of these places of learning would be the Second Life.

So e-learning in itself does not change in this second generation, just taking the influence of current interest and try to use all the technology possible to apply it to education learning. But it is true that the way to raise learning takes another way. In e-learning 1.0, the students were taking the contents of a course and conducting some practical exercises in order to obtain knowledge. Such practices were evaluated by the teacher, the current e-learning gives greater emphasis to communication and exchange of ideas either synchronous or asynchronous.

The first e-learning was focused on using the internet to replicate the instructor-led experience. Content was designed to lead a learner through the content, providing a wide and ever-increasing set of interactions, experiences, assessments, and simulations. E-learning 2.0, by contrast is built around collaboration. E-learning 2.0 assumes that knowledge is socially constructed. Advocates of social learning claim that one of the best ways to learn something is to teach it to others.

E-learning can provide for major benefits for the organizations and individuals involved:

- Virtual environment allows some reduction of paper usage.
- Reduce the costs of higher education.
- The time to update content as well as their correction is very low.
- The perception of the learner is a livelier interaction and a rich of content.

A great part of the Web evolution towards Web 2.0 or “social web” has gone to the idea of sharing knowledge (e.g. Wikipedia), developing nets which share ideas, situations, images, knowledge, or any educational resources and knowledge on an open way. UNESCO has established some definitions about open knowledge and knowledge-based society (UNESCO, 2005) and has adopted in 2002 the concept “Open Educational Resources” (OER) to refer to materials and other learning subjects offered openly through the use of information technologies, for consulting, use and adjustment to a user’s community with no commercial purposes.

The OpenCourseWare (OCW) project started at the Massachusetts Institute of Technology (MIT), in the year 2001, with the aim of offering pedagogical materials in an open and free of charge basis to society. At present, the MIT provide about 1800 courses freely and universally accessible on the net (Lerman, 2006). The main objective of this proposal is to promote and develop higher education sharing, in a free and consistent way, the teaching resources with other educators’ students, graduates and anyone in general who wants to improve its knowledge. This philosophy is being spread to the world main universities creating the OCW Consortium (OCWC), in which more than 200 Universities and Institutions collaborate.

The initial conditions to include Higher Educational Institutions in this project regard three different types: educational, technical and legal matters. Regarding technical demands a globally and approachable site via Internet with the right quality must be maintained. Although it has not been a requirement, most of participants have used the technology of content management based on eduCommons (COSL, 2009), an Open Source project built on Pone, developed by “The Center for Open and Sustainable Learning” of Utah State University specifically for the creation of OCW projects.

3 BLENDED LEARNING

Blended learning (b-learning) has allowed a new way of convergence between distance, on-line and on-class education. The convergence is going through the mixed model education that has a different percentage of any kind of methodology depending on the student or learner approach.

In this case the new approach is learner-centered instead the previous model of teacher or content oriented. Learners depending on their availability on:

- Time,
- Technology and communication, and
- Human resources,

will adopt a mix-approach from pure traditional education that are including now elements of on-line and on-class tutoring and collaboration tools through classic distance education.

This evolution from the post mail and telephone education in the distance model (1975) to this b-learning model (1995) is the answer of the large Universities for Distance Education to the Internet and the beginning of the learning-centered change.

Then, blended learning is the process of incorporating many different learning styles that can be accomplished through the use of 'blended' virtual and physical resources.

A typical example of the delivery method of blended learning would be a combination of technology-based materials and face-to-face sessions used together to present content. An instructor can begin a course with a well-structured introductory lesson in the classroom, and then to proceed follow-up materials online. The term can also be applied to the integration of e-learning with a Learning Management System using computers in a physical classroom, along with face-to-face instruction.

At first b-learning as we have said is the combination of e-learning (electronic) or m-learning (mobile) with other educational resources. But besides this, the key of b-learning is human intervention in some form, such as a sense of monitoring or tutoring.

As e-learning, b-learning also has a number of obvious advantages over a traditional course. The costs are quite significant for both the institution and for the learner; ease of access for people who already have another degree in addition to their professional career; flexibility of schedules and of workload. Of course it does take a few disadvantages which may be: having limited access to a computer or Internet, a lack of knowledge of the use of technology. These disadvantages are also present in the institutions for traditional course, because in many cases a course is supplemented by a volunteer and own use of technology in order to gain a greater understanding. So then, one could say such disadvantages are in all kinds of learning today.

4 SOA: SERVICE ORIENTATION PARADIGM

Being IT-based, e-learning is naturally being affected by the current IT paradigm shift towards service orientation. The term Service-oriented architecture (SOA) has been coined to encapsulate this trend.

Information Systems (IS) are built to support business processes (in the case of e-learning systems, the learning process and all associated sub-processes). SOA proposes building these systems as an ad hoc collection of smaller modules called "services". These “services” can be shared by more than one IS, and the details of the implementation are hidden from the IS that use them (even though their “business behaviour”, and any change in it, must be explicitly declared). Furthermore, they can be provided by organizations different from the ones developing or utilizing the IS that uses the services.

Current SOA implementations are usually based on Web Services; they are generally built utilizing one of the existing Web service frameworks, based on implementation platforms such as .Net or J2E. According to the W3C Web Services Architecture Working Group (W3C, 2004), a Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-process able format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards.

SOA is, however, a much broader concept than Web Services, and as such it provides a general framework capable of accommodating the peculiarities and specificities of e-learning. On the other hand, that broadness has led to the term SOA being used with differing - sometimes, conflicting - understandings of implicit terminology and components. Therefore, OASIS (Organization for the Advancement of Structured Information Standards - a not-for-profit consortium founded in 1993) created the Service Oriented Architecture Reference Model Technical Committee. After producing several drafts, that OASIS SOA-RM TC published in 2006 the Official OASIS Standard “OASIS Reference Model for Service Oriented Architecture 1.0” (OASIS, 2006), followed in 2008 by an initial draft of the more specific “Reference Architecture for Service Oriented Architecture” (OASIS, 2008).

The aim of the Reference Model is to avoid the proliferation of conflicting definitions of SOA by defining the essence of service oriented architecture through an abstract model that can remain relevant, irrespective of the various and inevitable technology evolutions that will influence SOA deployment (Figure 1).

Service Oriented Architecture (SOA) is defined as a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains.

People and organizations create capabilities to solve or support a solution for the problems they face in the course of their business. However, one person’s needs might be met by capabilities offered by someone else (i.e., one computer agent’s requirements might be met by a computer agent belonging to a different owner). SOA provides a powerful framework for matching needs and capabilities and for combining capabilities to address those needs.

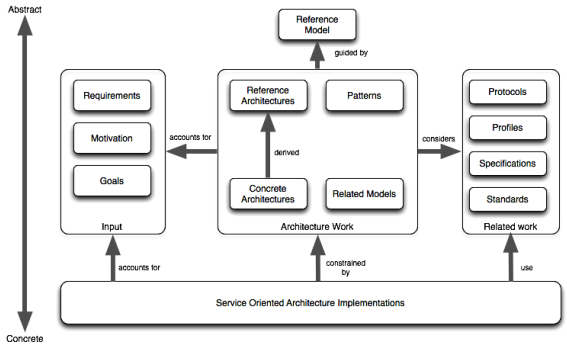

Figure 1: How a Reference Model relates to other work (OASIS, 2006).

Visibility, interaction, and effect are key concepts for describing the SOA paradigm. Visibility refers to the capacity for those with needs and those with capabilities to be able to see each other. This is typically done by providing widely accessible and understandable descriptions for such aspects as functions and technical requirements, related constraints and policies, and mechanisms for access or response. Interaction is the activity of using a capability and is typically mediated by the exchange of messages. The purpose of using a capability is to realize real world effects. An interaction is "an act" as opposed to "an object" and the result of an interaction is an effect.

Regarding the concept of "service", that term encompasses several related ideas:

- The performance of work (a function) by one for another
- The capability to perform work for another
- The specification of the work offered for another
- The offer to perform work for another

These concepts emphasize a distinction between a capability and the ability to bring that capability to bear. While both needs and capabilities exist independently of SOA, in SOA, services are the mechanism by which needs and capabilities are brought together.

SOA is a means of organizing solutions that promotes reuse, growth and interoperability. It is not itself a solution to domain problems but rather an organizing and delivery paradigm that enables one to get more value from use both of capabilities which are locally "owned" and those under the control of others. SOA does not provide any domain elements of a solution that do not exist without SOA.

Thus, under SOA, people and organizations offer capabilities and act as service providers. Those with needs who make use of services are referred to as service consumers. The service description allows prospective consumers to decide if the service is suitable for their current needs.

Although SOA is commonly implemented using Web services, services can be made visible, support interaction, and generate effects through other implementation strategies.

SOA shares many traits with Object Oriented Programming (OOP) paradigms (Anything can be a service in the same way anything can be an object). However, while as the focus of OOP is packaging data with operations, in SOA the central focus is the task or business function – getting something done. This leads to several distinctions:

- OO has intentional melding of methods to a given data object. The methods can be thought of as a property of the object. For SOA, one can think of the services as being the access to methods but the actual existence of methods and any connection to objects is incidental.
- To use an object, it must first be instantiated while one interacts with a service where it exists.
- An object exposes structure but there is no way to express semantics other than what can be captured as comments in the class definition. SOA emphasizes the need for clear semantics.

Rather than as a single, complex, monolithic system, SOA-based systems can be visualized as an ecosystem comprising people, machines and services. This leads to a number of ownership, management and governance issues, since there are strong limits on the control and authority of any one party when a system spans multiple ownership domains. Even when a SOA-based system is deployed internally within an organization, there are multiple internal stakeholders involved and there may not be a simple hierarchy of control and management.

5 SERVICES IN LEARNING

Learning Management Systems (LMSs), as eLearning platforms are generally known, provide a suite of tools which support the creation of, the maintenance of and the delivery of online courses, the enrolment and management of students, the administration of education and the reporting of student performance (Dagger et al, 2007).

They might be based on e-learning frameworks that provide specifications for LMS development,

which are increasingly SOA oriented (Alvarez et al, 2008). The IMS Abstract Framework (IMS, 2006) provides an abstract representation of the set of services that are used to construct an eLearning system in its broadest sense (Figures 2 and 3).

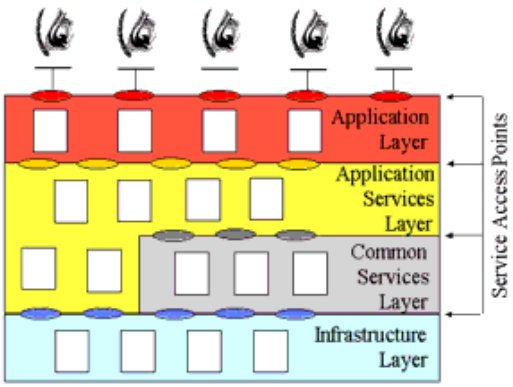

Figure 2: IMS Abstract Framework layered model (IMS, 2006).

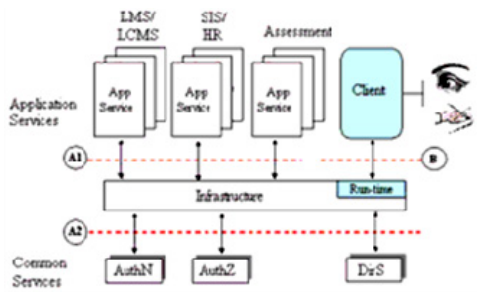

Figure 3: IMS Abstract Framework services (IMS, 2006).

The Open Knowledge Initiative (OKI, 2001) is an MIT project that sponsors a SOA-based set of Open Service Interface Definitions (OSIDs) (current version is V2, V3 is under development). OSIDs have been applied to integrate many educational applications with a variety of content publishers and have become a widely accepted strategy for repository integration.

The "e-Framework for Education and Research" (Olivier, 2007) is another international initiative (established by the UK's Joint Information Systems Committee (JISC), Australia's Department of Education, Employment and Workplace Relations, the New Zealand Ministry of Education and The Netherlands SURF Foundation), that advocates service-oriented approaches to facilitate technical interoperability of core infrastructure as well as effective use of available funding. Among their successful implementations they cite the City University, London (e-framework, 2008).

LMSs can be grouped into two main categories:

- Open source initiatives such as:
  - dotLRN (http://www.dotlearn.org/)
  - Moodle (http://www.moodle.org),
  - SAKAI (http://sakaiproject.org/),
  - ATutor (http://www.atutor.ca/) and
  - Whiteboard (http://whiteboard.sourceforge.net/)
- Proprietary solutions such as:
  - WebCT/Blackboard (http://www.blackboard.com/),
  - Gradepoint (http://www.gradepoint.net/),
  - Desire2Learn (http://www.desire2learn.com/)
  - Learn.com (http://learn.com/).

Open source LMSs are typically built upon extendable frameworks allowing implementers to adjust and modify the LMS to suit their specific needs. This approach, although traditionally not adopted by the proprietary sector, is emerging through such initiatives as WebCT's PowerLinks kit and Blackboard's Building Blocks. These provide software developers with "hooks" to tie third-party software into the LMS. Al-Ajlan and Zedan (Al-Ajlan, 2007) provide a detailed description of how using Web services in MOODLE would allow educators at different institutions to work together and share material by connecting individual courses together, which are hosted on different MOODLE's. Thus, they could teach the same course and share activities such as assignments or chats. Initiatives such as the The LearnServe Project (Learn Serve, 2005) at the Münster university make e-learning offerings available though Web services.

Dagger et al (Dagger, 2007) classify LMSs in successive generations (Figure 4) according to their degree of adoption of the SOA approach and the corresponding supporting standards and technologies.

Smart (Smart, 2008) summarizes the results or recent collective experience in the adoption of SOA approaches in Higher Education institutions presented at the recent IMS Global Learning Consortium Summit on Interoperability. She concludes that SOA has a great deal to offer to these institutions, but of all the challenges that remain, the cultural and governance issues seem to me to be the most difficult to tackle.

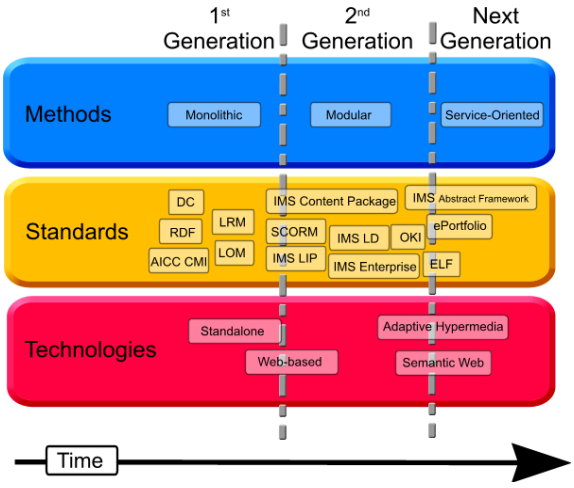

Figure 4: Generations of LMSs (Dagger et al, 2007).

This continuous evolution is providing us a complete word search mixing the learning with letters (Telefonica, 2007):

- B-learning, E-learning, M-learning.
- U-learning (ubiquitous)
- P-learning (pervasive)
- A-learning (ambience)
- C-learning (capacity)
- T-learning (digital TV)
- V-learning (video or visual)

According with this terminology, the concept of s-learning (services oriented to e-learning) is emerging at the same time that organizations create their own e-learning tools. As a consequence of that fact, s-learning promulgates a new methodology based on the creation of e-learning tools encapsulated in a service-shape. In this way, they will be easily integrated inside the different e-learning platforms.

One of the main reasons is to reuse the services that learning management system (LMS) already provide, such as identification and authentication modules; content managers, calendars and agendas; assessment modules; synchronous and asynchronous communication methods, etc. Thus, organizations only must focus on the creation of services to be integrated in a very rich environment of services, and not to reinvent the wheel in each development (Figure 5).

Following this methodology, UNED is developing several e-learning projects with the target of the creation of different services that will improve in some way the learning experience.

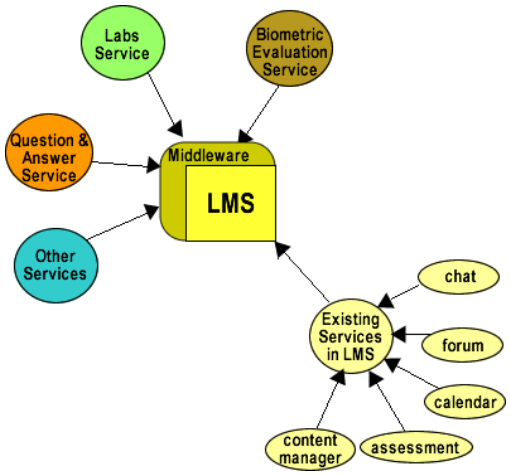

Figure 5: Example of integration of new services in a LMS.

A learning management system (LMS) is software for delivering, tracking and managing training. LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration.

Most LMSs are web-based to facilitate access to learning content and administration. LMSs are used by regulated industries for compliance training.

LMSs are based on a variety of development platforms, from Java EE based architectures to Microsoft .NET, and usually employ the use of a database back-end. While most systems are commercially developed and frequently have non-free software licenses or restrict access to their source code, free and open-source models do exist as we have already explained.

The virtual learning environment used by universities and colleges allow instructors to manage their courses and exchange information with students for a course that in most cases will last several weeks and will meet several times during those weeks. In the corporate setting a course may be much shorter, completed in single instructor-led or online session.

The characteristics shared by both types of LMSs include:

- Manage users, roles, courses, instructors, and facilities and generate reports
- Course calendar
- Student messaging and notifications
- Assessment/testing capable of handling student pre/post testing
- Display scores and transcripts

- Grading of coursework and roster processing, including wait listing
- Web-based or blended course delivery

From the LMSs it can talk about learning content management system (LCMS) which are systems that focus on the development, management and finally published content in an LMS.

An LCMS is a multi-user system where different users can develop, create, manage, reuse, store and send learning content from a central object repository.

Today LMS is used as a term to encompass the functionality of the LCMS but this is not entirely correct, since the LMS can not create or manipulate courses, even they can not reuse an existing course to create another. Instead LCMS applications allow one to create, import, manage, find and reuse units of learning content, which is known as learning objects (Kecheng, 2005).

The learning objects can include media files, assessment, simulations, text, graphics or any other object that may be part of the contents of a course.

An LCMS provides tools for authoring and re-using or re-purposing content (mutated learning objects) MLO as well as virtual spaces for student interaction (such as discussion forums and live chat rooms). Despite this distinction, the terms LMS is often used to refer to both an LMS and an LCMS, although the LCMS is a further development of the LMS.

In essence, an LMS is software for planning, delivering, and managing learning events within an organization, including online, virtual classroom, and instructor-led courses. The focus of an LMS is to manage students, keeping track of their progress and performance across all types of training activities. It performs administrative tasks, such as reporting to instructors but isn't used to create course content.

In contrast, an LCMS is software for managing learning content across an organization's various training development areas. It provides developers, authors, instructional designers, and subject matter experts the means to create and re-use e-learning content and reduce duplicated development efforts.

Rather than developing entire courses and adapting them to multiple audiences, an LCMS provides the ability for single course instances to be modified and republished for various audiences maintaining versions and history. The objects stored in the centralized repository can be made available to course developers and content experts throughout an organization for potential reuse and repurpose. This eliminates duplicate development efforts and allows for the rapid assembly of customized content.

6 REUSE OF SERVICES

As we have seen around the LMS it created an action of reuse internally and externally. Internally through the learning objects that can be changed, reused content of courses, manage them, and so on. What received the name of LCMS. In the same way as it reflected in the above figure (Figure 6) in addition to reuse content to generate more or less different courses between them, another thing different is add additional services to the learning management system to provide greater robustness of this system in place where it was implemented.

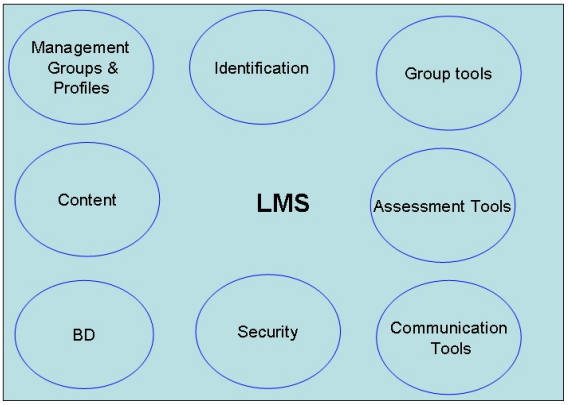

Figure 6: Diagram of Services in LMS.

The LMSs offer a range of services or packages that are almost common to all of them. These are broadly: identification, management groups and profiles; content (news, surveys, questionnaire, reviews, forum, calendar, tasks mailbox, etc.); database; group tools; assessment tools; communication tools; and security.

Within an LMS can generate different courses each with a different content, as it was said. Going up one level, this content could be used within a single institution or in the case of education in the same university. The possibility to extrapolate to other universities will depend on the LMS used. As seen, there are a lot of LMSs, a commercial and other free. All use standards but these are not common among them. So some courses made in a specific LMS would need to adjust to the new LMS where one tries to use them.

About services that a LMS offers there is the same level of reuse. At first a LMS is equipped with

basic packages, standards and databases that handle the content of the courses developed in the LMS. But it may be the case that for a specific situation would be necessary a new service that could be integrated in some way within the LMS. Also, let the new service to adapt to the growth of the institution and the changes of the environment. Thus the work done in the first instance would be valid for next situations.

Of course the level of reuse is also limited to the LMS in use for any new LMS should change the interface of communication or dialogue with the new service.

But if we conceive the idea of independent capsules of LMS and just depending on the environment. Simply create all possible generic services for a particular environment and reuse them in the same environments by changing the interfaces with the LMS.

Of course this idea suggests a poor design of the LMS in itself, which is not entirely true. For the vast majority of current situations an LMS can cover all points, personnel management, presentation of tasks of a subject, surveys, etc. An important point, whatever one wants to refine or strengthen an existing service which is the election of the administrator or developer of the LMS, is there are new virtual environments as a repercussion of the on-line learning that is using.

For example for virtual laboratories (Lang, 2006), it seems reasonable to introduce a system of reserve management to monitor the slot of time during which one can use a remote laboratory (Dominguez, 2005). These laboratories use real instrumentation which is limited, so then there must be a system of reserve them (Figure 7).

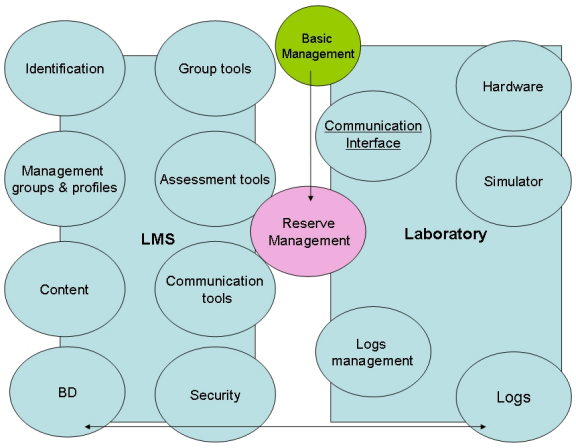

Figure 7: Example of services needed in vLabs.

7 REUSE OF LEARNING OBJECTS

E-learning is probably one of the means by which higher education can reach a greater number of people. It is the largest growth sector in training and development. Nowadays a process of standardization is taking place in learning resources. Learning object repositories are an effective way of sharing knowledge within and between academic institutions. However, simply making resources available on the network is not enough. An additional layer of services is necessary (Wilson, 2001).

A service is a software component supporting processing behaviour or access to information that is accessible to other services through a clearly defined interface (ERL, 2005). An infrastructure service might be user authentication, as well as a learning service might be an assessment capability used to measure student performance. Learning services – based on web services– enable integration of learning objects and other learning resources. Academic institutions offer an environment based on them. Course management systems, learning management systems, learning object repositories or the repositories of student information are some of its elements.

Users need to get access to educational portals based on their own personal profile. Students must identify themselves in this infrastructure to access their courses. Same way, instructors do it in order to publish their contents and communicate with their students or colleagues. Integration of all applications with a single sign-on for users obviates them to re-enter identifying information for each application. SSO systems and Identity federation and privacy data sharing are spreading slowly, such as Athens, Shibbolet or OpenID (Powell, 2007), (Tracking, 2009).

Until recent years, we did not have the means to share our works in different platforms. Learning objects are the best attempt to solve the interoperability, reuse, automated updating, and personalization issues (Hodgins, 2002). Search engines were not suitable to find digital resources. The fact is that many results use proprietary formats or the lack of information about them is usual pitfalls. Metadata can be used to obtain the additional information users need. They describe the nature and purpose of a learning object (i.e. authors, title, rights, etc.) so that it can be found, managed,

and reused. Instead of searching through lists of results, we explore collections of LOs about our topic of interest. This is possible with resources organized by pedagogical value. Dublin Core or IEEE LOM are learning standards on this subject. For interoperability across implementations, the latter is expressed on XML. Inside most communities, their characteristics are extended and adapted to the requirements of their own education system through application profiles (CanCORE, LOM-es, etc.), (Duval, 2003).

Courses must also be structured to allow them to be used in multiple environments, by multiple tools and systems. SCORM standardizes how Learning Management Systems (LMS) launch and track directed learning experiences promoting interoperability (Reload, 2008). A SCORM package (a zip file) contains a manifest file that declares its contents and is set up to describe the order in which the SCOs –a special kind of LOs– are to be delivered. SCORM can communicate learner information with any LMS using a standardized method based on Javascript. Metadata is stored in these packages following the LOM standard. In order to avoid unnecessary work load resulting from updating and publishing content, authoring tools for improving document creation and conversion have been developed.

Generally, we cannot find single LOs. They are stored in large collections with tools to view, edit and share their descriptions –and, of course, retrieve them. Learning object repositories can be accessed through Web services. Usually these repositories are programmed as web applications (web server, database and scripting language). This approach gives LOs a number of benefits, as expanded searching capabilities, accurate access or usage statistics (Sanchez, 2004).

Last but not least important is how to transfer content of metadata between multiple repositories. A federated search layer can be used as middle layer in the architecture without having to modify anything of the other previous tools. In a federated search system, queries from users are sent to different LOR's. The FS engine then merges the results received by these LOR's (Ternier, 2003). Protocols like OKI or OAI-PMH provide a method to reuse repository metadata from external applications. This allows individual institutions to build their own individual registries. The global network GLOBE allows sharing of index information of learning resources available from the five main individual services around the world (GLOBE, 2004). Users can search just one service to gain access to all of the content of all of the repositories.

8 CONCLUSIONS

The convergence towards the Common European Higher Education Area sets the framework within which the IT-based approaches analyzed in this paper must operate.

This massive, simultaneous redesign of all degrees presents daunting challenges but also offers unprecedented opportunities. On the one hand, since all degrees must be simultaneously redesigned, synergies among them can be effectively exploited, thus encouraging the re-utilization oriented approaches discussed in this paper (LCMS, standards like LOM, Dublin Corem QTI, IMS, SCORM, etc.). On the other hand, shifting the unit of academic measurement to student hours (through the ECTS) facilitates the seamless combination of face-to-face, distance and blended learning in academic degrees.

E-learning is naturally suited to distance learning and flexible learning, but can also be used in conjunction with face-to-face teaching, in which case the term Blended learning is commonly used. E-learning in itself does not change in the second generation, just taking the influence of current interest and try to use all the technology possible to apply it to education learning.

The nature of next generation e-learning platforms will be based on service-oriented visions. We have profiled the most prominent initiatives and actors on the scene of distance education. It is clearly a step forward in providing a framework that encourages the reuse and sharing of learning contents. However, now we must focus more on pedagogical and didactical issues of eLearning as well as knowledge management.

A framework built on the aforementioned protocols and metadata is capable of enabling a first level of interoperability between institutional repositories and to improve the discoverability of resources. Nevertheless, it is not enough for developing more intelligent, reliable and precise services or connecting institutional repository resources with other resources involved in the research process. If the future versions of SCORM and LOM want to have success, their specifications shall become equally easy to understand for developers and instructors. There are legal questions in the field of digital content creation. Ensure interoperability by standardizing the tools and data

management across LMSs is also a matter of utmost importance. It is here that we get an insight into the advancements of education.

ACKNOWLEDGEMENTS

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Electrical and Computer Engineering educator in the Spanish University for Distance Education (UNED), has an industrial engineering degree from the ETSII (Industrial Engineering School) of the Madrid Polytechnic University (UPM) and a doctoral engineering degree from the same University. Has received the Extraordinary Doctoral Award in the UPM and the Viesgo 1988 Award to the Doctoral Thesis improving the Scientific Research about the Industrial Process Electricity Application. Has received the 1997 and 1999 years UNED's Social Council for the Best Didactic Materials in Experimental Sciences and the 2001 Award for the Innovative Excellence in Teaching, Learning & Technology from the Center for the Advancement of Teaching and Learning. He works as researcher, coordinator and director in different projects, ranging from solar system and advanced microprocessor system simulation to telematics and distance learning systems, acting now as and senior technical director. He is now with the UNED (Spanish University for Distance Education) as Professor in the Electronics Technology subject inside the Electrical and Computer Engineering Department as well as he is Director of the Department. He was serving as UNED's Vice-Rector of New Technologies, ETSII's Research and Doctorate Vicedirector and Academic Affaires Vicedirector and UNED's Information Services Center Director. He worked during 5 years in Digital Equipment Corporation as senior system engineer. He publishes technical books and articles for journals and conferences as well as multimedia materials and radio and TV programas. He belongs to the organizing committee of IEEE FIE, ISES, TAEE and SAAEI conferences as well as reviewer and chairman. He is Fellow member of IEEE as well as member of the Administration Committee (AdCOM) of the IEEE Education Society and Founder and Past-Chairman of the Spanish Chapter of the IEEE Education Society.

LEARNING ISSUES IN OPEN-ENDED GROUP PROJECTS

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Abstract: Learning environments based on open-ended group projects (OEGPs) have the potential to meet complex learning goals such as professional and personal development, as well as more traditional subject related goals. OEGPs offer a setting in which a holistic approach to what the students should learn. There are however several pitfalls to pay attention to. Theories related to learning in OEGPs and practical examples will be presented in an attempt to promote an enlightened use of OEGPs in our education through raising awareness of the pros and cons of the method.

BRIEF BIOGRAPHY

Mats Daniels, Senior lecturer, Department of Information Technology, Uppsala University, Sweden. I have taught courses since 1980 at Uppsala University, except during 1989-90 when being a guest lecturer at La Trobe University, Melbourne, Australia. I have since 1991 been director of undergraduate education at the department and as such been intimately involved in the development of the education at the department.
My dedication to education, is manifested in working towards establishing Computing Education Research as a subject and driving several development and research projects, e.g. the Runestone project where students from Sweden and USA collaborate. My main body of publications is in educational conferences such as IEEE Frontiers in Education, ACM Australasian Computing Conference (ACE), and ACM Innovation and Technology in Computer Science Education (ITiCSE). I'm also director of the national center for pedagogical development in technology education in a societal and student oriented context (CeTUSS, www.cetuss.se that was founded 2004. I have been conference chair and program chair as well as functioning in other roles for the ACM ITiCSE conference, and am currently future ITiCSE Site coordinator. I was one of the founding members, and is since 2005 acting as chair, of the IEEE Nordic Education Society Chapter, which won the first IEEE Education chapter achievement award 2006.
My ambition when it comes to education is to find new formats and especially such where the students will experience a holistic learning environment, e.g. in Open Ended Group Projects. Vital in this work is to base it on a sound pedagogical foundation as well as the subject as such in a manner that is well anchored among the teaching practitioners.

QUALITY POLICIES CONFORMED WITH ABET IN A SPANISH ENGINEERING SCHOOL

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Keywords: Accreditation, Quality policies, Engineering Higher Education.

Abstract: The European Higher Education Area is an example of diversity of political systems, higher education systems, socio-cultural and educational traditions, languages, aspirations and expectations. In the light of this diversity and variety, technical universities set its face to develop their internal quality assurance systems according to the European standards and the guidelines, focusing more on what should be done than how they should be achieved, but also to different factors and sources. This presentation explains the definition of quality policies in a Spanish Engineering school, including engineering accreditation, programs, funding programs or improvement plans.

1 QUALITY IN THE EUROPEAN HIGHER EDUCATION

The issue of quality assurance has risen very high on the Bologna agenda and is seen now as one of the key instruments to promote the attractiveness of European higher education. It was made clear that when defining common criteria and methodologies in the European Higher Education is necessary to take into account the diversity of the various systems and traditions that will go into the construction of a comparable framework.

Harmonization should be the result of the conjunction of these traditions and should, under no circumstances, mean their reduction to a common pattern. For the implementation of an effective culture of quality, it is essential that governments, Higher Education Institutions (HEI), quality agencies, teachers and students all participate, in view of the expectation that this process will benefit not only all agents involved but also society at large. The Berlin Communiqué - while recognizing the role of HEIs in promoting quality invites the Quality Assurance (QA) and Higher Education communities to develop an agreed set of standards, procedures and guidelines on quality assurance (Roselló, 2004).

Institutions and agencies are achieved on a basis of greater transparency in accreditation processes.

To that end it is essential to promote a peer review process among agencies. But this proposal had a risk. The Institutional Evaluation Programme has given Europe a solid experience in transnational evaluation, evaluating close to 120 universities in 35 different countries. This ten-year experience, combined with the outcomes of the Quality Culture project, points to the fact that it is impossible to reach an agreement on quality standards when dealing with a diversity of institutions across a whole continent. On the other side, evaluation approaches -based on standards, quantitative methods, sets of criteria or checklists will not improve quality meaningfully and may not even control it significantly because they will not capture the complexity of the educational enterprise.

So, the Graz Declaration claims that "the universities are responsible for developing internal quality culture" and the Berlin Communiqué says that "the primary responsibility for quality assurance in higher education lies with the institution itself and this provides the basis for the real accountability of the academic system within the national quality network." As discussed at the Graz Convention (May 2003), among the policy goals for an appropriate European QA dimension are to achieve greater compatibility while managing diversity of QA procedures, to achieve trust and to preserve and extend institutional autonomy while meeting the demands for accountability. Autonomy is a precondition for a capacity to respond to change. Thus, university autonomy requires that each

institution decides on its standards in the context of its mission and goals (Wilson, 2004).

Increasing autonomy of HEI is the primary responsibility for quality. It is essential that the development of a European QA dimension accompanies and extends institutional autonomy in order to ensure that QA is not merely window-dressing and a compliance exercise. Quality assurance systems need to be flexible and embrace this diversity in order to ensure that higher education serves effectively society (Erichsen, 2004).

2 QUALITY POLICY IN A HIGHER EDUCATION INSTITUTION

The statement of Quality Policy in HEI documents the authority for the implementation of a quality management system in the form signed by the dean or director in charge of the institution implementing the quality management system. It must express the intentions of the institution concerning the quality of the academic offer and the rest of services and products it supplies. It is a way to guarantee the coherence of the processes, products and services covered by the quality management system.

According to ISO (ISO, 2005) with respect to the capabilities enclosed in the quality policy for which the organization is seeking certification, top management should ensure that:

- It is appropriate to the purpose of the organization
- It includes a commitment to comply with requirements and improvement the effectiveness of the quality management system
- It is understood and communicated a within the organization and
- It is reviewed for continuing suitability
- It provides a framework for establishing and reviewing quality objectives

Quality Management System, authorized and conformance by the existence of a Quality system, defines the policies, procedures, methods and standards for the management of the HEI. The policies for developing, implementing and maintaining the quality management system, first element of this Quality System, must be designed to ensure that stakeholders' requirements are met.

This paper proposes to identify these policies in European Engineering Higher Education, and its application in a Spanish Engineering School.

The statement of quality policy in HEI documents the authority for the implementation of a quality management system in the form signed by the dean or director in charge of the institution implementing the quality management system. It must express the intentions of the institution concerning the quality of the academic offer and the rest of services and products it supplies. It is a way to guarantee the coherence of the processes, products and services covered by the quality management system.

Which are the stakeholders that provide sources for the desired quality deployment of the institution?

3 A PROCESS TO DEFINE EUROPEAN ENGINEERING HIGHER EDUCATION'S QUALITY POLICY

Herein it is proposed a three-phase process to identify the Quality Policy (Tovar, 2009). These are the following:

- Phase I. Which are the stakeholders that provide sources for the desired quality deployment of the institution? In the case of European Engineering HEI and according to our experience, we have selected the following stakeholders, as providers of policies: Strategic plans of the institution, Guidelines from National Quality Agencies, and funding programs for the institutions.
- Phase II. Elicitation of policies from the sources identified
- Phase III. Specification of a consistent Quality Policy. A Quality Policy is specified trying to gather all the policies extracted from the different sources or stakeholders. This is a sub process to be defined by each HEI that will require the prioritization of each set of policies and an effort of synthesis to express in an only statement maybe several redundant policies.

4 SOURCES FOR QUALITY POLICY

Strategic Plans. Leadership systems (Miller, 2007) are the systems within an organization that provide-

direction and support. The leadership system directs an institution trough mission, vision, guiding principles, strategic goals and organizational structure.

Many European universities combine these elements of leadership system and Strategic Planning from a perspective of continuous improvement. This process scarcely differs from those elaborated in the corporate setting in terms of who needs to be involved and in the relative emphasis on financial issues. The strategic planning process is usually generated from a self-assessment process or a more detailed evaluation using the corresponding national or European standards for quality in education. A tool that is widely used to stimulate the reflection in preparation for the strategic plan is SWOT (standing for strengths, weaknesses, threats and then on opportunities). It provides useful information building a common perspective about the current state of the institution to consider the future. Finally, once the politics and strategies goals have been defined, the organization moves in the desired direction thanks to the actions plans defined.

Guidelines of European Networks of Quality Agencies. HIE themselves have sought external benchmarks to sanction and justify their conclusions (Marcellán, 2005). Those responsible for higher education policy in Europe have pressed determinedly for the establishment of entities and organizations that will facilitate assessment initiatives for their improvement. In a further step forward, the establishment of networks of assessing entities was sponsored by the European Commission in exercise of its competences in respect of promoting the European dimension and incorporating added value to Member States' initiatives. The supreme such entity is the ENQA (ENQA's General Assembly confirmed on 4 November 2004 the change of the former European Network into the European Association) which was recognized by the conference of ministers at Berlin in September 2003 as the preferred interlocutor in matters of quality assurance in the European Convergence process. The Ministers of the Bologna Process signatory states invited ENQA through its members, to develop an agreed set of standards, procedures and guidelines on quality assurance and to explore ways of ensuring an adequate peer review system for quality assurance and/or accreditation agencies or bodies. The standards and guidelines were designed to be applicable to all HEI and quality assurance agencies in Europe, irrespective of their structure, function and size, and the national system in which they are located. It will be for the institutions and agencies themselves, cooperating within their individual contexts, to decide the procedural consequences of adopting the standards contained in this report (ENQA, 2004). (Table 1)

Table 1: European standards and guidelines for internal quality assurance within higher education institutions.

1.1	Policy and procedures for quality assurance: Institutions should have a policy and associated procedures for the assurance of the quality and standards of their programmes and awards
1.2	Approval, monitoring and periodic review of programmes and awards: Institutions should have formal mechanisms for the approval, periodic review and monitoring of their programmes and awards
1.3	Assessment of students: Students should be assessed using published criteria, regulations and procedures which are consistently applied
1.4	Quality assurance of teaching staff: Institutions should have ways of satisfying themselves that staff involved with the teaching of students are qualified and competent to do so
1.5	Learning resources and student support: Institutions should ensure that the resources available for the support of student learning are adequate and appropriate for each programme offered
1.6	Information systems: Institutions should ensure that they collect, analyse and use relevant information for the effective management of their programmes of study and other activities
1.7	Public information: Institutions should regularly publish up to date, impartial and objective information, both quantitative and qualitative, about the programmes and awards they are offering

Further, these guidelines reflect the statement of Ministers in the Berlin communiqué that 'consistent with the principle of institutional autonomy, the primary responsibility for quality assurance in higher education lies with each institution itself and this provides the basis for real accountability of the academic system within the national quality framework'. In these standards and guidelines, therefore, an appropriate balance has been sought between the creation and development of internal quality cultures, and the role which external quality assurance procedures may play (Puirséil, 2004). In this way, the purpose of these standards and

guidelines is to provide a source of assistance and guidance to HEIs in developing their own culture of quality assurance, and to contribute to a common frame of reference for the provision of higher education and the assurance of quality in the EHEA.

The Thematic Network in Engineering Education has worked developing a tool fully compatible with ENQA requirements and, in general the European trends toward internal Quality Assurance of Programmes (M. Gola, 2007). The tool developed is named: "Tool for Quality Assurance And Assessment of Engineering Education". The Q.A. FRAMEWORK is designed to be maintained on an ongoing basis rather than as a periodic reporting structure. For this reason it is recommended that the ongoing maintenance could be controlled and delivered by internal Faculty;

Taking into account basic Quality Assurance requirements and European guidelines, the Framework has been wrapped around Learning Outcomes and/or Academic Competences, which are now the most interesting development under way at the international level. During design of the Q.A. FRAMEWORK, this line of thought has been deployed into the following set of hierarchical core requisites.

- The Programme must be clearly designed around external Requisites and related Competencies which are in agreement with the needs of the employers and the labour market; such relations should be present already at the design phase, and not only (as it often happens) at the moment of the Stage or of the final project:
- The Programme must be clearly deployed with up-to-date Learning Outcomes, which are in agreement (content, amount, level) with the target competencies.
- The Programme must expose the students to an appropriate learning environment, with appropriate and up-to-date equipment.
- The Programme appropriately certifies that Learning Outcomes have been reached, the exams have a certifying value

The Q.A. FRAMEWORK captures the critical information which is required by stakeholders such as employers, the labour market, students, educational policy makers, educational establishments. It collects all the details which are strictly necessary.

In the absence of any current prescribed model, this Framework can be adopted as a Programme design tool as a checklist for its evaluation and as a guideline for the implementation of internal Quality Assurance.

Meeting all three of these needs calls for an approach based on permanent monitoring: the degree program must be asked to produce and maintain the Q.A. FRAMEWORK that contains all the qualitative and quantitative parameters needed to arrive at an informed judgment about the degree program's aims, methods and the learning environment provided to the student.

While this Q.A. FRAMEWORK is necessarily a public document, it can be flanked by a periodic "Selfevaluation Report" prepared exclusively for parties inside and outside the institution who are involved in any form of evaluation and accreditation. This "Report" would describe quality factors and the actions involved in control, highlighting the degree program's strengths and weaknesses, corrective measures, review activities and follow-up, and their effects over time.

The Q.A. FRAMEWORK is thus the foundation for all future evaluation/accreditation processes. It must satisfy minimum requirements for content and form so that degree programs of the same or similar type offered by different institutions can be readily compared. (figure 1)

Funds. Concerns about money and accountability in public services do exist in several European countries. These concerns have led to the rise of previous evaluative activities and a posteriori evaluation which seeks to discover how far goals have been met. The HEI in many countries in this context have moved towards expenditure-driven as opposed to demand-related budgeting. This shift has promoted performance related funding and encouraged Performance Indicators or Quality Indicators which permit finer targeting of resources (Cave 1994). Despite the existence of this fact, systems of HEI vary in many ways including the degree of autonomy in institutions and individual academics. Furthermore within any country different policies might be pursued for different sectors of Higher Education.

5 THE CASE OF A SPANISH ENGINEERING SCHOOL

We show the application of the previous process to obtain the Quality Policy of an Engineering School of the Universidad Politécnica de Madrid in the context of the development of its Quality Assurance

Figure 1: The Quality Assurance Framework Matrix (M. Gola, 2007).

System. In ahead, we comment the results each phase of the process.

The definition of the quality policy in the Computer Engineering School of the Universidad Politécnica de Madrid has required the selection of the following stakeholders of the general providers of policies: Strategic plans of the institution, Guidelines from National Quality Agencies, and funding programs for the institutions.

Figure 2 shows these results.

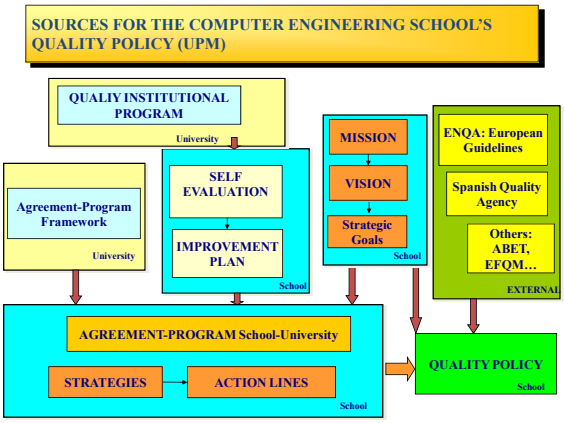

Figure 2: Quality Policy sources for a Spanish engineering school in a public university.

Strategic Plans. Strategic plans must distinguish those ones referred to the school and the university to which belongs. Although the Universidad Politécnica de Madrid (UPM) has currently an Institutional Quality Program (PIC), it has no strategic plan yet.

The UPM, (www.upm.es), approved in the year 2005 a quality program named "Programa Institucional de Calidad" (PIC, Institutional Quality Program) (UPM, 2005), with the following key objective: to measure the quality and to foster and to assist the initiatives of continuous improvement in the different Schools, departments and units of the institution.

The Mission and Vision Statements of the Computer Engineering School were approved last October (www.fi.upm.es). These are the basis too for the quality policy. As it says concerning to the accreditation: "… the academic offer shall be conformed to the European guidelines accreditation and others internationally recognized in the engineering sector…"

By this reason to establish a comprehensive quality policy and strategy, the criteria for quality certification and accreditation of different organizations in the USA and Europe have been taken into consideration, particularly ABET, Accreditation Board for Engineering and Technology (ABET, 2007), and Baldrige (Baldrige, 2007) in the USA, and EFQM (European Foundation for Quality Management, 2007) in Europe. Table 2 shows criteria for ABET Accreditation:

Table 2: ABET accreditation criteria.

1	Students: Admissions & Graduation Requirements, Evaluating Student Performance, Transfer Credit, Advising & Career Guidance
2	Program Educational Objectives: Consistency with Mission, Constituency Involvement, Achievement of Objectives

Table 2: ABET accreditation criteria (cont.).

3	Program Outcomes: List the outcomes that have been established for the program, Describe how the program outcomes encompass and relate to the outcome requirements of Criterion 3. State how each of the outcomes lead to the achievement of the Criterion 2 objectives. Describe the process used to achieve each of the program outcomes.
4	Continuous improvement
5	Curriculum: Evidence that the minimum credit hours and distribution are met. Information on capstone or other integrated Experiences
6	Faculty competencies and size
7	Facilities: Describe program classrooms, laboratory, facilities & equipment, computing equipment, and information infrastructure. Budget and Financial Resources.
8	Support: Program Industrial Advisory Committee
9	Program Criteria: Describe how the program satisfies any applicable

The preliminary conclusion is that, in general terms, the policy and strategy elements defined in the above mentioned criteria are quite similar to those covered by other sources: ENQA and ANECA guidelines, and the Institutional Quality Program, PIC, of the UPM. On the other hand, the certification criteria usually provide with more detailed quality requirements, since they focus on "how the organization does" kind of questions to evaluate the performance of the organizations. For this reason, the certification or award criteria are very useful as a guidance to identify the key processes in the organizations.

Guidelines of Quality Agencies. In Spain, the Agency ANECA (Agencia Nacional de Evaluación de Calidad y Acreditación: Nacional Agency for Quality Evaluation and Accreditation), member of ENQA, has adapted the ENQA guidelines to the Spanish context and has published a document (ANECA, 2007) with a set of guidelines for the systems of internal quality guarantee within HEI.

These ones should become in part of the quality policy of any institution conformed to these guidelines.

Funds. The PIC protocol establishes the need of a Program Agreement to be subscribed by the Chancellor and the directors of every HE institution. The aim of this program is to align the objectives of the Schools that form the University to a unique UPM policy and strategy, and to provide - the stakeholders with reliable information on the fulfilment of the agreed objectives.

With the above scope, the University has defined a "Framework of Program Agreement" (UPM, 2005) that will assure a common focus of improvement objectives, goals and indicators, with the flexibility required to adapt every Program Agreement to the particular improvement needs of the different Schools. The results of the Program Agreements will allow - the Schools to get an additional funding over the fix budget.

The structure of the Framework of Program Agreement is based on these three action lines:

- Line 1: Budgetary distribution of the operating and overhead expenses
- Line 2: Assistance to the implementation of improvements plans
- Line 3: Continuous improvement processes at the Schools

In table 3 are represented some of the most significant objectives of - line 2, assistance to the implementation of improvements plans, since they will be used, along with the line 3 objectives, in order to compare the strategic objectives of the different sources taken into consideration in this paper.

Table 3: Line 2 Program Agreement Framework objectives by areas.

Area	Objectives
Educational programs Planning	• Increment the number of new students • Educational profile taken into account the social and stakeholders needs • Curriculum and educational programs review • Implementation of mechanisms to track and – steer the development of the plan
Teaching, learning and Evaluation processes	• Improve and update the contents of the courses • Update and improve of the teaching-learning methods
Support to and communication with the students	• Facilitate the integration of new students • Design and implement tutorial plans • Funding assistance • Students placement and scholarships

Table 3: Line 2 Program Agreement Framework objectives by areas (cont.).

Resources and infrastructure	• Planning, evaluation and review of the library resources • Update the classrooms and labs to the current and future needs • Update and improve the ICT resources to the current and future needs
External relations	• Foster the external presence • Strength the relationships with alumni • Post graduate courses • Programs for knowledge and technology transfer
School Structure and Organization	• Faculty and Staff needs focus • Improve the Human Resources policies and management
Faculty and Staff training and support	• Promote and support the professional development • Encourage the participation in educational, research and innovation activities • Acknowledgement of the excellence in educational and research activities
Information management	• Put in place systems to capture, analyze and disseminate the information

Finally, we broach the specification of well-written policies, conformed to properties as precision, non ambiguity, relevance or non redundant. Because we start from statements elicited from several sources we had to make several actions to assure not only the previous properties mentioned but also other ones as consequence of the gathering process: coherence, integrity and coverage of the policies selected

These were the actions taken:

- Matching of the terminology used in each source, in order to assure.
- Distinguishing the priority of the different sources. In Spanish context Audit's policies are mandatory and they must be embedded in the final policy declaration. ANECA will verify the Internal Quality Assurance System of the School according to their guidelines.
- Defining quality policies with partial contributions of policies from all the sources matched by common areas. An example of how a policy is defined through the contribution of several policies from different sources can be seen in table 4.
- Validating the coverage of the quality policies defined with respect to all the strategic goals expressed in the sources considered.

Table 4: Example of elaboration of a Policy from multiple sources.

Example of final policy	Source's Policy	Source
The school shall control the existence, efficiency and effectiveness of mechanisms to assure the access, management, and training of its academic staff according to the functions assigned as well as the acknowledgement of its merits.	1.3 The University must implement mechanisms that assure the access, management and training of Faculty and Staff should be done with the necessary guarantees to fulfill their duties.	AUDIT
	3.10 Improvement of the scientifist acknowledge of academic staff in its knowledge area incrementing the number of publications	UPM Program Agreement
	L4. Promotion of the academic staff in teaching quality projects in the UPM	PIC
	L3. Linking training plans to the needs of services delivering	PIC
…	…	…

6 CONCLUSIONS

The issue of QA has risen as one of the key instruments to promote the attractiveness of European higher education Area. The Berlin Communiqué recognized the role of HEIs in promoting quality to develop an agreed set of standards, procedures and guidelines on quality assurance. HEI's autonomy is, by this reason, a precondition for a capacity to respond to the change. Thus, university autonomy requires that each institution decides on its standards and in the definition of the quality policies in the context of several sources. This paper has presented the process followed by the Computer Engineering School of the Universidad Politécnica de Madrid to elaborate the Quality Policy of the School, according to the

different elements, strategic elements, national quality agency and funds program of the HEI, concerned to this school This practical case is an example of how an European Engineering school develops its autonomy.

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INFORMATION TECHNOLOGIES AND EDUCATIONAL EMPOWERMENT
A Humanistic Perspective

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Keywords: Computer, Globalization, Humanity, Internet learning, Technology.

Abstract: In many industrialized societies, life has changed drastically due to the permeation of information technology (IT) in many aspects of society such as business, government, commerce, education as well as daily activities. How computer is viewed and valued in education depends greatly on the theoretical perspectives of the beholders. reveal different views and attitudes of the users. From a humanistic perspective, technology is a product of scientific knowledge in a human world which is culturally diversified. Our worldview, self-concept and identity belong to the human world. Technology should be used to change the way we think of ourselves in relation to other human beings and the land on which we live. It raises the issues of environmental awareness, international understanding, and human co-existent as world citizens. Technology permeates many aspects of society that it affects the quality of life both positively and negatively. The quality of life is not just about goods and services, but fundamentally it is about mindfulness. One of the big challenges in computer supported education is the response to the question: How should computer technology be used to enhance learners in terms of intellectual, social and emotional development? This challenge shifts our attention from the emphasis on a narrow context of academic learning to a humanistic learning discourse.

1 INTRODUCTION

First of all, I would like to express my great appreciation to the Conference Convener for inviting me to speak at this conference as a keynote speaker. I feel very privileged to have the opportunity to participate in this unique international educational conference which has attracted many delegates from various academic disciplines and international backgrounds. The two concepts, *technology* and *humanity*, are significant and powerful enough to capture the current context of education not only in a changing but also a challenging world. We are no longer confined to an isolated island metaphorically. An event in one part of the world could have a great impact on other regions of the earth. To some extent, technology has turned the world into a global village. However there are also challenges which require leadership to maintain harmony between technology and humanity. This conference gives me an opportunity to share my views on this important challenge.

2 THE MAGIC POWER OF COMPUTER TECHNOLOGY

In many industrialized societies, life has changed drastically due to the permeation of technology in many aspects of society such as business, government, commerce, education as well as daily activities. Whether we like it or not, we are at the mercy of computer technology. What would happen if computers and the Internet suddenly disappear? The potential Y2K computer disaster did not eventuate but the massive preparation for it confirms the view that we are still very much at the mercy of computer as computer technology permeates many aspects of society locally and globally. Occasional incidents of the Internet breakdown or temporary disconnection can easily hinder interaction, communication and services at work. We develop computer technology but we are so dependent on it that we can become its prisoners. As we have been deliberately or unintentionally acculturated into a computer-based society, we are still marveled at the

magical power that computer technology has offered us. What we knew about computer technology two decades ago now becomes things of the past and there will be many magical wonders ahead in the next two decades. History is measured in terms of time and events, but for digital technology, history is short but full of magical events and inventions.

In education, firstly the proliferation of software items and computer-based projects showing their positive impacts on teaching and learning is like constant tidal waves. The numerous papers on various aspects of computer-supported learning and teaching strongly reinforce this optimistic view. An internet search will prove this unstoppable phenomenon! A quick glance at several proceedings of the conferences on computers in education in 2007-2008 period shows thousands of research papers on how to use computer technology effectively and creatively in teaching and learning. It would be a daunting task for a researcher to conduct a comprehensive literature review of all the publications on computers in education in recent years.

Secondly, computer technology is rapidly growing at such a fast speed that what we consider as 'current development' will soon become outdated, metaphorically like images of yesterday. Computer educational software depends heavily on hardware. A new development in hardware can trigger changes in software development and implementation and vice versa. This interactive wheel gets bigger and stronger. The real challenge for educators is to examine how computer software and hardware are used to enhance learners' development intellectually, emotionally and socially.

3 COMPUTER TECHNOLOGY: A CRITICAL DISCOURSE CONSIDERATION

> Modern technology is no more neutral than medieval cathedrals or The Great Wall of China; it embodies the values of a particular industrial civilization and especially of its elites, which rest their claims to hegemony on technical mastery. We must articulate and judge these values in a cultural critique of technology. By so doing, we can begin to grasp the outlines of another possible industrial civilization based on other values (Feenberg 1991, p.3).

Computer, like many other products of different technologies, is an instrumental entity which is subjected to good use or abuse by social agents. It is a product and an instrument which cannot be divorced from its historical background and functioning. It can be exploited by some social institutions to serve their growing needs and to reinforce their power control on others. IT, particularly the Internet, does not exist in a harmonious global village. There are different social groups, locally and internationally, politically and religiously, in competing discourses and they can exert power on the use of IT to their advantages. According to Rolf (2008), the Internet is also a subject of discourse in its own right. Just as controlling the mass media of newspapers, television and radio gives the controllers the power to influence the masses, the control of the Internet also has this powerful influences. However, the distributed nature and scale of the Internet make such control very difficult as communication is no longer unidirectional. The Internet is a medium where those privileged to have a connection can 'speak their minds' on a global stage and therefore be viewed as a threat by, and to, those who fear the freedoms of speech and expression. It is important to understand how some would manipulate the meaning and position of the Internet within their society and, also, how discourse across the Internet can be influenced by those same groups. The recent events on control battles of the Internet between the government, Internet providers and users in a number of countries show that the Internet cannot be immune from discoursal influences. Its impacts are manipulated by different interest groups and those with great social power tend to exert stronger influences on the discourses across which the Internet travels.

Learning is not just about obtaining information and absorbing knowledge. Learning is fundamentally making sense of information and knowledge, to free the mind from hegemonic imposition of knowledge, and most importantly to empty our prejudices and presuppositions. At the International Conference on Education and Globalisation: Technology Innovation and New Learning Environment in 2008, Dr. Ayudhya, a prominent Thai scientist, gave a keynote speech, not on technology innovation, but surprisingly and admiringly on education and inner peace. His message was embedded in the following retold story about human vulnerability.

> A wife and her husband were having breakfast at their home. She looked at the clothes line in the garden of their neighbor and commented:

"Look at the clothes hanging there. They are so dirty! The woman in that house does not know how to wash her clothes cleanly. How dirty they are! She needs a washing machine."

Her husband kept quiet. The following morning, at breakfast the wife looked through the window and said the same thing:

"Again, her washing is still very dirty. She did not know how to wash clothes properly. She needs a modern washing machine, absolutely."

The husband did not say a thing. He kept eating peacefully. On the third morning, while eating breakfast, the wife could not believe her eyes. She said:

"What! I could not believe it! That woman knows how to wash her clothes.

They all are very clean now! ".

The husband calmly told his wife:

"Actually, I could not bear your unkind criticism of the neighbour any more. This morning I woke up early and cleaned our dirty window, and now you can see through clearly!"

This inspiring story gives us some thoughts on the nature of our technological discourse. One of the biggest challenges to IT managers, educators and IT users is not about the technological knowledge that IT has brought to society. The real challenges are about how to deal with controlling forces with their influence on the Internet, how to use it wisely to enhance the global village in which there are still so much social injustice, hegemonic globalization of technology, and lack of resource sharing.

4 TECHNOLOGY AND LEARNING ENVIRONMENTS

In the context of education, as Le and Le (2007) point out, instead of using traditional features for evaluating software such as screen design, navigation, text type, cost and user-friendliness, it is useful to employ the concept 'metaphor' as a basis on which we examine the role of computer in teaching and learning. How computer is viewed and valued in education depends greatly on the theoretical perspectives of the beholders. Educational software used by constructivists who strongly believe in meaning making is expected to be different from that used by those whose pedagogical principles are teacher-centred. We can use different computer metaphors to reveal different views and attitudes of educational software users and evaluators (Lê & Lê 2007).

- *Software as a Tool*. There are many types of software and they are produced and used for a purpose. In education, the most versatile function of software is instrumental. It is used for performing a certain function such as calculating, drawing, editing, proofreading, communicating, etc.
- *Software as an Instructor*. When software is used as an instructor, its primary role is to teach learners to develop knowledge and skills. Within the behaviorist paradigm, it is hierarchically structured in terms of content and skill complexity. Each lesson focuses on a specific content or skill and all the lessons are arranged from introductory to advanced levels. Instruction is sequential in the sense that learners are expected to move sequentially from the early lessons to the final ones.
- *Software as a Facilitator of Learning*. While the instructionist model of educational software focuses on the significance of instruction in teaching and learning, the constructivist model of educational software plays less attention to instruction and more on the active role of learners in the learning process. Learning is viewed as a meaning making process as learners bring their knowledge, experiences and worldview to learning.
- *Software as a Virtual Class*. Generally education software includes small items of software such as programs teaching phonics, multiplication, and typing. They are designed to teach a specific skill. There are also educational software packages which are designed for a targeted group of learners such as a web-based academic course and a multimedia-based training program. In this environment, courseware plays an essential role in providing the syllabus, teaching and learning experiences and communicative interaction.

In a dynamic educational environment, whether it is virtual, face-to-face or mixed modes, different teaching and learning strategies and experiences should be used. They include collaborative learning, task-based learning, individualized learning, and experiential learning. They are not mutually exclusive as far as they are user-friendly and learner-friendly.

5 THE RELATIONSHIP BETWEEN LEARNING AND COMPUTER TECHNOLOGY

In language and literacy education, the relationship between learning and language is perceived in terms of three dimensions: learning language, learning about language and learning through language. This three-dimension relationship can be used effectively to describe the link between learning and computer technology, particularly for school children.

5.1 Learning Technology

A child is as an untrained IT 'expert'. In applied linguistics, the concept 'critical stage of language acquisition' postulates that children learn a language quickly and effortlessly when they are young; whereas for adults, it can be an uphill battle. Similarly, children feel very comfortable with the computer. They can self-teach how to use software and hardware without going through training courses. Though one may not want to go so far as to postulate that there is a critical stage of technology acquisition in children, one would admit that children know what computer is when they discover what computer can do for them. Interestingly, their learning tends to orientate towards game-based activities, music and movie-type entertainment and social interaction. The challenge for teachers is that they should motivate children to divert their use of computer from entertainment-based activities to the academic learning discourse.

5.2 Learning about Technology

One of the main concerns of many parents about their children's safety and well-being in a technologically driven society is the way in which children are dangerously exposed to the Internet. The Internet can be so powerful that children can be acculturated into a virtual social discourse that the traditional family tie is lost. Parents cannot properly protect their children if they do not know whom the children interact with on the Internet. The children's world is no longer confined to the familiar contexts of the family and the close community. Thus children need to be educated to know well about dangers of the virtual world that computer technology has created. It is impossible for parents and teachers to protect children completely from the dangers inherent in the virtual world. The best solution is for them to learn about the positive and negative aspects of using the Internet, which is metaphorically a superhighway full of excitements, risks and dangers.

Learning about computer technology needs to go beyond the examination of the positive and negative aspects of the Internet in children's learning discourse. It is important to critically examine the impacts of computer technology on humanity in general, and on different cultures in particular. The Internet as a superhighway travels and carries passengers across various countries and cultures in the world and it cannot be value-free and ideologically neutral. While its impacts can be productive for some and they can be threatening for others. This is important when we examine the interrelated concepts of globalization and cultural diversity and IT.

5.3 Learning through Technology

Traditionally, particularly in a teacher-centred learning environment, the main resource in learning is the teacher. It is also known as the transmission model of learning model in which teachers transmit knowledge to learners. Teachers are knowledge transmitters and learners are knowledge receivers. This model of learning has been vigorously challenged by the constructivists who argue that learning is not about receiving knowledge but it involves making sense of knowledge and challenging knowledge. Thus knowledge should not be just derived from the teacher as the primary source but it can also come from a diversity of sources such as the learners themselves, the community and the Internet. Nowadays, the Internet can provide forums for discussion, virtual libraries, and a huge source of information covering different topics and issues. Teachers' role is to facilitate and guide learners how to use the Internet critically, creatively and constructively.

The introduction of Critical Literacy to education has shifted the focus of learning as knowledge attainment to making sense of knowledge through critical examination of texts. Knowledge is basically embodied in texts and texts are embedded with ideologies. Thus it is important to teach learners to critically examine knowledge and ideologies through critical text analysis. 'Multiliteracies' is a concept introduced by the New London Group (1996) with a critical literacy background which takes into account not only print texts but also e-texts from numerous multimedia sources, which children are now abundantly exposed to. Also the emphasis includes the variability of

meaning making in different cultural, social or domain-specific contexts.

6 COMPUTER TECHNOLOGY AND THE THREE WORLDS

Technology has undoubtedly made a great contribution to humanity. However, one needs not hastily accept its contribution without seriously considering its possible negative impacts. Technology provides modern conveniences to improve our quality of life. However, it can also create some conflicting discourses in our world socially and individually. As mentioned previously, it is important to look at education beyond the traditional subject-orientated discourse to include understanding and connection with what we consider here as the three worlds of humanity: the physical, human and spiritual words (Lê, 1995).

6.1 The Physical World

Scientists have constantly asked questions about the physical world as, in their inquisitive minds, it is full of mysteries and they are not satisfied with what they have discovered. Newton wanted to find out why things fall down, but not up. Archimedes' 'curiosity with the gold crown getting lighter in water' led to the establishment of the Archimedes Principle. Galileo was curious about the universe and he was among the first to use a refracting telescope to observe stars, planets and moons. Science will cease developing if scientists stop inquiring about the physical world which ordinary people tend to take for granted.

Children, like scientists, are also curious about the physical world. Their constant questioning about the world indicates that they want to learn about the world in which they live. They ask questions such as "why are there low and high tides?"; "why does the Sun rise in the East and sets in the West?". My 5-year old son asked why there are North Pole and South Pole, but not East Pole and West Pole.

Computer technology has made a great contribution to knowledge enhancement. A quick search on Google can open many windows for us to gain further knowledge about the physical world. We do not need to go to other parts of the world to know them well. Written and graphic texts on the Internet can provide us a great deal of information.

The challenge for educators is not to expand children's knowledge of the physical world but to help them to make connection to it. The physical world should not be treated as an external entity but as an important part of our existence. The changing of the physical environment can greatly impact on us. With the help of computer technology, children should be taught to understand the physical world and most importantly to protect it from human destruction. Issues such as global warming and climate change are not just physical issues. Fundamentally they are about humanity and its existence.

6.2 The Human World

When babies are born, they are born into a human world. In a village, they are surrounded by caring faces of their parents, grandparents, aunts, uncles, and other people in the family and the community. In a modern city, they are welcomed to the world by nurses, doctors, and other health workers as well as their family members. Whether it is in a remote village or a modern city, babies are introduced to the human world, which can be a mysterious place for them to discover gradually in their enculturation.

The arrival of computer technology, particularly the Internet, can expand children's human world. The traditional concept of family may not apply to some children. Their fathers and mothers may live in different places. Their relationship is no longer mediated through daily face-to-face family interaction. Text message and email add a different dimension to interpersonal communication. Thus computer technology provides a new discourse of human interaction and relationship. In other words, thanks to the Internet, parents, colleagues, neighbors are no longer the only people in our world. There are significant others in our existence. However, the expansion of our networking also creates issues and problems which may enhance our interpersonal relationship or destroy our happy co-existence with others. As mentioned earlier in this paper, it is dangerous for children to interact with strangers through the Internet as there are always 'big bad wolves' waiting there for them. Vulnerable children can easily become targets of abuse in a virtual world.

6.3 The Inner World or Spiritual World

We may develop a good understanding of the physical world and human world in which we live. However, it is difficult to stand aside as an observer to try to understand who we are. Questions about the

meaning of life are always with us, consciously or unconsciously. How do we value our life? How do we see ourselves in relation to our family, friends and the community?

It first appears that computer technology has nothing to do with the inner world as technology is a product of scientific knowledge whereas the inner world is personal and subjective. However, though our worldview, self-concept and identity belong to the inner world, they are a reflection of the outside world. A long harsh winter in a remote area without communication with others can bring loneliness and depression. Technology may change the way we think of ourselves in relation to other human beings and the land on which we live. It raises the issues of land care, international understanding, and human co-existent as world citizens. Technology permeates many aspects of society and it affects the quality of life both positively and negatively. The quality of life is not just about goods and services, but fundamentally it is about mindfulness.

Thus the big challenge for us as educators is our response to the question: How should computer technology be used to enhance learners in terms of these three worlds? This challenge has shifted our attention from the emphasis on academic learning to humanistic learning. This question seems to reflect well the Vietnamese concept of 'cultivated beings' in the Vietnamese educational tradition.

7 TECHNOLOGY, CULTURAL DIVERSITY AND GLOBALIZATION

Computer technology, cultural diversity and globalization are the three social forces which can co-exist peacefully to enhance humanity. However, they can also act as opposing forces and create conflicting discourses which lead to social disharmony, injustice and cultural domination.

Globalization has taken place for a long time when different nations have opened their doors to interact with one another. However, the concept 'globalization' and its impacts in an international discourse are perceived and interpreted differently. Basically there are two opposing perspectives on globalization. On one hand, globalization enhances the scope and magnitude of human contact, interaction, and collaboration. On the other hand, globalization reinforces cultural homogenization and cultural domination. It is a threat to cultural diversity and cultural preservation. According to Marsella (2005), we should not take globalization for granted and we should ask if the fruits of 'hegemonic' globalization constitute local and global improvements. Does globalization help to build a better world for all, or only for a small select group? We also need to ask: "Are the values and actions of the powerful, who support 'hegemonic' globalization, the values and actions we would choose given the opportunity to control our choices?"

> I am not against change, nor am I against globalization. I am, however, against 'hegemonic' globalization because of its consequences for homogenizing cultural diversity. I am against the asymmetrical concentration of power and wealth of 'hegemonic' globalization because it is driven by concentrated values and motives capable of homogenizing the world's diverse cultural traditions for commercial and political gain. 'Profit' is not in itself evil, but when 'profit' is driven by greed and avarice, it is simply violence. We need a globalization that is driven by equity and ethics (Marsella 2005, p.16).

Computer technology undoubtedly plays a key role in reinforcing globalization. With the Internet as a superhighway and English as a global lingua franca, globalization has become a powerful phenomenon. The challenge we need to face is: How should we handle computer technology as a part of scientific domain and technology as a product of science which can be subjected to use and abuse in a global context? How could developing countries make use of computer technology to enhance their society and at the same time maintain their cultural identity? There are no easy answers to these questions. For computer-support education, firstly we should try to maintain and value our own culture while at the same time being exposed to the world of computer technology. Secondly we handle computer technology so effectively that it not only has practical values but also helps in the development of the learner, making them more aware and secure in their cultural identity, more open to new form of experiences and more skilled in meeting their challenges.

8 CONCLUSIONS

Computer technology should be used to change the way we think of ourselves in relation to other human beings and the land on which we live. It raises the

issues of environmental awareness, international understanding, and human co-existence as world citizens. Computer technology permeates so many aspects of society that it affects the quality of life both positively and negatively. The quality of life is not just about goods and services, but fundamentally it is about mindfulness. One of the big challenges in computer-supported education is the response to the question: How should computer technology be used to enhance learners in terms of intellectual, social and emotional development? This challenge shifts our attention from the emphasis on a narrow context of academic learning to a humanistic learning discourse.

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Dr. Thao Le completed the Bachelors Degree in English linguistics at Saigon University in 1969. With a special interest in ethnography and an enthusiasm of a young graduate, he moved on to undertake a research Masters in Jarai, a highland minority language in Central Highlands of Vietnam. However his dream of living with culturally isolated mountain people as a part of his research fieldwork was dashed due to the fierce war taking place throughout Vietnam at that time.
In 1971 Dr. Thao Le was awarded a research scholarship by Monash University, Australia, to undertake PhD in linguistics. His PhD thesis was on semantically based theories.

Dr. Thao Le was offered a lectureship at the University of Tasmania in 1974 and has been teaching in the Faculty of Education till now. He has held various positions and played important roles in the development of the Faculty such as: Senior Lecturer, Assistant Dean, Director of the Masters Program, Graduate Research Coordinator and Associate Dean (Research). Currently he is lecturing in postgraduate courses and supervising eighteen research students. He was awarded the *Faculty of Education Mentor Award* and the *University Teaching Excellence Award.*
His research interests cover a wide range of academic areas: linguistics, inclusive education, educational multimedia, intercultural studies, Artificial Intelligence, and research methodology. His recent publications were three chapters in the book *Technology and Teaching* edited by Professor Sigafoos and published by Nova Science Publishers in New York in October 2007.

His forthcoming book *Critical Discourse Analysis: An Interdisciplinary Perspective*, to be published by Nova Science Publishers in New York in 2009.

HOMO ZAPPIENS, LEARNING IN A DIGITAL AGE

Wim Veen
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Abstract: Nowadays' students have grown up with technology as a commodity for playing, communication, information and for learning. Many of them act within virtual environments and have developed virtual identities as an extension of self (Second Life, WOW, Facebook, Plaxo, Plazes, Twitter, Dopplr etc.) Wim Veen argues that their online behavior and their virtual presence in cyber space have fostered the development of competencies that former generations could only do within a restricted realm of physical presence. For this generation, called Homo Zappiens, scarcity of reaching out, communications and resources has vanished to a large extent; Homo Zappiens lives in human and technical networks that provide new opportunities to act experiment and learn. Homo Zappiens learns within social networks where content is distributed and discontinuous. As a consequence, future learning will be based on concepts of aggregation, externalization, collective knowledge creation and immersion.

How do these uses of technologies go in parallel with developments in businesses, schools and society? How do prepare companies for these upcoming changes? And how relations between governmental authorities and citizens are going to change? In times of uncertainty and change the educational sector seems to react regressively: 'back to the past'. But schools have always been part of a socio-economic system, so looking away from what is happening in the outside world is not an option. If change is the only certainty for future, how technology can help to support change? A bunch of questions to be answered during the conference.

BRIEF BIOGRAPHY

Wim Veen (1946) is a full professor at Delft University of Technology, Faculty of Technology, Policy and Management. His research focuses on new concepts and strategies for ICT enhanced learning in both private companies and regular educational institutions. Traditional learning arrangements no longer hold in a society where knowledge is a key asset of networked organizations. Knowledge production and sharing require flexible strategies for professional development in which learning is an embedded and continuous team activity that is work based, networked, informal, self regulated, and strongly related to business goals or core activities of the organization. In the corporate sector, employees are the social capital of the business.

In regular educational institutions teaching and learning are also undergoing profound changes. Delivery modes are replaced by blends of distributed, networked, and face-to-face learning approaches requiring students to become active and productive learners.

Both in the private and public sector the uses of technology appears to be crucial in new ways of learning, knowledge co-creation and sharing.

Related to the above-mentioned changes in learning, Wim Veen is particularly interested in the cyber culture of the generation growing up with technology. He uses the concept of Homo Zappiens, a generation of learners that has never known its world without the Internet. This generation appears to develop a variety of meta-cognitive skills that are mostly disregarded by traditional teachers and managers. It is now time to learn from this net generation how to take advantage of ICT enabled learning in a networked society.

Wim Veen is teaching corporate learning. In addition, he is a consultant for educational institutions as well as for private companies and governmental authorities.

NEW FRONTIERS IN COMPUTER SUPPORTED EDUCATION

Itiel Dror
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Abstract: Education is not only about acquiring information and knowledge, but also (and mainly) about whether and how these are remembered and used. To understand education and learning and how technology can affect it, is less about what is taught and what technology is used, and much more about what learners learn: If you want people to learn using learning technology, you need first to understand how they learn. In this keynote talk Itiel Dror will illustrate that when you know what learning is all about, then seemingly small differences in the way learning materials are designed and delivered can make a huge difference to their effectiveness. The full potential of technology enhanced learning depends crucially on those involved having an understanding of what learning is all about, and the know-how to apply it in practice. Itiel's paper "Technology Enhanced Learning: The good, the bad, and the ugly" introduces some of this general approach, and a specific illustration of it can be seen in his paper "Helping the cognitive system learn: exaggerating distinctiveness and uniqueness".
These and other papers can be downloaded from: http://cognitiveconsultantsinternational.com/training.htm.

BRIEF BIOGRAPHY

Dr Dror holds a doctorate in cognitive neuroscience from Harvard University and specializes in the fields of learning, training & skill acquisition, technology & cognition, and human performance, expertise & decision making. He has received numerous awards for his research and teaching innovations, and is a recognized international leader in learning technologies. Dr Dror has conducted research and consultancy for numerous organisations, including the UK Identity and Passport Service, US Air Force, the Japanese Advanced Science Project, the European Aerospace Research & Development Agency, and for a variety of police forces in the UK and in other countries. He has also worked with a host of commercial companies, including IBM, Orange, PricewaterhouseCoopers, and Deutsche Bank.

Itiel's interest and experience is in taking scientific knowledge and theoretical academic models about the human brain and mind, and translating them into practical ways to improve and affect human performance and decision making in the workplace. Much of his applied work relates to learning and skill acquisition, decision making, and how technology can aid in changing behaviours and cognition. Dr Dror is an associate editor of *Pragmatics and Cognition*, and is editing a five year series on Cognition and Technology. A special issue on *Learning Technologies* is currently in press.

INFORMATION TECHNOLOGIES SUPPORTING LEARNING

FULL PAPERS

EXPLORING BASQUE DOCUMENT CATEGORIZATION FOR EDUCATIONAL PURPOSES USING LSI

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Keywords: Document Categorization, Latent Semantic Indexing (LSI), Computer Supported Learning Systems (CSLSs), Domain Module.

Abstract: In the process of preparing learning material for Computer Supported Learning Systems (CSLSs), one of the first steps involves finding documents relevant to the topics and to the students. This requires documents to be categorized according to some criteria. In this paper we analyze the behaviour of classification techniques such as Naïve Bayes, Winnow, SVMs and *k*-NN, together with lemmatization and noun selection, in the categorization of documents written in Basque. In a second experiment, we study the effect of applying the Singular Value Decomposition (SVD) dimensionality reduction technique before using the mentioned classification techniques. The results obtained show that the approach which combines SVD and *k*-NN for a lemmatized corpus gives the best categorization of all with a remarkable difference. The final aim pursued in this project is to facilitate the semiautomatic construction of the domain module of a CSLS.

1 INTRODUCTION

In the Information Age, learning occurs in contexts where information and knowledge are constantly changing. Finding documents relevant to topics and to the users involves one of the first steps in the process of preparing learning material (Vereoustre and McLean, 2003). Learning is opportunistic. It occurs in dynamic environments where new information, processes and people are appearing and disappearing. Current electronic document search engines do not provide a reasonable answer to most people's opportunistic learning needs. Following the guidelines set in (Aleven et al., 2003), the paper here presented tries to establish synergies between research occurring in the fields of Artificial Intelligence in Education and Electronic Document Technologies.

In Computer Supported Learning Systems (CSLSs) one of the main components is the *domain module*, where the subject to be learnt is modelled. The final aim of our project is to facilitate the construction of the domain module in a semi-automatic way. The process of creating it implies first the identification of learning material, i.e. the selection of the appropriate documents. This requires documents to be categorized according to some educational criteria. Most researchers propose approaches based on machine learning techniques, where automatically built classifiers learn from a set of previously classified documents. In our experiments, we use four classification techniques which have reported good results for categorizing documents: Naïve Bayes, Winnow, SVMs and *k*-NN.

Several experiments have been made to classify documents written in extended languages such as English. But, the reality of lesser-used languages, as it is the case of Basque, is different. In practice, one of the main problems we encounter is that only a short amount of manually classified documents is available. This fact restricts the capacity of the classifier and may, consequently, produce poorer results. In addition, we find that for educational use, even for extended languages such as English, there is no educational collection of documents (Nakayama and Shimizu, 2003). Taking this fact into account we have decided to separate the experimental design into two steps. In the first step, presented in this paper, we analyze the behaviour of the classification algorithms using documents which correspond to a Basque newspaper and which are categorized according to a recognized standard classification. In a future second phase, we will analyze the behaviour of the classification techniques using an educational corpus for Basque, which will have to be previously constructed.

There is also another reason because of which we have to make a special effort in our classification task; the morphosintactical features of Basque. In fact, we must take into account that Basque is an agglutinative language whose declension system has numerous cases (Alegria et al., 1996). This makes the categorization task even more difficult, because semantic information is not really contained in word-forms but in their corresponding lemma. Thus, the categorization of documents written in Basque turns out to be challenging. In our experiments we analyze the effect of preprocessing the corpus in order to reduce the dimension of the information to treat. In this way, we analyze dimensionality reduction techniques such as lemmatization, noun selection and Singular Value Decomposition (SVD).

In this work we perform two experiments. In the first one, we apply the classification techniques to three different corpora. In the second experiment, we apply the SVD dimensionality reduction technique by means of Latent Semantic Indexing[1] (LSI) implementation, before applying the classification techniques to the same corpora.

This paper is structured as follows. In Section 2 the research context is presented. In Section 3, we reference the classification algorithms used in our experiments, and examine the applications of LSI in text categorization problems and for educational purposes. In Section 4 the experimental setup is introduced, where both training and test corpora are described and lemmatization and noun selection processes are introduced. In Section 5, experimental results are shown, compared and discussed. Finally, Section 6 contains some conclusions and comments on future work.

2 RESEARCH CONTEXT

This work is part of a project that aims to acquire semiautomatically the domain for CSLSs. Concretely, the system that is being developed takes an electronic document as the base for building the Domain Module (Larrañaga et al., 2003). This module is enriched with additional documents and other didactic material. The process is divided into three different phases: Domain Module structure acquisition, generation of didactic material and domain enrichment and maintenance. In the Domain Module structure acquisition phase, first the document table of contents is analyzed obtaining the main topics of the domain and the relations among them. These topics and their relations constitute the first version of the domain ontology. Once the initial process has been finished, the whole document is analyzed in order to look for new topics and relations. The generation of didactic material is an ontology-driven analysis which splits out the whole document into Learning Objects (homepage, 2001) categorizing them according to some pedagogical purpose.

Finally, in order to enrich the Domain Module with more didactic material and to maintain it up to date, new documents are analyzed and incorporated to the domain module. The work presented in this paper will help in this last phase. Document classification will allow to connect the new documents to the concepts of the domain.

3 CLASSIFICATION TECHNIQUES AND LATENT SEMANTIC INDEXING (LSI)

Text categorization consists in assigning predefined categories to text documents (Sebastiani, 2005). When the bag-of-words text document representation is used, the number of attributes in the corpus is usually considerable, and this can be problematic in inductive classification. Therefore, it is usually convenient to apply techniques that reduce the dimension of the representation. This reduction can be carried out in different ways: eliminating irrelevant features (terms), substituting some words by others that represent them (lemmas, etc.), applying SVD technique, etc.

The SVD technique compresses vectors representing documents into vectors of a lower-dimensional space (Berry and Browne, 1999). This operation is called dimensionality reduction, and the space to which document vectors are projected is called the reduced space. When using the reduced space, most of the important underlying structure that associates terms with documents is captured and consequently, noise is reduced.

In our experiments we use LSI (Deerwester et al., 1990) (Dumais, 2004) to calculate the SVD and the cosine similarity measure among the document to be categorized and all the documents in the reduced space (training set). LSI has been successfully used in the categorization of documents written in english (Dolin et al., 1999) (Dumais, 1995). It has also been used for a variety of educational applications, such as the representation of knowledge in CSLSs (Zampa and Lemaire, 2002), tutoring dialog (Graesser et al.,

[1] http://lsi.research.telcordia.com, http://www.cs.utk.edu/∼lsi

2001) and automatic essay grading (Miller, 2003).

We use classification algorithms which have reported good results for text categorization in other languages; in this way, we use Naïve Bayes (Minsky, 1961), Winnow (Dagan et al., 1997), SVMs (Joachims, 1999) and *k*-NN (Dasarathy, 1991).

4 EXPERIMENTAL SETUP

The purpose of this section is to describe the document collection used in our experiments and to give an account of the lemmatization, noun selection and feature selection techniques we have applied.

4.1 Document Collection

As we have pointed out in the introduction, we are interested in the categorization of documents written in Basque with educational purposes. The ideal would be to have available an educational collection of documents categorized according to some standard labelling, but there is neither such educational corpus nor a standard educational classification. Among all the electronic documents available in Basque, we have selected newspaper texts, because there are standardized categories for this domain, and we have access to a sufficient amount of documents manually categorized. This will allow us to analyze the behaviour of the selected classification techniques when applied to Basque documents.

The documents used in this experiment correspond to the *Euskaldunon Egunkaria* newspaper, corresponding to the articles published during two months of 1999. They are a total of 6.064 documents categorized to the 17 standard first level IPTC categories[2]. Each of the documents has a unique category associated to it. It must be noted that all categories do not have the same number of documents, as can be seen in Table 1.

Document categorization is achieved in two steps: during the *training* step an inductive generalization of the set of documents is obtained, and during the *test* step the effectiveness of the system is measured. Therefore, the 6,064 documents have been split into two different sets of documents: 4,548 documents for training (75 %) and 1,516 documents for testing (25 %). This proportion stands in each one of the 17 categories, as can be observed in Table 1.

[2]http://www.iptc.org

Table 1: Number of documents distributed by categories.

Category	Training	Test
1. Culture	600	202
2. Justice	129	42
3. Disasters	75	26
4. Economy	234	78
5. Education	82	27
6. Environmental Issues	69	22
7. Health	35	12
8. Human interests	36	11
9. Labour	132	43
10. Lifestyle	40	13
11. Politics	1.184	393
12. Religion	25	8
13. Science	35	12
14. Social Issues	464	156
15. Sport	1.283	429
16. Conflicts	100	33
17. Weather	25	9
TOTAL	4.548	1.516

4.2 Feature Selection. Lemmatization

Basque is an agglutinative and highly inflected language. In order to face the difficulties derived from these morphosintactical features, we have applied two types of feature selection techniques. On the one hand, stopword lists have been used to eliminate non-relevant words, i.e. the most and least frequent words in the training corpus. On the other hand, we use linguistic methods such as lemmatization and noun selection to reduce the number of features. Indeed, recent experiments show that lemmatization helps in the process of categorizing documents written in an inflected language using LSI (Nakov et al., 2003). Therefore, we expect that lemmatization, and noun selection in particular, should allow us to maintain the same semantic information, reducing the number of attributes to be processed.

We have used the Basque lemmatizer designed by the IXA natural language processing group (Ezeiza et al., 1998), which obtains for each word in the document, its corresponding lemma, as well as its part-of-speech tag. This system reduces the different number of features from each category by more than 50%.

5 EXPERIMENTAL RESULTS

In this section we show the results obtained in the two experiments. In both of them we use the general-purpose classifier named SNoW (Carlson et al., 1999) for Naïve Bayes and Winnow algorithms and Weka

Table 2: Accuracy rates before applying SVD.

		all	>1	>2	>3
Naïve Bayes	Words	**80.09**	78.89	78.10	77.77
	Lemmas	**81.53**	81.07	80.74	80.28
	Nouns	79.49	**79.62**	79.35	79.62
Winnow	Words	80.09	**81.13**	80.47	79.49
	Lemmas	80.15	**80.47**	78.10	77.77
	Nouns	**79.35**	78.83	76.78	76.45
SVMs	Words	81.53	82.72	83.18	**83.71**
	Lemmas	84.10	**84.56**	83.58	83.11
	Nouns	81.40	**82.58**	81.60	81.99
k-NN	Words	37.80	**54.75**	38.32	40.96
	Lemmas	50.66	40.11	58.91	**59.17**
	Nouns	61.08	69.53	70.84	**72.16**

(Witten and Frank, 2005) for SVMs. We apply the classification algorithms to three different corpora: a corpus of text documents (words), a second one of lemmatized documents and a third one in which only nouns appearing in documents have been kept.

5.1 Experiment before Applying SVD

In this experiment, elimination of irrelevant words, lemmas and nouns has been performed based on the word frequency in documents; terms that appear in more than 1, 2 or 3 documents (>1, >2, etc.) are kept. The accuracy rates using the test-corpus for each classification technique are shown in Table 2. The best results obtained for each technique and corpus appear printed in boldface.

As shown in Table 2, the best result has been obtained by using SVMs after removing words that appear in only 1 document (>1) and using the lemmatized corpus (84.56 %). We want to emphasize that, taking into account the morphosintactical features of Basque and the reduced corpora used, the accuracy rates obtained with this method are high for all the three corpora. In fact, they are as good as some results reported for other similar corpora and language features (Nakov et al., 2003).

Results obtained using Naïve Bayes and Winnow are also very good. Both have been obtained using SNoW, and we argue that the processing it performs is very adequate for text categorization tasks. Both work better with more attributes, in general. Moreover, we can see that lemmatization and noun selection help Naïve Bayes in general, but this is not the case for Winnow.

However, results show that *k*-NN algorithm is not suitable for text categorization using raw data, even though noun selection gives acceptable accuracy rates (72.16 % the best). The accuracy rates in the table have been obtained for different *k* values (*k*=1,..., 10), and using the Euclidean distance.

Table 3: Accuracy rates for SVMs and *k*-NN after SVD.

		LSI dim.	Accuracy
SVD+SVMs	Words	1000	75.00%
	Lemmas	500	**81.46**%
	Nouns	500	80.34%
SVD+*k*-NN	Words	300	84.89%
	Lemmas	400	**87.33**%
	Nouns	200	85.36%

5.2 Experiment after Applying SVD

In this second experiment, LSI has been used to create the three reduced spaces for the training document collections. Different number of dimensions have been experimented $(100, 200, 300, 400, 500, 1000)$. The weighting scheme used has been logarithm for local weighting and entropy for global one.

When using *k*-NN, different experiments for different number of neighbours ($k = 1, \cdots, 10$) have been made and the following criteria has been followed: regarding the categories of the *k* closest (with the highest cosine), the most frequent one was selected. In case the result is a tie, the category with the highest mean is chosen.

The best results in this experiment have been obtained by using *k*-NN. In Table 3 the best result for each corpus is shown, and it can be observed that, the highest accuracy rate has been obtained for the lemmatized corpus, which significantly improves and increases up to 87.33 %. This confirms our hypothesis that lemmatization helps improving results in agglutinative languages such as Basque. Selecting nouns also gives better results than word-forms, but they do not give the best ones.

However, when SVMs are used after applying SVD, results become poorer. This is because SVMs are good enough when the number of features is high, and consequently, the dimensionality reduction does not benefit to them.

We have also used Naïve Bayes and Winnow to categorize the documents after applying SVD, but we do not include the results in Table 3 because they are fairly worse that the ones obtained before applying SVD. The reason may be that the way SNoW treats data makes it adequate to work with raw texts instead of with the reduced dimensional vectors obtained after the SVD.

Finally, given that the best results have been obtained by combining SVD and *k*-NN, we consider interesting to show all the accuracy rates obtained for different dimensions and number of neighbours. In Table 4 the results for the best *k* are shown: *k*=10 (Words) and *k*=3 (Lemmas and Nouns).

Table 4: SVD + k-NN accuracy rates for Words, Lemmas and Nouns.

	100	200	300	400	500
W.	82.98	84.30	**84.89**	84.76	84.63
L.	85.95	86.61	86.81	**87.33**	87.07
N.	84.37	**85.36**	84.83	85.03	84.76

6 CONCLUSIONS AND FUTURE WORK

Along this paper, we have analyzed the categorization of documents written in Basque with the purpose of facilitating the construction of the domain module in a CSLS. This work constitutes an important step in the process of semi-automatically acquiring the domain module of CSLSs. The two experiments performed in this study show that advances in the field of Electronic Document Technologies can find interesting applications in the field of Artificial Intelligence in Education. Results demonstrate that the k-NN classification algorithm combined with the SVD dimensionality reduction technique gives very good results even for a lesser-used and highly inflected language such as Basque. We would like to emphasize that when lemmatization is used, results increase up to 87.33%.

In our experiments we have confirmed that categorization results are also good when documents are written in Basque. This will permit us to face the Basque document categorization problem for an educational environment in a more established way. It will be a great advance in the process of constructing the domain module for CSLSs in a semi-automatic way. However, the lack of a Basque educational collection of documents makes this first step of acquisition of learning material be harder. Our future work will be conducted to construct such a corpus (Ghani et al., 2001) and repeat the experiments in order to confirm the good results.

Regarding the domain acquisition task, we are currently working in the automatic extraction of the main topics and the pedagogical relations among them represented, explicitly or implicitly, in the table of contents of a document. A set of heuristics that infer such relations and the part-of-speech information have been already defined (Larrañaga et al., 2004) (Larrañaga et al., 2008).

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TEACHING LARGE STUDENT COHORTS IN SECOND LIFE
Scalability Issues and Student Satisfaction in a Virtual World

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Keywords: Second Life, Virtual Worlds, Student Activities.

Abstract: There are high expectations on Second Life, a multi-user interactive virtual environment, to play a prominent role in higher education in the future. Across universities worldwide many projects aim to engage students in a variety of activities related to Second Life. However typically the number of students participating in those projects is small and the use of Second Life is an optional addition to the syllabus. We present two activities, conducted in 2007 and 2008 where Second Life has been used as an integral, non voluntarily part of an assignment in project management. Feedback from the 200 participants has been collected in the form of a questionnaire and interviews. Our results show that students have found the experience mostly positive, or, at least, didn't object to it. However technical and administrative problems have been identified that still question the suitability of Second Life for a smooth provision of these activities on a large scale.

1 INTRODUCTION

Second Life (Linden Lab, 2003) is an online three dimensional virtual world with an advanced way of building, interaction, socialization, communication, collaboration and networking. Businesses and institutions of various backgrounds such as IBM, Toyota, Reuters, BBC or Adidas enjoy a virtual presence in Second Life (Salomon, 2007). At the time of writing (November 2008) Second Life statistics records over 1,000,000 users "logged in last 60 days" and more than 60,000 users "online now". In the educational sector it is often seen as a modern method of teaching and learning online. The huge expectations on Second Life as an educational tool manifests itself in statements such as *"As students expectations rise, educational institutions will have to find ways of providing a mass-customised service, and virtual world technologies provide a cost-effective way of providing individualised support in a superior way to the current Web 2.0 platforms such as Blackboard or Moodle."* (Kingsley, 2007)

However current studies of student behavior in Second Life are pilots with small student cohorts (Sanchez, 2007; Ritzema and Harris, 2008) and often optional in the student's course diet. In contrast our study seeks to answer the question of how such activities scale to large student cohorts in a situation where Second Life constitutes a mandatory and integral assessment part of the module syllabus.

In doing so we not only question the validity of the statement quoted above but also are able to demonstrate the problems arising with scaling Second Life to large cohorts. The result could be summarized as follows. While students are indeed willing and ready to accept the inclusion of Second Life as part of their learning experience, the technical underpinnings of Second Life itself need to improve before we can expect its widespread use in teaching.

The paper is organized as follows. First we give an overview about the virtual presence of the University of Bedfordshire where this study has been carried out and put this into the wider context of educational activities in Second Life. This is followed in Section 3 by a description of the tasks given to the students. In total 200 students have been "sent" to Second Life. Evidence of their experience has been gathered via a questionnaire and interviews in addition to anecdotal observations. This evidence is presented in Section 4 followed by the conclusions in Section 5.

2 UNIVERSITIES IN SECOND LIFE

Second Life is an online virtual environment offering opportunities for interaction between many different sections of the world-wide community. There are several different types of activities that can be undertaken within the Second Life "grid": interacting with other users (known as avatars), buying and selling objects such as clothing, participating in or attending live events. Utilizing Second Life and taking on the role of an avatar is free. Therefore from an educator's point of view, it is possible to discover areas where opportunities for students' development can take place. Many educational establishments and commercial bodies have a presence within Second Life and it is clearly becoming a point of interest for the larger web-community.

Activities in the UK are well documented (Kirriemuir, 2008) and show a great variety: Projects range from small student driven projects up to large developments across nine Second Life "islands". Many universities have externally funded research projects in Second Life. Casually browsing the Internet and Second Life itself suggests many similar activities from universities all over the world.

(Ritzema and Harris, 2008) attempted to evaluate the use of Second Life as a tool for facilitating distance learning. The team rebuilt real life examples from a computing laboratory in the Second Life grid for students to experiment with. The group in this case was relatively small (fourteen individuals), but the feedback was extremely positive and indicated that many of the students found that the online activity enabled them to better understand the laboratory work.

(Sanchez, 2007) reports on the social and technical issues in the context of a student activity involving a focus group of eighteen students. There the picture is less positive and a number of both social and technical issues are highlighted.

Anecdotal experience gathered from various personal discussions with educators in Second Life seems to indicate that typically the use of Second Life at universities is an initiative of a small number of individuals, usually teachers, that in addition to their teaching activities (in the context of their Second Life activities) assume the roles of technical and administrative support. Often the use of that "game" in teaching is merely tolerated by senior administrative management and (in the best case) not been hindered by technical support. This is reminiscent to the early days of the Internet where educators who wanted to make their teaching material available electronically had to adopt the additional role of their own web master.

The situation at the University of Bedfordshire is much better. Land in Second Life has been acquired by the Teaching & Learning Support Department and championed by the technical support. Innovative teaching using Second Life is explicitly encouraged. We are going to show however that even in such a seemingly optimal environmental and organizational context the use of Second Life as a mandatory part of a student assignment is not without problems. Evidence has been gathered from two assignments involving 200 students in total. While the students' feedback is generally positive, technical difficulties that arise from the inherent workings of Second Life itself prevail, or to put it more bluntly: While students are ready for an assignment of that style, Second Life itself is not (yet).

We want however add a caveat: Second Life provides a whole plethora of opportunities for universities. This paper is not meant to question such activities in principle. In particular it may well be suitable for individual projects of creative and interested students in areas such as art, psychology, computer science or architecture. However the *scalability* of such projects to a large cohort of students that a priori cannot be assumed to have any specific aptitude towards virtual environments is questioned here.

3 THE TASKS ASSIGNED TO THE STUDENTS

3.1 Context of the Assignment

Figure 1: View over Bedfordia (front) and the University of Bedfordshire (back) in Second Life.

The location of the student activities that we are going to describe in the following sections took place at the island "Bedfordia" owned by the department of Teaching and Learning of the University of Bedford-

shire, For clarity it should be noted that the university also owns a second adjacent island named "University of Bedfordshire" which is primarily used for marketing purposes. In particular while the "University of Bedfordshire" island has been designed to give a look and feel of the real university by featuring characteristic university buildings such as a library or student union, the island of Bedfordia has been landscaped by a skilled builder to stimulate creative activities. It features atmospheric structures such as lakes, woodlands, a tree house and a swimming pool (Figure 1). The Teaching and Learning island Bedfordia has a size of 32560 sq. m. For the assignment an area of about 5632 sq. m. has been made available as a building area - "sandbox" - for the students. The use of Second Life has been championed as well by the university's Information Systems Department so that there have been no principal issues to be resolved concerning firewalls, blocked ports or Second Life client installations on student machines (difficulties that are often encountered at other universities). In summary it can be said that the environmental and technical conditions have been optimal to run the learning activities described in the next section.

3.2 Pilot Activity, Autumn 2007

In 2007 the provision of the Second Life island by the University of Bedfordshire was brought to the attention to the teaching team of the undergraduate 3rd year module "IT Project Management". At that time Second Life has been accessible from inside the university via client installations in a lab specialized in computer graphics. Given this availability a decision was made to pilot the use of Second Life to a larger cohort of students. In that module 84 students were enrolled.

In previous years the assessment of the project management module already contained an element that focuses on team cohesion and human interaction. Students were randomly assigned into teams and given access to a team-owned discussion board. The core task for the students was to organize social meetings in order to "improve the team coherence". The marks were based on the students evaluation of those meetings. For more details (without the Second Life context) please see (Conrad et al., 2006) where the assignment and learning outcomes are presented and the relevance to cultural profiles of teams is discussed.

In 2007 this activity has been altered by requiring the students to meet virtually in Second Life. Because introducing students to the specific demands of "virtual teams" has already been part of the syllabus in previous years the use of Second Life would blend in naturally. The students were given the following case study (in the following all emphasized text denotes a direct quotation from the assignment sheet the students received): *"BedTime Books Ltd wants to set up a (virtual) branch in Second Life (see http://secondlife.com). BedTime Books' branch should be located near the University of Bedfordshire at the island Bedfordia. Your company has no previous experience with virtual worlds. For this project BedTime Books has assigned you to a project team of 7 or 8 people. As the team members come from different locations [...] a group discussion board has been set up [...] to enhance communication."* The notion of "different locations" has been simulated by sourcing the groups from different practical sessions meaning that there was a priori no default time slot in the week where students can meet either virtually or really. This must be negotiated within the student group. The students had to work against the following two goals:

- *To form a coherent team that could actually start with building the branch [...].*
- *To familiarize all team members with the virtual environment provided by Second Life, and in particular the island Bedfordia.*

The meeting had to be evidenced by providing a screenshot and the whole process had later to be evaluated in an individual report. The activity concluded with the following note: *"No particular help will be given from the tutors on how to use and interact with Second Life. To identify suitable resources such as tutorials is part of the task of the project team."* As Second Life is designed in a way that it is usable by the general public and even more because the students have been enrolled in computing related degrees where an affinity towards the use of software can be assumed this approach seemed feasible. As a matter of fact the validity of the remark has not been questioned by any of the students.

The activity is essentially designed as an individual assessment in so far that marks are primarily not given on the group performance as a whole but rather based on the individual students' interactions and their reflection on those in the final report. A template for this report has been provided and we included an evaluative questionnaire on the experience of the students in Second Life. While the answers of this evaluation questionnaire have not been considered to be relevant for the students' grade they nevertheless allowed to gather the quantitative and qualitative feedback that informed the use of Second Life in the next assignment described in Section 3.3. For details on the results of this questionnaire see Sec-

tion 4.3. From the 84 students enrolled in this activity around fifty filled in the questionnaire.

The assignment helped to get an initial feeling about what it means to use Second Life as a tool in teaching and assessing students. In addition it helped to sort out some teething problems in deploying the necessary Second Life client software as a default application on the workstations so that it is accessible by the students.

3.3 Building of a Showcase (Professional Project Management)

Inspired by the positive experience in autumn 2007 as described in the previous section a decision was made to include Second Life in the assessment process of the postgraduate module "Professional Project Management" that run in spring 2008. In this module 114 students have been enrolled. The focus of this assessment is the successful application of a project management processes within a real-world environment. More specifically the following learning outcomes have been addressed in this activity:

- To understand the importance of team coherence in a professional (team based) project
- To clearly communicate in a variety of media at an advanced academic level
- To develop Key Skills in the areas of Performance Management and Presentation and Evaluation
- To apply a project management methodology within a real-world context.

At the start of the assignment students have been pre-assigned into teams of 4-6 people. It should be noted that this module is part of the syllabus of various different postgraduate awards in Computing at the University of Bedfordshire. As far as possible the teams have been assigned in a way so that all students in any particular team share the same award. This should provide a common basis to work on the project mandate that was described as follows (quote from the assignment sheet):

"You have been asked to work in a group of IT specialists to develop a set of products that can be used to educate the general public about your specialist area, e.g., Networking students will educate the general public on wireless and mobile networks; Computer Scientists will educate the general public on pervasive computing, and how computing is becoming an integral part of our lives; Generalists will educate the general public on the increasing use of E-commerce, and the security implications that this has."

Then the set of products to be developed is further described:

- *"Poster [. . .]*
- *A wiki page [. . .]*
- *A Second Life showcase that would serve to raise the awareness of visitors of the virtual University of Bedfordshire to essential issues regarding your specialist area. This showcase will be presented to the Programme/Corporate Management (i.e. the module tutors) but should be designed and build in a way that it is accessible to the general public."*

The assignment sheet than finally gave further direction on the processes to be used. Concerning Second Life the following paragraph was added:

"Second Life is accessible from the CIS labs (or, of course, from home). You have to register an account with Linden Labs at www.secondlife.com. No particular help will be given from the tutors on how to use and interact with Second Life. To identify suitable resources such as tutorials is part of the task of the project team and must hence be included in the project brief. A dedicated space to build up the Second Life showcase will be provided [...]. Please ensure to produce regular screenshots in order to document the progress of the project.

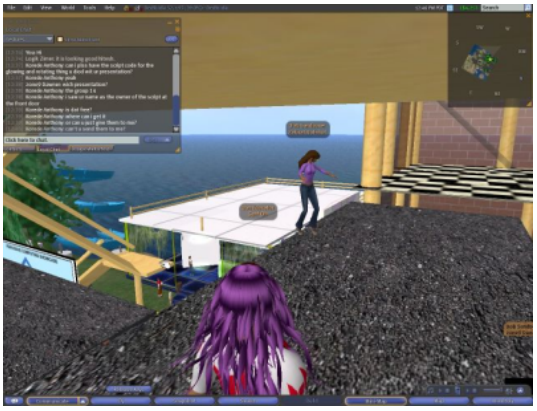

Figure 2: Students working on the assignment in Second Life.

Evidence on how this assignment has been perceived has been gathered by interviews with the students at the end of the course.

We want to point out here that Second Life has been introduced to the students as a platform for productivity and not as a means to communicate with each other remotely or as a place to have virtual meetings. Those features though have been mentioned as side effects in the lectures and practical sessions.

4 FEEDBACK FROM THE ACTIVITIES

4.1 Anecdotal Observations

We start our discussion on feedback with reporting some of the students' reactions made at the beginning of the assignment or shortly after.

- Only one student of the second cohort challenged the tutor in questioning the use of Second Life in principle. Those concerns could be addressed by pointing out the relevance of virtual teams in locally distributed real life projects and also in hinting that Second Life is not a game but a social platform that is used for education also by other institutions throughout the UK and worldwide.
- Some students had difficulties with the term "showcase" used in the assignment. This has been addressed by reference to showcases of companies and other institutions in Second Life. As it was intended to give the project teams ownership in making their own design decisions it was abstained from giving step-by-step details on what should constitute an acceptable end result.
- The intention that no help was to be provided by the tutors was overoptimistic to say the least. While that approach was feasible in the much simpler undergraduate assignment as described in Section 3.2 it was felt that most students found the task to actually build in Second Life very challenging. Hence it was decided to start one of the lectures with a short fifteen minute long demonstration on how to actually build a simple poster in Second Life by starting with a slide in PowerPoint (saving the PowerPoint slide as png-file, uploading the file and applying the texture to a prim in Second Life). Actual building of the students in Second Life then started essentially after that demonstration. In addition some useful building tools have been provided in-world for the students to work with and individual help was given by the tutors (see below).
- Once students had completed the process of registering an avatar on Second Life they were required to send an instant message to an assigned member of staff so the student could be placed in a group with appropriate access to build and create objects. It was then decided to provide a minimal level of instruction for the students as we considered this to be an important part of each individual project's development. Tutors spent time with the students explaining the nature and abilities to manipulate objects in Second Life within the University's sandbox area. One of the voluntary residents on the Bedfordia island provided students with links to other areas and to textures and objects within Second Life.

4.2 Questionnaire Evaluation of the Pilot Activity

The following questionnaire has been distributed to the students after the activity:

In the second part of the assignment you have been asked to use Second Life. To help us to understand your experience with this new format better we would like you to answer the following questions.

1. *On a scale of 1 (easiest) to 5 (hardest) how easy did you find it to to get into Second Life?*
2. *What things were difficult (if anything) about getting IN to Second Life?*
3. *On a scale of 1 (easiest) to 5 (hardest) - how easy did you find it to get to Bedfordia?*
4. *What things were difficult about getting to Bedfordia?*
5. *What was your opinion of Bedfordia?*
6. *In what ways did you find Second Life useful for the task you were set, i.e. to have a project meeting?*
7. *In what ways do you think Second Life as a learning tool is different from BREO? [The university's Blackboard based content management system]*
8. *In what ways do you think Second Life could be used to support your learning?*

From a cohort of 84 students 50 responses have been received. Note that only questions one and three give quantitative results while the other questions are of qualitative character. In question one for 80% of the respondents getting into Second Life was easy or neutral 20% found it hard. The problems encountered by those 20% are about installing Second Life at home (which was not a requirement) or difficulties to register.

For question 3 only 3% of the students found it hard to find the island of Bedfordia (the student's home location) in Second Life. Those problems were not substantial and could be easily resolved by asking a tutor or friends (question 4).

The impression students got from the island Bedfordia (question 5) was overwhelmingly positive. Students commented with words like "exciting", "well designed", "interesting" or "pleasant". It seems here that the fact that the island has been landscaped by

a skilled Second Life builder has been paid off. It is our feeling that professional landscaping is a non-negligible factor when designing an official presence in Second Life. It facilitates students to accept the virtual world as "theirs", as a professional service of the university designed to enhance their teaching.

Question 6 *"In what ways did you find Second Life useful for the task you were set, i.e. to have a project meeting?"* suggests a more subtle picture. Many remarks were enthusiastic, however for reasons that are essentially generic to any software that supports virtual meetings. One of the critical answers put it to the point: *"I could see nothing that Second Life did that an instant messenger could not."*, or similarly *"Since there are many communication softwares on the market, in my opinion for a virtual project meeting I would choose another software. [. . .]"*. Still, the majority was willing to freely assume the usefulness of Second Life as a proper tool for virtual meetings. It seems odd that the obvious overhead like registering, creating an avatar and learning basic moves has largely not been seen as an obstacle by most of the respondents. It may also be surprising that not a single response somehow addresses the issues that one's identity in Second Life is presented by an avatar and that a meeting by such proxy-identities might be perceived somehow differently then a (virtual) meeting where participants identify themselves by their real name.

Question 7 evaluates the student's perception of Second Life as a learning tool. In particular it has been asked to compare Second Life to the university's Blackboard type content management system. Many differences have been highlighted such as *"Second Life is more interactive"* or *"Second Life is a real time experience and is fun"* and virtually no similarities have been identified by any of the students. The response *"Personally I wouldn't call it as a learning tool, but more of virtual excitement game."* is an example typical to many of the student responses. This is interesting in view of the statement we quoted in the introduction *"[. . .] virtual world technologies provide a [. . .] support in a superior way to the current Web 2.0 platforms such as Blackboard or Moodle."* (Kingsley, 2007). If this were truly the case, wouldn't we expect that at least some of those who now had experience in both Blackboard and Second Life see some potential there?

Finally, Question 8 asks how Second Life would enhance one's learning experience. Here the answers are rather negatives *"can't think of any way in which it may be used to support my learning."* and similarly *"Not useful because you can only use it for discussions and getting to know purposes, and not learning lecture notes for example."*. If at all, the usefulness of Second Life as a meeting tool has been highlighted, essentially in reference to answers given already to Question 6.

In summary the questionnaire suggests a certain openness towards the use of Second Life in general. In particular there were hardly any difficulties with the enrollment process or any issues with the concept of having an avatar in Second Life as part of an assessment task. Students in general felt positive about the island of Bedfordia and how it was built. However the answers to questions 7 and 8 made it painstakingly clear that they didn't see any relevant connection between Second Life and an electronic learning platforms such as Blackboard. The perception seemed rather that of a "game" that added some interesting colour to their teaching experience.

4.3 Interview Results from the Building Activity

Feedback from the second activity that required the actual built of structures in Second Life (see Section 3.3) has been gathered by conducting interviews. In each interview session approximately ten students took part and a recording device has been used to provide transcripts of the interviews. We structure the following sections around the main topics that have been addressed during those interviews.

4.3.1 Students Getting Signed up to Second Life

Most of the students had little difficulty signing up to Second Life: However this operation appeared to occur continuously throughout the activity. First, many of the groups assigned one or two persons to be responsible for the development of their group's showcase within the island. Towards the end of the project many of the other group members decided that they wanted to review the progress personally (i.e. with their own avatar within Second Life), or to in some way aid the development of the showcase. This sudden rush which coincided with the nearing project submission date caused issues with our ability to respond. At one point over 40 instant messages have been received in one day and considerable time was spent trying to deal with "confused" students who wanted to build a showcase, but clearly were not aware that their fellow group members had already built substantial structures.

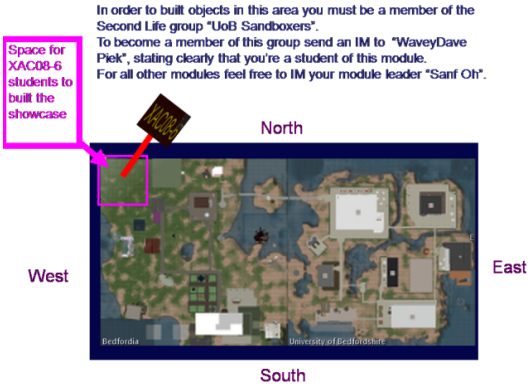

Figure 3: Instructions given to students where to find the building place.

4.3.2 Instant Messaging, but Instead Adding as a Friend

Our students had problems using the Second Life interface to send instant messages. Initial instructions indicated that students would need to message a member of staff (Figure 3). However many of the students thought that to send an instant message they needed to be friends with the staff member. Friend requests formed a substantial part of the traffic sent to the inbox of staff.

4.3.3 Students Navigating around Second Life

Many of the students found the initial orientation island useful but a little confusing. The comments we received seemed to suggest that students would need much support in the way of building and learning how to build items within Second Life. However most were able to operate within the environment without too many problems.

4.3.4 Finding Space to Build and 'prim' Space Availability

Many of the students had problems with finding an area to build within the designated area. Most of these issues stemmed from students arriving very close to the submission deadlines to build their showcases. We had to make suggestions and in some cases changes to more capacious structures. Some groups elected to build skyboxes to ensure that they would not interfere with spaces closer to the ground. Towards the submission date we also found that the space on the island had run out of prim space ("prims" are the smallest building units that can be used to set up structures within Second Life. Essentially the number of prims that can be used on any given land is limited). Extra space had to be added.

Rather fascinatingly students perceived that their showcase buildings needed items like roofs, stairs and even chairs. During interviews it transpired that students thought the buildings needed to "look like proper buildings" otherwise they would not get marks for their project. We took opportunities to question students about the addition of items such as chairs, and in one case a coffee maker, it appeared that the students wanted to create a truly personalized experience for those visiting the showcase.

4.3.5 Miscellaneous Issues

Aside from the main issues addressed in the previous sections feedback also included the ability to undertake project meetings regardless of geographical location, the potential for creativity and use of imagination, and the contrast to other projects. Considerations over appearance include appropriate dress and indicates that students typically identified themselves with their avatar: *" 'Furies and animal avatars' are weird - people should be dressed in their own gender"*. Some benefits were suggested in relation to an international audience: *"If people from different cultures and background wanted to work together Second Life would provide an excellent tool. In real life you have to be able to understand others' accents etc. Second Life has text chat which makes this process easier."* Students had difficulties with some typical Second Life efforts such as learning to build and upload objects and textures, object number limits on Bedfordia, and obtaining the local in-world currency ("Linden Dollars").

Use of Second Life does not avoid the familiar group project difficulties - motivating group members (to build), and trying to better understand the requirements of the project. On the whole the efforts run at Bedfordia have been well-received by the students.

4.4 Administrative and Technical Issues

In this section we highlight some issues that have been identified by the educators complimentary to student feedback.

- Usability issues: To make a build it was necessary to enrol students in a Second Life group, the instructions as shown in Figure 3 have been distributed to the students. This enrollment procedure has been felt to be too time consuming. For further activities a process to streamline access of student groups to land in Second Life needs to be identified.
- Student guidance: Students needed more guidance then expected. Although Second Life is full

of structures set up by non-IT professionals and hence postgraduate students in computing degree could be expected to acquire the necessary skills and knowledge themselves, it quickly turned out that some basic guidance needed to be provided.

- Updates: Second Life requires frequent updates of the client software. As student accounts are typically limited and the update requires administrator rights, this regular procedure implied a considerable additional workload to technical staff.
- Backups: The assessment process heavily depends on the availability of Second Life being accessible in a stable and reliable way. Hence there is an inherent risk of data loss, essentially not controllable by the university, that might have spoiled the structures set up by the students. It has been tried to safeguard against such an incident by regular in-world visits of the tutor. During those visits screenshots have been made to document student progress. Luckily no such incident occurred.

5 CONCLUSIONS

The students found the experience mostly positive or were at least neutral. Even students without an aptitude towards virtual worlds or "computer games" developed a sense of professional identity with their avatars. The production of a showcase provided them with a sense of ownership and achievement. Learning outcomes that address responsible and professional behavior in virtual environments have been met.

However from the administrative point of view a number of problems have been encountered and there is a feeling that accommodating those large student groups in Second Life is still very resource intensive. A straightforward and manageable process to ease controlled enrollment and to provide students with land to build on still needs to be identified.

An issue that remains essentially unresolved is the lack of a backup process that would facilitate a fair marking of the students work in case of a system failure.

Second Life enthusiasts often emphasize the suitability of that virtual world for education, but identify the steep learning curve for the students concerning basic steps on how to create, design and use their avatar as the main obstacle. While there are some minor issues when it comes to creatively building structures such a view merely hides the real, resource intensive, problems concerning enrollment and managing land accessibility. We have found that students are generally willing and ready to adopt a virtual presence within Second Life as part of their module diet. It is Second Life itself that has still to mature technologically to allow smooth management of large numbers of students.

However in view of ongoing research in this area, to name only the SLOODLE (Kemp and Livingstone, 2006) project at the University of Edinburgh that aims to integrate Second Life with the "traditional" content management system MOODLE, it can be envisaged that the technological difficulties will be overcome eventually and that Second Life will play a more prominent role in the educational sector in the future.

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SYNCHRONOUS ONLINE DISCUSSIONS

Participation in a Group Audio Conferencing and Textual Chat as Affected by Communicator's Personality Characteristics and Discussion Topics

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Keywords: Online discussion, Participation, Synchronous e-learning, e-Communication, Extroversion-introversion, Discussion topic, Audio conferencing, Textual chat.

Abstract: The development of instructional technology increases the use of synchronous e-learning procedures which enable real-time interactions. The study explores whether the willingness to participate as well as actual participation in synchronous group discussions is affected by participant personality (extroversion-introversion), medium characteristics and discussion topic sensitivity. The research is composed of two sequenced sub-studies. The first one investigates the *willingness to participate* while the second study explores the degree of *actual participation* in discussions. An online self-report questionnaire was completed by 405 adult Internet users. Following that, 120 volunteers extracted from this sample were randomly assigned to face-to-face, audio conferencing, or textual chat gender-mixed experimental conditions and conducted two short discussions (having low and high degrees of topic sensitivity). The relation between estimated and actual participation was explored, as well as the equalization effect of online interactions. The first study findings show that, in general, participants prefer conventional over sensitive discussion topic; they also prefer face-to-face discussion rather than online communication. As hypothesized, participant personality affects the willingness to partake in discussions: extroverts prefer taking part via a more revealing communication medium; introverts express greater readiness for discussion via textual chat. The results of the study expand the understanding of student behaviour in synchronous e-learning.

1 INTRODUCTION

The quick development of Internet technologies increases the use of synchronous communication which enables real-time interpersonal interactions in cyberspace. Participation in online group discussions is affected, among other factors, by medium characteristics, discussion topics, and participant personality. The present study investigates the level of participation in face-to-face communication versus synchronous interaction through audio conferencing and textual chat. Specifically, the study explores whether the willingness to participate, as well as actual participation in group discussions, is affected by participant personality (i.e., extroversion-introversion), medium characteristics, and the sensitivity of discussion topic. At this point in time, the research of the willingness to participate in group discussions (the first study of two-study series) is finished, and the exploration of actual participation (the second study) is work-in-progress. The results expand the understanding of behaviour in synchronous e-learning, and group e-communication within social and organizational contexts.

2 RELATED STUDIES

There are several theories that differentiate media by their inherent features in order to predict efficient communication. One of the leading theoretical approaches is the Media Richness Theory (Daft &

Lengel, 1984). According to this theory, face-to-face communication is considered the most efficient way to convey complex messages. Empirical research regarding the influence of media richness on communication provides mixed results: some studies found evidence supporting it (for recent review see Donabedian, 2006), while other findings pointed to the fact that a rich medium provides distracters that may negatively affect communication (Blau & Caspi, 2008; Caspi & Levin, 2008; Setlock, Quinones & Fussell, 2007). Some researchers even claimed that a "lean" communication medium (such as e-mail or textual chat) may provide rich interpersonal communication. Walther's (1996; 2007) findings on the "hyperpersonal effect" of e-communication showed that text-based interaction can possibly equal or even exceed relational effects derived from comparable face-to-face interactions. This approach received extensive theoretical and empirical support in studying online communication (e.g., Joinson, 2003; 2007; Suler, 2004) and e-learning (e.g., O'Sullivan, Hunt, & Lippert, 2004). The claim that online video, audio, or textual chat may be as efficient as face-to-face communication (Walther, Loh & Granka, 2005) has been studied mostly in a textual environment. The increasing use of online audio and video conferencing (Ng, 2007; Wang, 2006) requires studying the impact of these media' characteristics on online behaviour. Voice provides meta-communication features of human messages through loudness, intonation, pitch, and breaks (Pickett, 1998). Thus, audio conferencing may have a different effect on interpersonal interaction than chat (Barak, 2007), and result in different group behaviour (Blau & Caspi, 2007).

Studies comparing synchronous online and face-to-face communication showed controversial results: while some of them found decreased participation in audio conferencing and textual chat (Berge & Fjuk, 2006), others claimed that textual chat (Hudson & Bruckman, 2002; Lobel et al., 2002) and audio conferencing (Blau & Caspi, 2008) increase participation compared to offline interaction.

Personality characteristics of users may impact interpersonal and group online behaviour; the trait of extroversion-introversion is considered of particular relevance to Internet use (Amichai-Hamburger, 2005; 2007). An extrovert is a friendly person who seeks company, desires excitement, takes risks, and acts on impulse, whereas an introvert is a quiet, reflective person who prefers his or her own company, does not enjoy large social events, and does not crave excitement (Eysenck & Eysenck, 1975). Discussing the role of the Internet as a compensatory psychological tool, Kraut et al. (2002) claimed that people who easily befriend offline would also have more online friends ("the rich get richer" phenomenon). Other researchers hold that the protected Internet environment may assist introverts in expressing themselves more freely in an online than in an offline relationship ("poor to get rich"; Amichai-Hamburger, 2007; Maldonado, et al., 2001; McKenna, Green & Gleason, 2002). It has been noted that while extroverts feel comfortable both offline and online, introverts express themselves significantly more freely on the net (McKenna, Seidman, Buffardi & Green, 2007). Interacting online, introverts adopt offline behaviour patterns of extroverts (Amichai-Hamburger, Wainapel & Fox, 2002; Maldonado et al., 2001; McKenna & Seidman, 2005), among others active participation in discussions (McKenna et al., 2007).

It should be taken into consideration that the relation between personality characteristics and online behaviour may be mediated by participant demographics (Hamburger & Ben-Artzi, 2000; Maldonado et al., 2001), type and amount of Internet use (Anolli, Villani & Riva, 2005; Peris et al., 2002), and discussion topic sensitivity (Hertel, Schroer, Batinic & Naumann, 2008).

3 METHOD

The present study aims to explore some psychological aspects of synchronous group communication using the Internet. Group behaviour in face-to-face communication versus online interactions through audio conferencing and textual chat are compared. Specifically, the study investigates whether medium characteristics, participant personality (i.e., extroversion – introversion), and discussion topic sensitivity affect the willingness to participate and the actual degree of participation using the different media. The research is composed of two sequenced sub-studies.

3.1 Study 1

The first study investigates the *willingness to participate* in discussion as related to medium characteristics, participant personality, and discussion topic sensitivity. The hypotheses were that extroversion-introversion would correlate with willingness to participate in face-to-face communication mode compared to audio conferencing or textual chat discussion (because of the differences in the degree of perceived

anonymity) and that the sensitivity of discussion topic would augment this tendency.

3.1.1 Participants

An online viral sampling of 405 Israeli adult Internet users, 118 of them men (29.1%), was composed. Figure 1 shows the distribution of participants' age (Range: 18-76, Median: 29, Mean: 31.89, SD: 10.97, Skewness: 1.08).

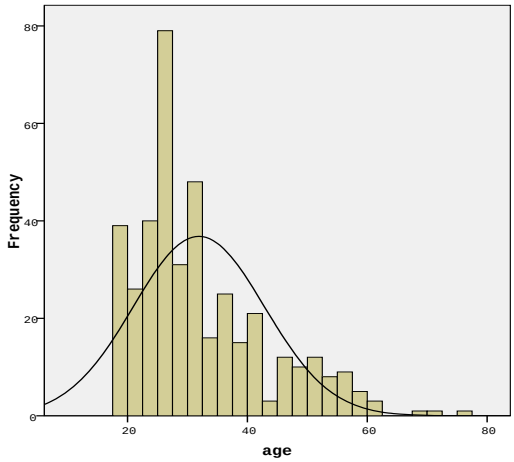

Figure 1: Participant age distribution.

Table 1 shows the percentage of the participants' Internet usage in general and online synchronous communication tools in particular.

Table 1: Percentage of the Internet and communication applications usage.

Usage level	Internet-general	Personal chat	Chat room	Audio
Each day	85.7	24.4	0.2	0.7
2-3 times at week	10.6	14.6	0.7	6.2
Ones at week-ones at month	3.7	13.8	3.2	9.4
Less then ones at month	0	15.1	6.9	18
Not using	0	31.9	87.2	62.7

3.1.2 Instruments and Procedure

The participants completed an online self-report questionnaire sent by email. To measure the trait of extraversion-introversion we used a scale composed of 12 items from Hebrew short version of the NEO-PI-R questionnaire based on the Big Five model (Costa & McCrae, 1992). Scale internal consistency was high (α=.80). The score of extroversion-introversion (Range: 21-69, Medium: 51, Mean: 51.26, SD: 8.08) was computed by summing up participant answers to the items (scale 1-6). For the statistical analysis the participants were divided into two groups (extroverts and introverts) using the median scale score (the participants who received the median score were defined as introverts).

In addition, the participants were asked to imagine group discussions and report (on a scale of 1-8) about their willingness to discuss conventional and sensitive topics using different communication media: face-to-face, audio conferencing and textual chat (following Hertel et al., 2008).

3.2 Study 2

The second study explores the degree of *actual participation* in a group discussion as influenced by medium characteristics, participant personality, and discussion topic sensitivity. In addition, the second study investigates the relationship between estimated and actual participation, as well as the equalization effect of online communication (i.e., more equal online participation compared to offline one, because of the diminished status differences between communicators). The hypotheses were that extroversion-introversion would correlate with actual participation in face-to-face versus audio conferencing or textual chat discussions, and that the sensitivity of discussion topic would augment this tendency. In addition, it was hypothesized that the willingness to participate positively correlates with actual participation, and participant personality characteristics moderate this correlation. Concerning the equalization effect, it was hypothesized that online participation would be more equal compared to offline one, and the participation using textual chat would be more equal in comparison to participation through audio conferencing.

The participants of the second study consisted of 120 volunteers derived from Study 1. The participants were randomly assigned to three (i.e., face-to-face, audio conferencing and textual chat) gender-mixed experimental conditions and two short non moderated discussions (i.e., having low and high degree of topic sensitivity) were conducted. The discussions were recorded and the willingness to participate was compared to actual behaviour in each communication mode.

4 STUDY 1 RESULTS AND DISCUSSION

4.1 Effects of Media and Discussion Topics

Table 2 shows the means (1 = "not at all", 8 = "very much") and SDs of the participants' willingness to discuss the conventional and sensitive topics through audio conference, chat, and face-to-face.

Table 2: Means and SDs of the willingness to discuss different topics through communication media.

Medium / Topic Sensitivity		F2F	Audio	Chat	Average
Conventional	M	6.60	3.15	3.23	4.33
	SD	1.57	1.90	1.95	1.06
Sensitive	M	6.06	2.66	3.06	3.93
	SD	1.98	1.77	2.26	1.03
Average	M	6.33	2.90	3.14	4.13
	SD	1.43	1.63	1.80	0.91

A 2x3 repeated measures ANOVA showed main effects for communication medium, the sensitivity of the discussion topic, and their interaction (see Table 3).

Table 3: Effects of medium and discussion topic sensitivity on the willingness to participate: Repeated measures ANOVA.

Effect	F	df	p
Medium	483.1	2, 403	<.001
Topic	62.02	1, 404	<.001
Interaction	3.45	2, 403	<.05

Generally, participants preferred the conventional (M=4.33) over the sensitive discussion topic (M=3.93, $p<.001$); they also preferred face-to-face discussion (M=6.33) rather than audio conferencing (M=2.90) and chat communication (M=3.14, $p<.001$). For online interactions, participants preferred using chat rather than audio conferencing ($p<.05$). Discussing a conventional topic, there were no statistically significant differences between audio (M=3.15) and textual communication (M=3.23), but offline interaction (M=6.60) was preferable than both online communication modes ($p<.001$). Discussing a sensitive topic, the participants also preferred offline (M=6.06) than online communication, but chat (M=3.06) was preferable than the interaction through audio conferencing (M=2.66, $p<.001$). Is seems that participants felt more comfortable discussing the sensitive topic via a "lean" communication medium. The use of personal textual chat mediated the media effect on the willingness to participate in discussions; using audio conferencing mediated the effects of medium, discussion topic and their interaction. Thus, participants' media preferences seem to be affected by their past experiences in using audio conferencing and chat communication.

4.2 Effects of Extroversion -Introversion Trait

Table 4 shows the means and SDs of extroverts' and introverts' willingness to discuss different topics using different communication media. As hypothesized, participant personality affected the willingness to partake in discussions (see Table 5).

In general, extroverts (M=4.29) were more inclined to participate in discussions than introverts (M=3.98). Participant personality interacted with type of medium. There was no statistically significant difference in willingness of extroverts (3.11) and introverts (3.18) to discuss through textual chat. However, using audio conferencing ($p<.01$) and face-to-face ($p<.001$) extroverts (audio conferencing M=3.12, face-to-face M=6.63) were more inclined to partake compared to introverts (audio conferencing M=2.70, face-to-face M=6.05).

Table 4: Means and SDs of the willingness to discuss by extroversion-introversion, type of medium, and topic sensitivity.

		Extroverts				Introverts			
Medium / Topic Sensitivity		F2F	Audio	Chat	Average	F2F	Audio	Chat	Average
Conventional	M	6.88	3.41	3.21	4.50	6.34	2.91	3.25	4.17
	SD	1.36	1.90	1.87	1.05	1.70	1.87	2.03	1.06
Sensitive	M	6.39	2.83	3.01	4.08	5.75	2.50	3.11	3.79
	SD	1.86	1.77	2.21	0.96	2.04	1.75	2.30	1.06
Average	M	6.33	3.12	3.11	4.29	6.05	2.70	3.18	3.98
	SD	1.43	1.60	1.72	0.86	1.54	1.63	1.87	0.94

Through online discussions, extroverts did not show preferences for a particular communication medium, while introverts preferred chat (M=3.18) than audio conferencing interactions (M=2.70, $p<.01$).

Thus, introverts expressed greater readiness for discussions via medium low in transmitting social communication cues than did extroverts. The use of personal textual chat mediated the extroversion-introversion trait effect on willingness to participate in discussions.

Table 5: Effects of extroversion-introversion, medium, and discussion topic sensitivity on the willingness to participate: Repeated measures ANOVA.

Effect	F	df	p
Extroversion	12.14	1, 404	<.001
Type of medium	484.26	2, 403	<.001
Topic sensitivity	62.01	1, 404	<.001
Medium x Extroversion	3.81	2, 403	<.05
Topic x Extroversion	.14	1, 404	n.s.
Medium x Topic	3.46	2, 403	<.05
Medium x Topic x Extroversion	.54	2, 403	n.s.

5 THE STUDY CONTRIBUTIONS

The current study contributes to cyberspace and media communication research. On the *theoretical* level, the study explores the effect of communication media as well as psychological factors on online behaviour. The impact of personality characteristics and their interaction with media features are analyzed. Online interaction is investigated through communication media having different degrees of anonymity (visual anonymity vs. both visual and auditory anonymity).

Methodologically, the study combines quantitative (measurement by a questionnaire) and qualitative (a content analysis) research methods. Such a mixed design allows the exploration of both universal and unique aspects of human online behaviour. A methodological weakness of previous studies was overcome through random assignment of participants into different experimental conditions. However, the study did not rely on a laboratory experiment; conducting the research in a natural habitat of actual Internet environment improves the ecological validity of the study and enlarges the generalization of its findings (Riva, Teruzzi & Anolli, 2003). In addition, the study crosschecked the willingness to communicate through different media with actual online behaviour, and explored whether participant personality characteristics moderate the relationship between the declared and actual participation.

The present study proposes some *implications* concerning the use of synchronous online communication, and especially audio conferencing which – despite its growing use in social, learning, and organizational context – has rarely been studied. In addition, the study explores both social and performance aspects of communication – a combination especially relevant to e-learning and group e-communication in organizations. The results of the study broaden the understanding of human behaviour in synchronous online communication.

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WATERFORD ASSESSMENT OF CORE SKILLS
A Computerized Adaptive Reading Test for Pre-K through 2nd Grade

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Keywords: Computerized Adaptive Test, Reading Assessment.

Abstract: The Waterford Assessment of Core Skills (WACS) is a new computerized adaptive test of early literacy for students in Kindergarten through 2nd grade. WACS includes assessments in letter recognition, letter sound and initial sound recognition, blending, segmenting, reading real and non-words, reading comprehension, listening comprehension, and vocabulary. A CAT for this age group will be highly beneficial by allowing whole classes to be tested together without additional personnel, by assessing a large number of content areas in reduced time and with fewer questions than a standard paper and pencil test, by producing immediate and accurate score reports, and by engaging students with animations during the test. Reliability and validity analyses indicate that the test is internally coherent and that the subtests correlate well with other reading tests used with this age group, including DIBELS, IRI, ITBS and TPRI.

1 INTRODUCTION

For the last 33 years the Waterford Research Institute has strived to develop high-quality educational models and programs to enable all children to receive the finest education possible. Over time it has become evident that the ability to easily assess student skills in the youngest grade school group, when students are most responsive to intervention, is lacking. Many current assessments available for this age group, Kindergarten through 2nd grade, require one-on-one administration (e.g., DIBELS; Good & Kaminski, 2003), which may result in a great deal of error variance due to differing administration techniques by individual testers or differences in scoring ambiguous answers. In addition, tests that do not require one-on-one administration are limited in the scope of what they can cover and they risk introducing too much variance from fidgety 6-year-olds (e.g., ITBS; Hoover, et al., 2003). A computerized test, such as the Waterford Assessment of Core Skills could provide consistent and efficient test administration by removing the need for a human test administrator and providing an engaging testing environment.

2 METHODS

The Waterford Assessments of Core Skills (WACS) is a web-based adaptive literacy test for pre-kindergarten to second grade students. The new test, soon to be available to schools and home users, assesses early literacy skills including letter recognition, letter sound and initial sound recognition, blending, segmenting, the reading of real words, non-words, and sight words, and comprehension of paragraph-level text. WACS also assesses early language skills including vocabulary and listening comprehension. As an adaptive test, WACS can assess a large number of content areas in reduced time and with fewer questions than a standard paper and pencil test. In addition, computerized adaptive tests (CATs) may reduce frustration for lower performing students and boredom for higher performing students.

2.1 Design

The award winning product design team at Waterford (Software and Information Industry Association, 2008) have created an engaging test that students actually enjoy taking. Throughout the test students are guided by a groundhog named Wyatt (see Figure 1) who is asking for their help on a number of tasks they have to do together. At the

end of each section and at the end of the assessment the students receive a non-judgmental reward screen that serves as a short mental break of dancing characters, with a new character appearing after each skill has been completed. When students have fully completed WACS, Wyatt presents them with a deputy badge as a reward for finishing the assessment.

WACS may be used by home users as well as school users, allowing home-schooling parents access to assessment tools similar to those used in the public or private schools. Home users will be able to complete the test by streaming the required media, while schools will be expected to download the related media to the computers in the classrooms or computer labs.

Figure 1: Wyatt, demonstrating the Sight Words Assessment.

2.1.1 Item Design

All test items are presented visually and aurally but do not require the child to speak the answer. For Letter Sound, Real Words, Sight Words, and Nonwords, the letter/word appears on the screen with three speakers underneath (see Figure 1). Each speaker says a different letter/word name. The student must click on the correct speaker to match the word or letter that is on the screen.

Vocabulary differs slightly from this arrangement with a sentence missing one word written at the top of the screen. The sentence is read to the child and the child must pick a word from the speakers that best completes the sentence.

In the case of Letter Recognition, Initial Sound and Blending there is a single speaker or picture at the top of the screen and three pictures or letters at the bottom of the screen (see Figure 2 for example). The speaker/picture emits a sound or a series of sounds and the student must select the picture below that begins with that same sound, matches the series of sounds, or select the letter that matches the letter name from the speaker.

Figure 2: Example of the Initial Sound Assessment. The answer is selected by clicking on the chosen letter with the cursor, the green arrow.

For Reading and Listening Comprehension the student is given a passage to read or listen to. When finished, the child is presented with a question about the passage followed by three possible answers. In Listening Comprehension the questions and answers are presented aurally. Each reading or listening passage includes four questions of varying difficulty. Each child receives three passages depending on skill level.

The final task, Segmenting, differs from all of the other tasks. Here, a picture is presented to the student and he/she must move a series of blocks representing the sounds into the correct order for the word associated with the picture.

For all skills, the computer introduces the question including the correct answer and the distracters. The student can use the mouse to roll over the question or the answer options to hear the instructions again.

2.1.2 Sequence Design

Importantly, all children do not receive all assessments. WACS includes eleven different assessments, a subset of which is given to students depending on their grade level and performance. Limiting the number of assessments completed for each child continues to reduce time required to test the student and allows for a more pinpointed report. It is assumed that students who are advanced in reading do not need to be tested on pre-reading skills such as letter recognition. However, students from advanced grades may receive basic skills if they fail

to complete advanced skills at their grade level. On the other hand, advanced students at lower grades may receive more advanced skills if they prove to be competent at the more basic skills.

2.1.3 Report Design

One of the greatest benefits of computerized testing for students is the ability to receive scores immediately after testing has completed. WACS has been designed to provide reports about individual test takers, as well as class, school, and district level reporting. The reports indicate the child's grade level for each of the completed assessments as well as detailed information about what was actually being assessed and ways that any problem areas could be addressed in the home or in the classroom. The past three test results for the students are also generated on the report, allowing parents and teachers to compare changes over time in relevant assessments.

2.2 IRT Analysis

In September, 2007, 8,800 students in Utah, Idaho, Nevada, California, New York, Texas, North Carolina, and Florida completed the first round of testing with WACS. This first group was given a random sample of questions from each assessment, all questions representing varied expected difficulty levels. The sample of students from twenty six schools was representative of US socio-economic status, ethnicity, geographic location, and type of school, based on information obtained from the US 2002 census.

Based on the responses, difficulty values for these 2,680 items were calibrated using the Rasch model analysis for item response theory. Results revealed 131 items with an outfit mean square greater than 1.7, indicating high error variance in the item. These items were excluded from the test. An additional 131 items with outfit mean square less than .5 were excluded, since items with outfit mean square smaller than .5 are considered less productive to the measure. Subsequent differential item functioning (DIF) analysis revealed 21 items that had a gender bias. These items were removed for content review. Item difficulty was then calculated for the remaining items.

Utilizing IRT analysis on test items, the adaptive nature of the test allows a student's response to determine the next set of items. For example, if a student fails to answer a question correctly within a skill area, the next question he receives will be less difficult. If the student answers that second question correctly, the next question is harder, but not as hard as the previously missed question. In this way, a computerized adaptive test identifies the student's skill level in a particular area. Because WACS can test up to eleven different areas, detailed information about the student's abilities are subsequently available to teachers and parents.

2.3 Validity

Validity is the argument that a specific test score interpretation or use is valid. In other words, a test is valid when it does what it is supposed to do. There are three major categories of validity: those associated with content, criterion, and construct.

2.3.1 Content Validity

In order to establish content validity, this paper discusses the reasons for the test design and content as well as the association between the given test and state standards or curricula. First, content experts investigated the most important skills for pre-kindergarten through 2nd grade students and established guidelines for writing items based on published research. The areas covered included acquisition of letter names and sounds (Adams, 1994; Evans, 2005), early phoneme awareness (Wilson, 1996), sight word reading (Carroll, 1971; Wilson, 1996), real and non-word reading (Wilson, 1996; Ganske, 2000), vocabulary (Stemach & Williams, 1988; Beck, McKeown, and Kucan, 2002), and reading and listening comprehension (Snow, Burns, & Griffin, 1998). In addition, all comprehension passages and questions were written by professional writers, reviewed by content experts, and edited by writing experts. Reading comprehension passages were Lexile certified for their grade levels.

Upon completion, items from all of the subtests were reviewed by additional content experts and sent to Marilyn Jager Adams, an external content expert, for review. After IRT testing, analysis was conducted to insure that item difficulty, as determined statistically by IRT analysis, correlated with the item difficulty as determined by the content experts.

In addition to creating items based on researched concepts, a valid reading test should also cover standards accepted by the states for reading and language development. Thus, state standards were examined and correlated with WACS skills and items. With the exception of Iowa (which did not list

standards below grade three), a minimum of three, and a maximum of eleven, WACS assessed skills were also listed as state education standards for PreKindergarten through grade two.

2.3.2 Criterion-related Validity

The effectiveness of a test in predicting performance on a related task can be measured by assessing performance on two tests at the same point (concurrent validity) or at two different time points (predictive validity). To assess concurrent validity WACS was administered to students nationwide in September and October. Student performance was then compared to performance on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS), the Idaho Reading Inventory (IRI), the Iowa Test of Basic Skills (ITBS), and the Texas Primary Reading Inventory (TPRI). Additional test data for the Stanford Achievement Test (SAT 10) and ITBS will be collected in April, 2009.

Data for predictive validity will also be collected in the spring. WACS will be administered to the same students from the fall testing. Those students are also completing a spring round of testing for DIBELS, IRI, or TPRI, making it possible to examine predictive validity as well as a second assessment of concurrent validity.

All five tests used to measure WACS validity examine early reading skills and some include subtests similar in name and concept to those given in WACS, providing a stable comparison.

2.3.3 Construct Validity

Construct validity is typically measured with factor analysis or principle component analysis. Because the data was acquired with a computer adaptive test, the large amount of missing data makes a typical factor analysis less useful. Instead, a Rasch Factor Analysis, completed in WINSTEP software, performs a principle component analysis in order to verify that our data is unidimensional. An additional modified factor analysis is run with SPSS for confirmation.

2.4 Reliability

Reliability refers to the consistency of a measure; tests that have adequate reliability will yield more or less the same scores across periods of time and across different examiners. Because WACS is administered on the computer there is no error generated from different examiners. However, error may still be introduced into the resulting final scores through lack of attention to the task at hand, faulty headphones, and disinterest. Because of these concerns, it is important to examine test-retest correlations with a small gap between testing dates as well as the internal consistency of the test.

Computerized adaptive tests differ on measures of test-retest reliability since an individual does not see the exact same test at each time point. The resulting correlation coefficient is regarded as a conservative estimate since content sampling adds an extra degree of error beyond individual performance. CATs also differ on measures of internal consistency. Traditional methods, split-half reliability and Cronbach's Alpha, are statistically inaccurate when applied to a CAT tailored to achievement. Instead, the marginal reliability coefficient provides a better measure of internal consistency by combining measurement error estimated at multiple points on the scale. The resulting coefficient is almost identical to Cronbach's alpha.

3 RESULTS

3.1 Concurrent Validity

Concurrent validity analyses were performed with DIBELS, IRI, ITBS, and TPRI. The Kindergarten WACS combination of tasks includes Blending, Initial Sound, Letter Recognition, Letter Sound, and Vocabulary. The first and second grade combinations include Real Words, Nonwords, Sight Words, Reading Comprehension, and Vocabulary. Overall, correlations between relevant WACS assessments and the associated paper and pencil test are highly significant (Table 2), even with the currently low number of participants taking the ITBS (see Table 1).

Table 1:Number of students completing comparison test.

Assessment	N Kindergarten	N First	N Second
DIBELS	206	142	137
IRI	120	61	126
ITBS		66	69
TPRI	170	155	190

DIBELS Beginning Kindergarten assessment, consisting of Letter Naming Fluency and Initial Sound Fluency, significantly correlates with WACS Kindergarten Skills ($r = .74$, $p < .001$). Similarly, DIBELS Beginning First Grade assessment, consisting of Letter Naming Fluency, Phoneme

Segmentation Fluency, and Nonword Fluency, significantly correlates with WACS 1st grade Skills (r = .72, p < .001) and DIBELS Second grade assessment, consisting of Nonword Fluency and Oral Reading Fluency, correlates with WACS 2nd Grade Skills (r = .61, p < .001).

Patterns or correlations for the IRI are similar to those seen with DIBELS. The IRI includes only one test for Kindergartners, the Letter Naming Fluency test, and this task correlates significantly with WACS Kindergarten Skills (r = .57, p < .001). First grade IRI tasks, Letter Naming Fluency and Nonword Fluency, also correlate highly with WACS 1st grade Skills (r = .74, p < .001). Finally, second graders taking the IRI receive only the RCMB, a reading fluency task. This IRI reading task also significantly correlates with WACS 2nd grade Skills (r = .58, p < .001).

The ITBS includes a number of areas of assessments. For our purposes, comparisons are only made to the Reading subtest for 1st and 2nd graders. ITBS Reading significantly correlates with WACS 1st grade Skills (r = .7, p < .001) as well as with WACS 2nd grade Skills (r = .41, p < .001).

The TPRI is designed for students to receive additional assessments based on previous performance. Only Letter Sound, Blending, Letter Name, and Comprehension are given to all Kindergartners. This combination significantly correlates with the WACS Kindergarten Skills (r = .52, p < .001). The TPRI combination given to all first graders includes Letter Sound, Word Reading, Word Per Minute Rate, and Comprehension Questions. This combination also significantly correlates with the WACS 1st Grade Skills (r = .64, p < .001). Finally, the TPRI combination given to all second graders, including Word Reading, Words Per Minute Rate, and Comprehension, also significantly correlates with WACS 2nd Grade Skills (r = .5, p < .001).

Due to the way the test sequencer works, very few students were given the Segmenting assessment this fall. As a result, Segmenting could not be added to any of the combinations for the grades. However, in order to more thoroughly understand how this task correlates with other reading-related tasks, Segmenting was correlated with two relevant tasks for which the n was over 30. Segmenting correlated significantly with both DIBELS Nonword Fluency (r = .42, p < .05) and IRI Reading (r = .37, p < .05).

Table 2: Relevant correlations between WACS and school-administered assessments.

	WACS Assessments		
	WACS Kindergarten Skills	**WACS 1st Grade Skills**	**WACS 2nd Grade Skills**
DIBELS, Beginning Kindergarten	r = .74, p < .001		
DIBELS, Beginning 1st Grade		r = .72, p < .001	
DIBELS, Beginning 2nd Grade			r = .61, p < .001
IRI, Kindergarten	r = .57, p < .001		
IRI, 1st Grade		r = .74, p < .001	
IRI, 2nd Grade			r = .58, p < .001
TPRI, Kindergarten	r = .52, p < .001		
TPRI, 1st Grade		r = .64, p < .001	
TPRI, 2nd Grade			r = .50, p < .001
ITBS 1st Grade		r = .70, p < .001	
ITBS 2nd Grade			r = .41, p < .001

3.2 Construct Validity

In general, when over 60% of the variance is explained by a single factor, a test is considered to have only one underlying factor. For WACS, 63.5% of the variance is explained by a single factor. Unexplained variance within the 1st factor is 4.5 % (unexplained variance smaller than 5% confirms that there is a single factor). An additional modified factor analysis run with SPSS produces similar results, with the first factor explaining 60.5% of the variance and the next highest factor only explaining 9.7% of the variance. All assessments load strongly on the first factor (all weights above .63) and only Letter Recognition and Letter Sound have weights above .4 on the second factor. In addition, the scree plot indicates a dramatic drop from the first (eigen value of 6.7) to the second factor (eigen value of 1). Finally, another test of the internal coherence of WACS overall is to examine correlations between subtests. Resulting correlations indicate significant relationships among all of the WACS subtests, ranging from $r = .38$ (between Letter Recognition and Listening Comprehension) to $r = .74$ (between Letter Sound and Initial Sound), supporting the conclusion that all subtests can be grouped together as a unidimensional test.

3.3 Reliability

Test-retest correlations will be completed in April, 2009, when students take their spring WACS test. The preliminary reliability correlation for WACS Kindergarten Skills, with a sample size of 127, was significant ($r = .52$, $p < .001$) as was the reliability correlation for WACS 1st Grade Skills, with a sample size of 85 ($r = .73$, $p < .001$).

Internal reliability has already been measured with the marginal reliability coefficient, examining internal test consistency. Reliability for WACS, is very strong ($r = .93$).

4 CONCLUSIONS

Currently, very few standardized assessments are capable of being used in for pre-K through 2nd grade educational group. Even tests that can be used with these young children often aren't used, likely due to difficulties in keeping young children engaged. WACS has been designed specifically for young children, and by presenting the testing information on the computer, the children are able to stay engaged with the animated characters. Current No Child Left Behind standards require testing beginning in third grade. However, research demonstrates that early detection and intervention are essential for academic success. Identifying struggling students early increases these student's chances of being successful readers and meeting the NCLB requirements. With an assessment that is easy to administer, engaging for the students and provides accurate immediate results, more students are likely to be reading at or above grade level in the future. With validation on the Waterford Assessment of Core Skills completed this coming spring, WACS will become an important part of grade school education.

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UNDERSTANDING THE BEHAVIOUR OF CDMA-BASED CELLULAR NETWORKS WITH A USER-FRIENDLY SIMULATION SOFTWARE

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Keywords: Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access (CDMA), Simulation Software, Virtual Labs, e-learning in network engineering.

Abstract: The Universal Mobile Telecommunications System (UMTS) has been developed in order to create a unified telecommunications system with multimedia capabilities. UMTS uses the Code Division Multiple Access (CDMA) technique. In this type of system, all users share the same frequency at the same time. Interference then plays a major role in the behaviour of a CDMA network and causes the coverage to vary according to the load. Furthermore many parameters have an impact on the coverage (spreading factor, user rate, transmission power etc...). So motivating students to learn CDMA concepts is often difficult because they find it very difficult to understand the physical phenomena. To overcome this problem, students need to practise several laboratory exercises. Then they need a suitable simulation tool. In this paper a simple cellular model is introduced and a CDMA software based on that model is described. Its effectiveness as a teaching method is explained. This simulator can help students to understand the CDMA network behaviour more accurately.

1 INTRODUCTION

The exciting pace of wireless telecommunications system evolution has marked the last few years. This fast evolution is the result of the huge success of digital mobile systems and the increasing demands of mobile users for Internet oriented applications. Second generation systems mainly offered telephony services and data transmission with moderate rates. Third generation networks have multimedia capabilities, such as the support for high bit rates and the introduction of packet data/IP access.

Main third generation systems are UMTS (Universal Mobile Telecommunication System) standardized within 3GPP (Third Generation Partnership Project) (Lagrange, 2005) and CDMA2000, which is an evolution of the north-American system IS-95 and which is standardized by 3GPP2.

Both air interfaces use the CDMA (Code Division Multiple Access). CDMA is suited for data transfer with bursty behaviour. However, CDMA is much more complex than classical Time Division Multiple Access (TDMA). All users in a cell are transmitting on the same frequency and thus create interference to each other. Power control has, therefore, a major impact on a network based on CDMA. Each transmitter has to adapt its transmission power to the optimal level that allows both a good quality of service and a high capacity. That transmission power level increases with the number of the users. Hence coverage and capacity are two antagonist notions. The higher the load is the lower the coverage is.

In this paper, a user-friendly simulation software that may ease understanding of the behaviour of CDMA-based cellular networks is presented. This paper is divided into seven sections. Section 2 is a reminder of spread spectrum and cellular CDMA systems. Section 3 describes the simulation tool context and objectives. Section 4 introduces the model used in the simulator software and the main functions. Section 5 gives the simulator features. Section 6 presents some laboratory exercises for students that can be achieved through the simulator tool. Section 7 gives some feedbacks on the use of the tool. Finally, section 8 proposes some possible evolutions of the simulator.

2 CELLULAR AND CDMA FUNDAMENTALS

2.1 Spread Spectrum Interest

In a transmission system, the correct reception of a transmitted information bit requires a certain relationship between the energy received per information bit E_b and the noise spectral density N_0. The ratio E_b/N_0 must be higher than a threshold to guarantee a maximum bit error rate (BER). That threshold can be assumed in the first approximation step to be independent of the transmission and modulation scheme. Consequently that threshold is given by :

$$E_b/N_0 \geq (E_b/N_0)_T \tag{1}$$

where the threshold $(E_b/N_0)_T$ is typically 6 dB for a 10^{-3} BER (ratio 4 in a linear scale).

In direct-sequence spread spectrum systems, devices transmit chips instead of bits at a higher rate than necessary. For a user bit rate R, chips are transmitted at a rate W : each bit is replaced by a sequence of W/R chips. In order to keep good spectrum properties the sequence is pseudo-random and hence the bandwidth of the transmitted signal is W for simple modulation schemes as opposed to the bandwidth of the user bit flow that is R. As a conclusion, the spectrum is spread and ratio W/R is then called the spreading factor or the spreading gain.

In the transmitter, each data bit is multiplied with the spreading sequence and then sent on the air. In the receiver, the spread signal is also multiplied by the same sequence and integrated over the bit period (this is the simplest receiver, for an exhaustive presentation see (Proakis, 2001)). This operation is called de-spreading. The original user flow is then recovered. The signal is generally interfered by thermal noise and interferences. However, de-spreading is neutral for all noise and interferences thanks to the random properties of the spreading sequence. Let C be the received signal power at the receiver. Let I_{tot} be the power of all the interferences. The following formula is admitted:

$$\frac{E_b}{N_0} = \frac{W}{R}\frac{C}{I_{tot}} \tag{2}$$

Let $\beta = (E_b/N_0)_T \frac{R}{W}$. Constraint 1 may be combined with equation 2 and be re-written as follows:

$$\frac{C}{I_{tot}} > \beta \tag{3}$$

Equation 3 shows that β is the minimum required C/I. In UMTS (Holma and Toskala, 2004), $W = 3.84$ Mchip/s and R depends on the user service but is typically 15000 bps for voice services. Hence $W/R = 256$ (spreading gain 24 dB). In all cases W/R is larger than 1 and consequently $\frac{C}{I_{tot}}$ may be lower than 1. As a conclusion, spread spectrum systems tolerate a level of noise and interference much higher than the signal. For instance with $(E_b/N_0)_T = 6$ dB and a spreading gain of 24 dB then $\beta = -18$ dB. For the system to work well C/I_{tot} must be just higher than -18 dB.

2.2 CDMA Principle

Code division multiple access (CDMA) is a form of multiplexing that does not divide up the channel by time (as in TDMA:Time Division Multiple Access) or frequency (as in FDMA:Frequency Division Multiple Access) but by codes. CDMA uses direct-sequence spread spectrum but the sequences are based on Walsh codes constructed with Hadamar matrices (Viterbi, 1995). The spreading sequences of the different users are orthogonal. However, the orthogonality is only guaranteed if synchronization is possible between the different spreading sequences. Such synchronization is simple when there is a common transmitter : it can then be used on the downlink of cellular systems as the same base station is transmitting to all mobiles of the cell. However, it is not possible on the uplink as mobiles cannot be synchronized to each other at the chip level because of variable propagation delays. Different users then use different pseudo-random spreading codes on the uplink (Viterbi, 1995).

To illustrate the access of the CDMA type, we can make an analogy with a gathering of people from different nationalities where everyone is speaking at the same time but is using different languages. A newcomer who for example understands only French language would be able to extract only the French sentences stated of the ambient hubbub. Conversations of the others seem to him like a noise deprived of mean. However, if the general level of noise coming from the other conversations is too important, it will be more difficult or even impossible for our visitor to understand the speech of his compatriot.

2.3 Interference Analysis in a Regular Network

In a cellular network mobiles do not receive a perfect signal from their serving base station. The signal is affected by noise and interference. The noise is mainly due to thermic agitation of electrons (thermal noise) and to imperfections of the first amplifier stage. It is denoted by N_{th}.

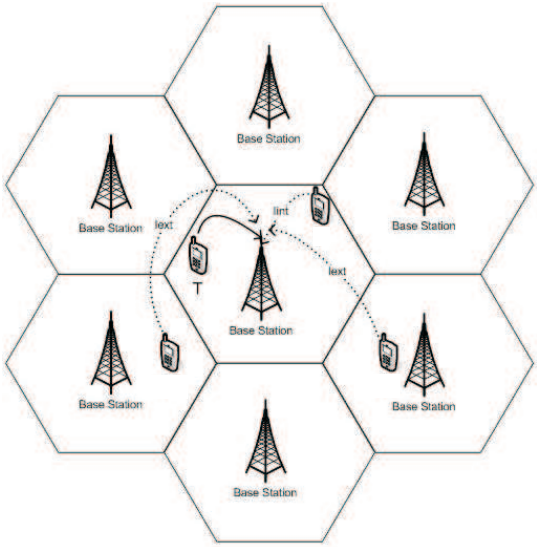

Figure 1: Interferences in the UpLink come from mobiles in the other cells and in the same cell.

Interference is mainly due to the reuse of frequencies in several cells and is called co-channel interference. Other types of interference are negligible compared to the co-channel interference. In CDMA networks the same frequency is used for all terminals in all cells. The level of interference is then high compared to TDMA or FDMA networks.

Due to the limitation of the text length, we develop the impact of the interference on the uplink (terminal to network). The same phenomenons are observed on the downlink though there is some differences due to the possibility to have orthogonal codes between transmissions to different users of the same cell (Lagrange, 2000).

A user terminal T is transmitting on frequency f_0 to its serving base station B in one cell. All terminals in the same cell are transmitting on f_0 to B and generate internal interference. Furthermore f_0 is also used by all terminals connected to other base stations. Such transmissions generate external interference (for T). Let I_{int} be the internal interference and I_{ext} be the external interference (see fig 1). The C/I ratio may be written as :

$$C/I_{tot} = C/(I_{int} + I_{ext} + N_{th}) \tag{4}$$

2.4 Power Control

In a CDMA system power control is a very important issue because all the users of the network use the same frequency band at the same time.

The general objective of power control is to ensure the same E_b/N_0 ratio for all users. In order to minimize the power consumption the E_b/N_0 target must be the lowest acceptable value. That is :

$$E_b/N_0 = (E_b/N_0)_T \tag{5}$$

In order to reach the $(E_b/N_0)_T$, each mobile must adapt its transmission power. As N_0 is the same for all mobiles in the same cell, reaching an E_b/N_0 target is equivalent to reaching a common signal target denoted as C_{tg}. The more mobile there are, the higher N_0 is and hence the higher C_{tg} is.

The maximum capacity is obtained when all mobiles are received at the same power level at the base station. However, that level is not the same in all base stations. Determining the level target for each cell is a complex task in an operational network. Iterative algorithms that try to approach the optimal solutions are used. In a simple regular network it is possible to analytically determine that target (see (Zander, 1992) for more details). Such an approach is used in this contribution but is not detailed for the sake of simplicity.

2.5 Notion of Pole Capacity

If only one cell is considered and if the thermal noise is negligible then with a perfect power control the C/I_{tot} is given by:

$$C/I_{tot} = \frac{C_{tg}}{(M-1)C_{tg}} = 1/(M-1) \tag{6}$$

where M is the number of mobiles in the considered cell. Equation 6 and constraint 3 demonstrate that the maximum number of mobiles able to transmit in one cell is limited. Even if mobiles were able to transmit at very high power it is never possible to have more than $\frac{1}{\beta}+1$ active mobiles in one cell. The *pole capacity* is then defined as the maximum number of mobiles per cell in a network with infinite power mobiles. An upper bound of the pole capacity is $\frac{1}{\beta}+1$ but determining it is not simple when external interference is taken into account.

2.6 Variation of the Coverage According to the Load

The coverage in a CDMA system is directly related to the load of the network. The load is defined as the number of active users.

The more the number of mobiles in the cell increases, the more they must increase their emission power. However, each mobile is characterized by a maximum transmission power. Consequently, mobiles that are located at the edges of the cell are no longer able to reach the base station (the required power would be above the maximum value). This

phenomenon is known as cell breathing : coverage decreases as the load increases.

The exact coverage depends on several parameters like the data rate allocated to each user, the level of noise but especially the load on the cell. In a simple regular network with perfect power control, the coverage can be calculated on the uplink and downlink.

3 SIMULATION TOOL OBJECTIVES

At TELECOM Bretagne (Ecole Nationale Superieure des Telecommunications de Bretagne) cellular network fundamentals are given in first year of graduation studies (MSc level). The second year is rather dedicated to more advanced systems like 3G and 4G wireless networks. In this context, spread spectrum concept and CDMA is taught. As it was introduced in part 2 there is a lot of interaction in cellular networks due to the impact of the interference. Understanding how a network ”lives” is not simple. Sometimes students are confused by the technical details and do not understand the basic physical phenomena. It is then necessary to have labs where the student can practice. As network UMTS devices are very expensive, simulation is the only way for laboratories.

3.1 Simulation Tool Overview

Indeed, major simulation tools like OPNET (OPNET, 2008) or COMNET (COMNET, 2008) are more protocol oriented and require a lot of time to be used correctly. Furthermore the multi-cell aspect is generally not included. Other planning tools such as ATOLL (FORSK,) or PLANET (MARCONI, 2008) are more adapted to predict the coverage in a given environment. They use sophisticated digital elevation models to predict coverage and evaluate the quality of service delivered in a zone. The behaviour of a network for different loads is precisely modelled and may be displayed. However, a huge number of parameters have to be manipulated. When some variations in the coverage are apparent, it is very difficult to identify the reason for them. For example, the coverage level may be deeply impacted by some specificities of the propagation models rather than the basic physical CDMA characteristics.

There is then a need for a user-friendly simulation software of a CDMA network that reflects the behaviour of a CDMA wireless network.

3.2 VICTOR Objectives

The objective at TELECOM Bretagne was to have a tool that every student could launch and use within 5 minutes. Simplicity was the first objective. The simulation is thus not event-oriented but is closer to a Monte-Carlo approach. The developed software is based on a model which will be described in the following and the simulator is called VICTOR (Visualisation Interactive du ConTrOle de puissance dans un Reseau regulier) : Interactive Visualization of power control in a regular network.

4 MODEL PRESENTATION

4.1 The Network Model

A regular hexagonal network with omnidirectional base stations is considered in VICTOR. The number of cells is set to 7 : one central cell is surrounded by six neighboring cells. Terminals are randomly spread over the 7 hexagonal cells. They are assumed to be fixed. However, they are called mobiles, as it is usually done in cellular networks.

The radius of the cells may be changed by the user but the default value is 1 km. A regular propagation is considered also in VICTOR. The effect of obstacles is not simulated in details. Irregularities in the propagation are modelled by a random variable. Such an approach is very classical in much research work (see (Gilhousen et al., 1991) for instance). The user has access to a large number of parameters (propagation law, spread spectrum factor, noise figure,...). However, predefined values that correspond to a typical coherent system are set by default.

4.2 Main Functions of the Software

VICTOR propose two possibilities to fix its configuration parameters: i) at the beginning of the simulation, ii) at any time in the simulation. Once the parameters are fixed, the user can very easily change the number of mobiles in the network through the slider. For a given number of mobiles, VICTOR calculates the target level of the reception power in the downlink and in the uplink. It derives the required power level for each mobile on the uplink and for each base station on the downlink.

In some cases, it is not possible to serve all mobiles. Mobiles that cannot be served are called *inactive mobiles* : on the uplink the transmission power of inactive mobiles is set to 0. On the downlink, no

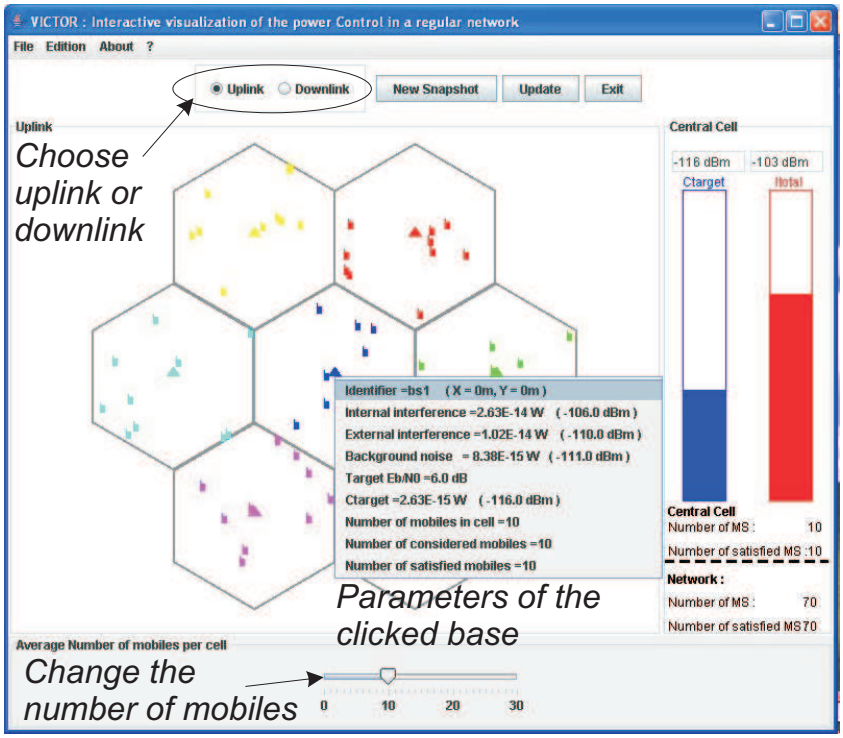

Figure 2: All mobiles are covered in the network: 10 mobiles in the central cell and 70 mobiles in the whole network.

power is dedicated to inactive mobiles. The communication of such mobiles would be cut or not established in an operational network.

Once the transmission powers of the mobiles and the base stations are defined, VICTOR computes the internal and external interferences for each mobile and for each base station, the path loss and many other fields. All the computation is done both on the uplink and the downlink. The user chooses either the downlink display or the uplink display. He or she can very easily switch from one view to another one thanks to a radio button .

5 OVERVIEW OF THE SIMULATOR

VICTOR is programmed in Java language and can run on any operating system. There is also an applet version of VICTOR which can be used from any browser (http://formations.telecom-bretagne.eu/ressources/rsm). The software is approximately 10 000 lines.

The main principle window of VICTOR is divided in 4 parts (see fig. 2). The network is represented by the cells, the different base stations and mobiles. In the right of the window, some gauge indicators are disposed : i) in the uplink case, the two gauges represent the target power and the total interference (internal, external and thermal noise) of the base station of the central cell; ii) in the downlink case, the two gauges indicate the target power and the total interference for a test mobile. In addition to the two gauges, there are two indicators of the number of mobiles and the number of satisfied mobiles (well served mobiles) on both the central cell and the network.

VICTOR offers the possibility to select the visualization of the network either on the uplink or on the downlink by a radio operator button. The position of the mobiles in the different cells can be changed by carrying out a new random choice (while pressing on the new Snapshot button). Finally, the user may see the information such as the received power, the internal interference,... by clicking on a mobile or a base station.

Let us consider the case of 10 mobiles in each cell of the network (see fig. 2). In the central cell, the interference level is weak (-103 dBm) and the target power level (-116 dBm) is low enough to serve all the mobiles. Consequently, all the mobiles are covered in the central cell (10 mobiles) and in the whole network (70 mobiles). Fig. 2 shows all the information of the base station on the uplink such as the internal interference, the external interference and so on.

Let us now consider 30 mobiles in each cell (see

fig. 3). Mobiles that do not have enough power to reach the base station are barred with a cross. As it is depicted in the latter figure, the number of covered mobiles (110 mobiles) is lower than the number of mobiles in the network (210 mobiles). For example, if the user looks at the central cell there are only 16 active mobiles among the 30 mobiles because of the high interference level (-87 dBm). Consequently, the user deduces that the cell has attained its pole capacity (16 mobiles). Fig. 3. shows all the information of the mobile station on the uplink such as the transmission power, the path loss... All these examples are given for uplink. However, VICTOR can also be used to visualize the pole capacity notion on the downlink.

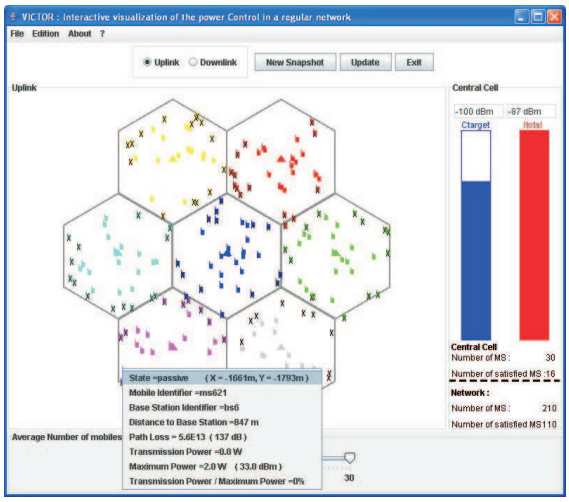

Figure 3: Pole capacity on the uplink: 16 mobiles in the central cell and 110 in the network.

6 LABORATORY EXERCISES

In lectures, the basic concept of a CDMA network and related issues and challenges are introduced. These concepts are reinforced when the students set up the laboratory exercises. In the following we present several labs.

Laboratory 1: The Cell Breathing Phenomenon on Uplink. In this introductory lab, students are first asked to analytically determine the maximum radius of a cell on the uplink without any load. By considering only thermal noise, they calculate the minimum level received power C_{min} by combining equations 3 and 4. Using propagation equations with C_{min} and the mobile transmission power they then find the range of mobile terminals. The obtained value is much higher than the radius of a hexagonal cell. This shows the coverage for a non loaded network is very good.

Students then use VICTOR and look at the number of mobiles that can reach the base station for different loads. They realize the total interference level increases with the number of mobiles in the network. They are asked to determine the maximum number of mobiles served. They are then asked to increase the transmission power of mobiles by typically 3 dB to check that the capacity increases slightly. They repeat the same process (power increase). Above a certain power they note the capacity does not increase anymore : the pole capacity has been reached. They note this maximum is the same for different snapshots. In completing this practical, students develop a sound knowledge of the impact of interference in a CDMA system and an understanding of the pole capacity.

Laboratory 2: The Cell Breathing Phenomenon on Downlink. As in lab 1, students are asked initially to calculate the pole capacity on the downlink case and to check it with VICTOR. They notice that beyond a certain power of the base station the number of covered mobiles does not exceed the already theoretically calculated value. The pole capacity has been reached. In completing this practical, students develop a better understanding about the pole capacity on the downlink case.

Laboratory 3: Impact of the User Rate. CDMA is interesting in multimedia cellular networks because it provides flexibility. A network is able to accommodate different user rates R. As the bandwidth W remains the same, increasing the user rate decreases the spreading factor. Hence, higher rates require higher power. In this lab, students are asked to increase the user rate and to determine the impact on the capacity both on the uplink and the downlink. Let us note that VICTOR is not able to mix different user rates in the same simulation like a UMTS network. However, it is possible to change that parameter and to see the impact of a new value with exactly the same position of mobiles. Students can then really understand the impact of high rates and the corresponding cost in term of power budget.

Laboratory 4: TDMA vs CDMA. Due to multipath, the different transmissions of a base station are not perfectly orthogonal. This is generally modeled by integrating in the interference calculation a non orthogonality factor α. This factor may vary from one mobile to another and depends on its position in the network. However, for the sake of simplicity the same value is considered for all mobiles in VICTOR.

Students fix the number of mobiles per cell to the pole capacity of the uplink and they notice that all mobiles are covered on the downlink for $\alpha = 0.5$. In-

deed, the internal interference value on the downlink is much lower than on the uplink thanks to orthogonal codes on the downlink. Students are shown that for α equals to 0, the internal interference is eliminated. Consequently, the maximum capacity increases because mobiles receive less internal interference and need less power. For $\alpha = 1$, the capacity is lower due to the rising internal interference in the cell. In this case, the base station must redistribute equitably its power between the mobiles.

In the following, a complementary lab describing the behaviour of a CDMA system compared to a TDMA system is presented. Let us consider the case of a strong non-orthogonality on the downlink. Two strategies are proposed: i) the base station transmits simultaneously two user flows on two different codes; ii) the base station transmits one flow, then the other, by reducing the spreading factor and by increasing the instantaneous rate (case of the TDMA). Students are asked then to consider the two strategies. Students show that in the first strategy there is internal interference but in the second strategy internal interference is eliminated. Consequently, the network performance becomes much better. Students may then conclude that TDMA is better on the downlink of a given base station when there are no strict delay constraints. In completing this practical, students gain experience in modelling orthogonality on the downlink and received a good introduction to the basis of 3.5 systems like HSDPA (High Speed Data Packet Access) that rely on a time shared downlink channel.

7 ASSESSMENT

7.1 Evaluation by Students

VICTOR was used during autumn semester in 2006-2007 and 2007-2008. In 2006-2007, there were 32 students who were registered for the course unit. As it was a trial, they did only labs 1 and 2 after the theoretical courses.

VICTOR software was evaluated anonymously by students. The aim of the evaluation is to check VICTOR is really easy to use and to analyze the perception of students on VICTOR's benefits. Students were asked 5 questions as shown in figure 4. One additional open question asks them to give their opinion on VICTOR. More than 95% find the software is easy or very easy to use. They do not spend much time to become familiar with VICTOR as more than 65% needed less than 5 minutes to that. Some students who have an above average ability to follow theoretical courses found VICTOR unnecessary since the concepts covered were simple. However, more than 95% found it useful. Note that 61% consider VICTOR is useful but does not exempt them from working on the theoretical lessons. Students were asked to write one sentence for their evaluation of VICTOR. Here are a few answers:

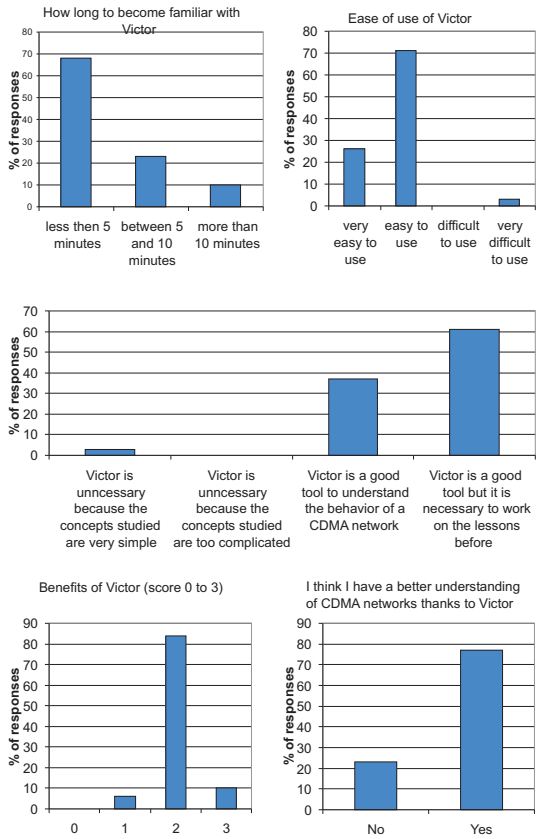

Figure 4: Subjective evaluation of VICTOR by students.

- VICTOR is a good way to have practical applications of the theoretical courses,
- VICTOR facilitates understanding of the course,
- VICTOR is a simple software that really helps to fix the basic concepts of CDMA networks,
- I won't say that I learnt new things. However, I have understood why some elements of the course are useful and thanks to VICTOR I asked myself good questions. It is then a very useful help to understand the course.

7.2 Objective Evaluation with a Quiz

Before the labs, students were asked to make a technical multiple-choice test comprising 12 questions. The same test was used after the labs to analyze the benefits of the labs.

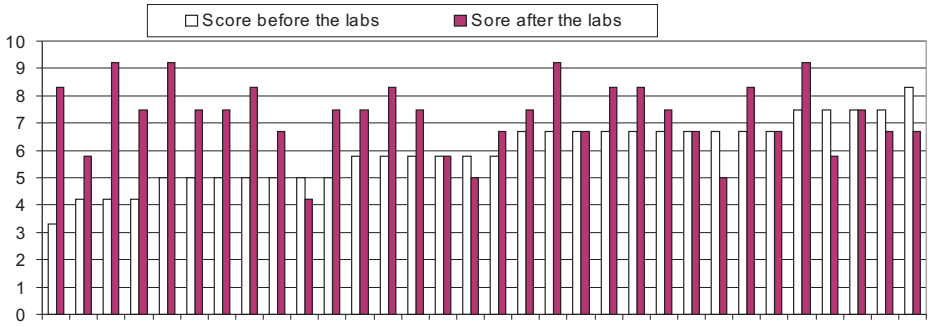

Figure 5: Scores of all students before and after the labs (sorted in ascending order for the first test.)

The individual score of each student is given in figure 5. Most students (78%) got a better or an equal score after the labs. The average score was 6/10 before the labs and 7.3 after the labs. Strangely, 6 students got a lower score after the labs. This is due to two different factors : firstly, some students answered randomly to some questions. Secondly, the questions were short. Hence, a few questions were partly ambiguous. Several students thought they include traps. Instead of giving the simple direct answer, they misinterpreted the question and gave a wrong answer though they had well understood the concept. One can notice that the students who had a low score at the first test improved their score greatly in the second test. This should suggest that these students have the ability to understand the concepts but have difficulties in classical lessons. For such students lab work is very important.

8 CONCLUSIONS

VICTOR can be used either for class demonstrations, in enhancement of the traditional lecture environment, or in the computer laboratory for hands-on practical work in a UMTS networking course. It is easy to use and provides a suitable interface that helps users to gain better understanding of UMTS network.

The possibility of VICTOR enhancement are numerous. However, the challenge is to keep a very simple man-machine interface to have software which is very easy to use. Students may focus their attention on the radio and network aspects and not on how to use the software.

ACKNOWLEDGEMENTS

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A HYBRID APPROACH TO COMPUTER SCIENCE EDUCATION
A Case Study: Software Engineering at Aristotle University

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Keywords: Open source, Software engineering, Open learning environment, Participatory learning, Open participatory learning ecosystem.

Abstract: Traditionally one characterization of formal education has been that it is 'closed', resulting in the fact that learning spaces with their educational materials, and individual students' learning processes and outcomes remain unavailable for the general public. The hybrid approach to Software Engineering piloted at Aristotle University during the winter semester 2008 / 2009 on the other hand builds upon the way learning and knowledge creation at the participatory web takes place, in particular within the Free / Libre Open Source Software (FLOSS) communities. This is to say that on the hand the learning environment used at this course is open for participation of any individual interested at the subject (inviting in), and on the other hand Aristotle's software engineering students are engaging at students driven small scale learning projects, with each of those learning projects being associated to an open source project (sending out). This combination of 'inviting in' and 'sending out' is what we like to call a hybrid approach. One objective of the hybrid approach is to provide the foundation required for an evolutionary growing learning ecosystem where learning processes and outcomes have the potential to become learning resources for future students and therefore connecting content to discourse.

1 INTRODUCTION

There are a number of challenges for formal education to fully explore the benefits the participatory web provides for education. With regards to collaborative learning and knowledge production the main challenges might relate to the traditional 'closed' and 'semester based' structures of educational systems.

Closed structures on the one hand prevent that students at one institution could engage and collaborate at the web in a 'semi-structured' way with peers from fellow universities or the wider world. This closedness also prevents that the learning resources of the institution might be improved by the outside world, or enhanced through external sources that are brought in by individuals or through technology.

Semester based structures on the other hand provide a challenge to establish a learning ecosystem that would allow for continuous and evolutionary growth; as well on a community level, including the full spectrum of participants ranging from newbies over advanced learners to old foxes, as on a learning resource level. Such a learning ecosystem would on the other hand be desirable as it connects learning resources to learning processes (and related discourse) or the possibility to establish peer support, correction, development or even assessment systems.

A third challenge to education, though not necessarily related to 'closed' or 'semester based' structures, is the question how to provide students with meaningful and motivational learning opportunities that would allow them to develop their professional skills within a real world scenario and impart them as well subject matter skills as also key

and soft skills, such as ICT literacy, critical and analytical thinking skills, project and time management skills, or presentation, negotiation and conflict management skills. To respond to this third challenge web based communities in general, and FLOSS communities for computer science education in particular, might be an adequate equivalent to traditional physical internships, placements or trainings-on-the-job.

So how to address those challenges that prevents education within its traditional structures to fully take advantage of the collaborative learning and knowledge production opportunities the web and the FLOSS paradigm provides?

2 FLOSS COMMUNITIES AS AN EXAMPLE FOR OPEN PARTICIPATORY LEARNING ECOSYSTEMS

To deepen our understanding how collaborative learning and knowledge production takes place at the web we first reviewed at the EU funded FLOSSCom project (FLOSSCom, 2008) one of the likely most mature open participatory learning ecosystems: the FLOSS communities.

Surprisingly the underlying technology used by most FLOSS projects is relatively simple, yet mature, usually including versioning systems, mailing lists, chats, forums, wikis or similar knowledge bases. Additionally free web based services such as Sourceforge provide each FLOSS project with an initial working and community environment therefore facilitating the take off of new projects (Meiszner, 2007).

The way learning takes place in FLOSS is usually a mixture of more than one approach and unlike in formal education learning materials are usually selected by the learner and not the educator. But more importantly, those learning materials are commonly generated by the community itself and also include the code and dialogues between contributors. Further on students are not acting in isolation from previous cohorts of students, but the history of other learners and contributors, and their remaining availability for follow up contacts, constitutes a vital element of the learning materials (Weller & Meiszner, 2008). FLOSS participants also take on tasks such as knowledge brokering (Sowe et al., 2006) therefore taking information and knowledge forward and backward between groups, communities or even language domains.

From a pedagogical perspective learning in FLOSS is characterized by self-studying, project-based learning, problem-based learning, inquiry-based learning, collaborative learning, reflective practice or social learning. It is not assumed that those pedagogies were deliberately set out, but rather that due to the structure, approach and governance of FLOSS communities certain pedagogies have emerged (Glott et al., 2007; Weller & Meiszner, 2008).

Although institutional education might be seen today as the prevalent way of learning, self-education and practical knowledge have their historical foundations long before the institutional formal knowledge. Therefore, communities of common interest like the FLOSS communities, show how exchange and creation of knowledge can be supported by the web in a not institutional way.

As described by Glott et al. (2007) one of the FLOSS characteristic is usually known as ‘openness’ or ‘inclusivity’ of the FLOSS community. FLOSS communities, like any other social formation, have established specific cultural and social patterns and norms that require from anyone who wants to join a certain degree of assimilation. Openness and inclusivity does therefore only mean that those who want to join the community do not have to pass enrolment procedures or have to pass formal performance assessments. Openness also fosters transparent structures as the FLOSS ecosystem is openly accessible, including not only code and documentations, but also communications, discussions and interactions of any kind, e.g. through forums, mailing lists or chats sessions.

A second characteristic relates to ‘volunteering’ and ‘volatility’ since FLOSS participants voluntarily decide which role(s) they want to play or which responsibilities to take on. As a consequence, roles and responsibilities (or capacities) of community members can change over time but also at the very same time depending on the different contexts. This results in a very vivid and volatile internal structure and dynamics of the community (Glott et al., 2007).

A third characteristic is the ‘use of large-scale networks’ and the way they are established and maintained. Besides the individual motivational aspects that must be addressed to attract participants, and to which we will refer later, FLOSS communities enable ‘re-experience’, which is a fundamental mechanism for online learning and knowledge-building (Hemetsberger & Reinhardt, 2006) and also facilitates new member integration. Enabling re-experience and the availability of large-scale networks are also pre-conditions for the FLOSS volunteering support model.

The fourth characteristics relates to 'content-richness' and 'specialisation'. FLOSS communities, though revolving on software development, offer a range of opportunities to participate that by far exceed the scope that is closely related to software (Glott et al., 2007). Content in FLOSS communities provides users with various types of learning resources including manuals, tutorials, or wikis, but also resources that might not be at first recognized as learning resources like e.g. communications, discussions or interactions at mailing lists, forums or chats. One common aspect of the different types of content is that they are jointly generated by users and developers and after generation are overall continuously updated and improved. This however is not limited to a given FLOSS community, but also includes the re-use of artifacts that were produced by other FLOSS communities, or artifacts that are in general freely available through the web. Those external sources are usually brought in to the community by individuals that act as information and knowledge brokers (Sowe et al., 2006).

A fifth characteristic is the aspect of 'modularity', which for the FLOSS case reduces systemic interdependencies between different files of the same product, allowing a higher level of task partitioning and a lower level of explicit coordination and interaction among programmers. Modularity might be achieved through a clear division of labour between the core product and more 'external' features such as modules, add-ons or plug-ins (Mockus et al., 2000). Within an educational context modularity might be translated to organizational aspects of learning, e.g. to allow participation at a lower entrance barrier, at lower initial skills, or with less time commitment or more efficient usage of time available, or to organizational aspects with regards to modular course design, including resources created by educators and learners.

Learning in FLOSS appears to be comparable with traditional educational settings regarding the underlying technology and pedagogical approaches applied, with one of the main differences residing perhaps on the conceptual and organizational side.

3 POSSIBLE ADOPTION OF FLOSS APPROACHES IN EDUCATIONAL SETTINGS

We suggest three different scenarios on the adoption of FLOSS approaches within educational settings (Weller & Meiszner 2008; Meiszner et al., 2008), with each of them having a different level of complexity and a different degree of benefits:

1. The 'inside approach' refers to the practice of taking the principles found in FLOSS communities and applying them within the higher education context. In line with Fischer's work (2007), this approach involves mapping the key principles onto education, including an evolutionary growth of the course and its environment. This is to say that current students would build upon the work of earlier students developing course and content further year by year, therefore improving content quality and richness and providing regular feedback. Such feedback might refer to course structure, material, processes and tools. The inside approach thus takes the sort of characteristics and tools found in FLOSS as its inspiration. The 'meta-design' framework and 'courses as seeds' process model is one example for a structured attempt of the inside approach aimed at supporting self-directed learners within virtual learning communities by creating socio-technical environments that support new forms of collaborative design (Fischer, 2007). Fischer (2007) talks of users creating socio-technical environments and has a continuum of participation ranging from passive consumer to meta-designer. This mirrors some of the roles of engagement in FLOSS communities which range from passive users to core developers.

Within the 'inside approach' institutions might also decide to 'open up' their virtual learning environments to fellow universities or the general public to view what is going on within the environment. Within the inside scenario an institution might even allow those outside groups to participate and engage at this environment, in the case doing so, this likely would be a first step towards a hybrid approach.

A general limitation of the inside approach is that the outside world remains largely or totally disconnected, depending on the degree of openness (e.g. open to view, open to participate, etc.). An example for a semi-open environment is MIT's Open Course Ware project that is partially open for outside observers, but participation is limited to formally enrolled students only. Another limitation relates to 'community building' and 'evolutionary growth', since this is *per-se* limited within a given institution that only involves the own student population, and usually even further limited due to (a) a 100% student turnover per semester / course and (b) a comparatively small number of potential community member (formally enrolled students of a course).

The inside approach might be relatively moderate to implement since the technology should be already in place at most higher education institutions, although admittedly modifications very likely would be necessary. On the down side this approach still would keep the students of the institution within this learning environment preventing their semi-structured engagement and collaboration within the wider web. It would also limit the opportunities of 'best of breed', as the wider web might provide better technological solutions or already established and mature communities for respective study fields.

2. The 'outside approach' at which institutions would send out their students into already well established and mature environments to engage at and collaborate within those communities on pre-defined tasks. In contrast to the inside approach, the outside approach might take traditional education as the starting point by providing theoretical information and then sends the students 'outside' to find well established communities, such as the FLOSS ones, to work within those communities and to apply and deepen their theoretical knowledge.

In particular for the area of software engineering this approach might be suitable due to the existence of a large number of mature FLOSS projects and a myriad of educational resources. This is seen in the work of the Aristotle University of Thessaloniki in Greece, where undergraduate students are sent out into real FLOSS communities as part of their degree in software engineering. Students are provided with an initial academic background in principles of software engineering, testing software and the tools and approach in FLOSS communities and then are required to choose and engage with a real project. This clearly has benefits in computer science as it gives students real experience of collaborating with other developers and also of the different types of roles and work required in software development. The outside approach, however, is not restricted to computer programming. It can be realized whenever there is an external, 'real' community that is operating on FLOSS type principles. The case of Washington Bothell University (Groom & Brockhaus, 2007) is a good example for this where students were required to contribute to actual Wikipedia articles as part of their assignment work, thus gaining much of the practical experience of collaboration and authenticity experienced by the software programmers at Thessaloniki.

The outside approach might be the least complex and almost cost neutral; and therefore relatively easy to implement. The benefits of this approach are that it responds to the third challenge as mentioned at the introduction and also would allow for collaborative learning and knowledge production. However, the results of this collaborative learning and knowledge production would remain within this outside community and therefore likely be lost for future students. This scenario would also not provide next year students (newbies) with an easy entrance as no former learners, nor the resources they created, are present at the institutional level to facilitate the newbie entrance.

3. If we view the inside and the outside approaches as opposite ends of a spectrum, then there is clearly a range of blended, hybrid approaches in the middle, which take components of both elements. Such a 'hybrid' approach might be seen as the best option as it allows a continuous evaluation (by educators, students and the wider world) of what 'the best of both worlds' is and how the transferred elements actually suit in their respective new environments. One of the underlying assumptions is that using a hybrid approach, as maybe also partly valid for the inside approach, could be a response to challenges such as a 100% student turnover per semester as (a) not all participating students (and educators) should start at the same time and (b) free learners outside of formal education and practitioners are not bound to any course schedule at all.

Perhaps one such model for this hybrid approach is that of an open participatory learning ecosystem, as outlined Brown & Adler (2008). The concept here is that some of the principles of FLOSS communities are adopted in education (thus it is an inside approach), such as collaboration, use of technologies, or peer production. People learn by doing, for example by remixing or remashing content that is viewed by others. However these activities occur in a broader ecosystem that is open for everyone combining students, informal learners, tutors, experts, organizations, etc, and in this manner it is an outside approach since learners are engaged in a real global community consisting of a range of different spaces. Such a hybrid approach likely would include a number of environments where students could engage at in a semi-structured way and where guidance and support is provided through the use of technologies (e.g. RSS, suggested contents, etc.) and the use of the human factor (e.g. knowledge brokers, community support, etc.).

The hybrid approach also has the potential to open new doors for e.g. (a) new revenue models that could be based in assessment of learners outside of formal education against fees and formal recognition

of informally acquired skills, (b) the provision of niche courses and faster identification of potential new courses, (c) up to date learning resources and continuous improvement of processes and products, or (d) an evolutionary growing community including the inherent peer support system.

The drawback of the hybrid approach might be that it probably requires the most drastic overhaul of higher educational practices and might be the most complex to implement.

There are a number of cases within formal education (dePaula, 2001; Groom & Brockhaus, 2007; Wilkoff, 2007; Weller & Meiszner, 2008) that suggest that the 'inside approach' and the 'outside-approach' are viable. Those cases indicate that FLOSS principles can be successfully leveraged to educational settings to provide students with similar learning resources, or allowing them to become content creators. The hybrid model potentially offers the highest benefits but remains to be explored.

4 CHALLENGES FOR THE ADOPTION OF FLOSS APPROACHES IN EDUCATIONAL SETTINGS

There are a number of general challenges such as quality assurance, students' assessment or cultural restraints (Schmidt, 2007) that might prevent the take up of FLOSS approaches within educational settings. As the outside approach has been already applied at Aristotle's Software Engineering course since the academic year 2005/2006, we would like instead to address at this section questions that appeared to us more challenging with regard to the hybrid approach and to which we might not be able to respond within the educational framework we are acting in.

1. The availability of a large number of (volunteering) participants, which is in the case of FLOSS communities characterized by volunteering and volatility, is probably one of the cornerstones of the efficiency of the FLOSS community as a learning environment. A crucial question for transferring FLOSS principles to formal education is how similar networks can be created within formal environments, which usually have small classes. On the other hand, FLOSS community members have regular contacts to only 1 to 5 other community members (Glott et al., 2007) and therefore a question is how to reap similar network effects from small networks in formal education. Meanwhile the 'outside approach' is taking advantage of existing online communities, the 'inside approach' and the 'hybrid approach' will need to establish structures, incentives and motivations to bring together the different involved stakeholders and to establish such a community.

2. How to allow re-experience? Within FLOSS much of the learning processes and outcomes are made visible and therefore allow future learners to learn from what others did and to build upon those experiences – how should this be translated to an educational setting? A project based approach, analogue to development processes in FLOSS, might provide an answer to this as collaboration and discussions could emerge around those project works.

3. The motivational aspect: Motivations to participate at FLOSS are e.g. 'to learn', 'gaining reputation' or 'personal enjoyment', but also a clear 'win / win scenario' between information seeker and information provider resulting in learning benefits for both sides (Demaziere, 2006). Those motivational aspects might be difficult to transfer to and apply in formal educational settings, where the main motivation relates to obtaining a formal degree. While learning in the FLOSS community is efficient because 'project managers' and 'community managers' (and many more roles) voluntarily assume responsibility for organising work, tasks, content, and communication, in formal educational settings roles, tasks, and responsibilities are more pre-determined and rigid (Glott et al., 2007). And even if allowing for such roles within an educational setting, what would be the motivation to assume such roles?

There are a number of possibilities to provide incentives within formal educational settings such as rewards for students who voluntarily assume positions, similar to project or community managers in FLOSS, or to include into the curricula the obligation of more experienced students to share their knowledge with the less experienced. Free learners outside of formal education might also be offered a certification of their learning outcomes against fees, or a virtual credit account that rewards them for taking on roles such as mentor, facilitator, moderator or tutor. Those virtual credits than might be used to pay for assessment and certifications. With regards to incentives for practitioners to participate one possibility would be to involve learner into concrete project works – e.g. to provide computer science students with the opportunity to take on some tasks at a respective open source project. Participants of FLOSS communities are also

aware that the skills they learn have a positive value on the labour market and are able to judge this value realistically. Precondition for competing with others that have a comparable formal degree is that informally attained skills in the FLOSS community must be provable (Glott et al., 2007). Peer-reviewing and recognition within the community is very important in this regard to build up a repute that can be shown to possible employers. Similar opportunities, as well for students as for free learners, therefore might be required within an educational setting.

But even if addressing all the points above it might still be a challenge to provide an easy entrance strategy for own and fellow students, or free learners outside of formal education. This challenge relates to questions such as 'what are learners supposed to do' or 'how to get involved'.

5 META-DESIGN & COURSES AS SEEDS AS A SUPPORTIVE DESIGN FRAMEWORK

As a suitable supportive framework for a hybrid approach we identified Meta-design (Fischer, 2007) with its underlying courses as seed process model (dePaula et al., 2001).

Meta-design aims at "defining and creating socio-technical environments as living entities. It extends existing design methodologies focused on the development of a system at design time by allowing users to become co-designers at use time" (Fischer, 2007). Meta-design is aimed to support self-directed learners within virtual learning communities by creating socio-technical environments that support new forms of collaborative design. Meta-design pays tribute to the fact that future uses and problems of socio-technical systems can not be totally anticipated by the design time and must be flexible to changes during use time and allow an evolution through changed or identified user needs. Meta-design pays also attribution to the fact that users might become active participants within a socio-technical environment that bring in their ideas and help shaping and forming the environment and contribute to it. Meta-design is thus describing relatively precisely what can be observed within the FLOSS sphere and was therefore seen to be a suitable supportive framework for the development of a hybrid learning environment.

6 THE CASE OF SOFTWARE ENGINEERING AT ARISTOTLE UNIVERSITY

6.1 Initial Experiences with the Outside Approach

Since the academic year 2005/2006 the 5th semester course 'Introduction in Software Engineering' at Aristotle University of Thessaloniki follows what we have been described as an 'outside approach'.

The duration of the course is 12, 5 weeks and has an average student number of 150 with one of the students' assignments being to participate at a FLOSS project or a proprietary software exercise. In the case selected, the assignment counts for 40% of the total grade. Also, students can work on their assignments beyond the 12,5 weeks of the official lecturing period and submit it at a later time at 3 pre-defined dates per year – by the end of the course in February, or alternatively in June and September.

At the year 2005/2006 15 students volunteered for the FLOSS assignment with the objective of testing FLOSS and to identify bugs.

In the second academic year of the course (2006/2007), which had 24 students opting for a FLOSS assignment, the framework remained the same with the main difference being that students now had two options: to test FLOSS or to develop FLOSS.

At the third academic year (2007/2008) the framework of conducting the course was modified, with the only remaining possible assignment option for students being FLOSS projects, but no proprietary software exercises. Further to this students now had three options: to test FLOSS, to develop FLOSS, or to write a requirement specification documentation for a FLOSS project that still had none. For that academic year 55 students have accomplished their assignment by June 2008.

Motivated by those results, and backed by the theoretical work of the FLOSSCom project, we decided to experiment during the semester 2008/2009 with a hybrid approach.

6.2 Design & Trial of the Hybrid Learning Environment

As part of the FLOSSCom project we developed an experimental hybrid learning environment (www.netgeners.net) and run subsequently a small scale 4 month trial with 10 volunteering students from Greece and Spain, which were located in 5

different countries and supported on a regular base by 1 educator and 2 further less regular participating ones.

This experimental learning environment provided the same type of tools as identified within the FLOSS case and tried to take into account FLOSS particularities such as modularity and project based work. It was aimed to provide learners on the one hand with a basic 'on-board' set of communication and collaboration tools (Blog, Chat, Forum and Wiki) and on the other hand providing a personal space and a space for personal learning projects, including rating and commenting systems as e.g. provided by Amazon.

We than tried to transfer the principle of modularity and project based work through the concept of small students driven learning projects that would allow learners to engage (to a certain degree) within areas of their personal interest; individually or together with other learners as a group work; therefore contributing with their learning projects to the overall development of the learning environment and enhancing its richness up to the point where it might culminates into a very diverse and rich learning ecosystem.

The concept of project based learning projects was also seen as a potential bridge between 'static' content on the one hand and learning processes and activities (discourse) on the other hand that might allow a similar type of 're-experience' as in FLOSS. Learning projects therefore might allow a FLOSS type engagement, where content is often taken forward and backward, contextualized, adapted, translated, re-mixed, embedded into processes or feed into new products by individuals. Those individuals act as knowledge brokers allowing content to be dynamic and causing it to continuously change.

This approach did not intend to provide the learner with a finished set of expert developed 'static' content to be consumed, but instead expects the learner to become an active participant in the respective study field, to acquire subject matter skills through practice, and providing the potential of gaining key and soft skills as a result of their activities and engagement. An underlying believe is that for many 'questions' or 'needs' the answer, or an approximate to it, is already 'somewhere out there at the web' and therefore, instead of 'reinventing the wheel' each time, learners need to learn how to find, analyse, evaluate and use what already exists at the web and to incorporate it into their own work.

Additionally two key aspects of Meta-Design were considered during the design time:

- "A system should be open to change during use time and involves all stakeholders in the design process during design time and use time" (Fischer, 2007).

Though the initial core environment has been largely designed without stakeholders' participation, it allowed for stakeholder modifications from day one of its use time

- "A system should be underdesigned at design time to allow learners ('owner of problems') to create solutions at use time" (Fischer, 2007).

This was taken into consideration by allowing learners to:

- Make use of the communication and collaboration spaces provided 'on-board' or to use any other space at the web that they felt more comfortable with and to link those spaces to the existing learning environment.
- Decide on the objectives, tasks and activities, roadmap of their learning projects and to define its outcomes.
- Provide learners with support and assistance through e.g. regular chats.

6.2.1 Experiences from the Initial Trial

Despite the small group size of participants this initial trial provided a number of valuable information through participants responses to an initial set of questions and two subsequent face 2 face round table discussions.

The obtained feedback suggested that from the technological perspective the learning environment, albeit very simple, responds to the initial needs with the main issues to be addressed being of an organizational nature. Organizational aspects included: more activities that foster community building (e.g. through regular community chats), increased availability of virtual guidance and subject matter support in particular at the beginning, or supportive face 2 face meetings within a class environment.

Some of those aspects should be addressed at our hybrid pilot, which will provide – at least for formally enrolled students – face 2 face meetings and subject matter support. Other aspects, such as community building actions, still need to be taken into account.

6.3 A Hybrid Approach to Computer Science Education – Software Engineering Course 2008 / 2009

Based upon the experiences and work as described above we have been modifying the hybrid learning

environment for the 2008/2009 course 'Introduction to software engineering'. The three options students might choose from remained unchanged to the previous year, namely: to test FLOSS, to develop FLOSS, or to write a requirement specification documentation for a FLOSS project.

Besides the potential benefits of such hybrid learning environment that we outlined above, we do hope that this type of learning environment will provide students with an informal collaboration and cooperation space that is of a practical value to them. This is to say that the initial cohort of students for the year 2008/2009 won't be able to gain from earlier students' works, and therefore we must assure to provide by other means, like e.g. regular chats, prompt responses to forum posts, or initial content uploaded by us, that this online environment is of an added student value. Within this, we will also encourage our past year students, which already worked and accomplished their assignments, to participate within this environment and to offer their help to this years students. Such help, as we observed, very often happens on campus and we hope to be able to take part of this discussion online.

Following the hybrid approach our learning environment is open to fellow universities, learners outside of formal education and also open source practitioners, which we hope find some interest in it and join our effort to develop the space further over time in size and scope.

7 DISCUSSION

During this paper we have outlined the rationale behind the hybrid approach to computer science education at Aristotle University, the design approach taken and the initial experiences we gained. We explained which principles of FLOSS and their communities we consider being desirable for educational settings and which might be some of the key challenges to be addressed.

At such an early point it is not possible to predict the applicability of a hybrid approach within the educational structures we are operating at, or what still needs to change. However, having chosen an open design approach, both in terms of methodological framework as well as open in terms of underlying open source solutions, one of the advantages is that we can respond relatively flexible to identified student needs, or the needs of external participants.

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A CODE-COMPARISON OF STUDENT ASSIGNMENTS BASED ON NEURAL VISUALISATION MODELS

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Abstract: In this present multidisciplinary work, measurements taken from source-code comparisons of practical assignments completed by students of computer programme are analysed and visually represented, and conclusions are drawn so as to gain insight into the situation and the progress of the group. This representation is compared with another one generated by conventional code metrics, and the scope and meaning of the results are assessed in each case. These analyses use various statistical and neural dimensionality-reduction techniques for sets of multidimensional data.

1 INTRODUCTION

Analytical and multidimensional data visualization techniques are often applied in a range of professional contexts. They provide tools that are intended to facilitate the interpretation of results, and thus improve the effectiveness of decision-making that might affect the progress of a business. It appears reasonable for computing professionals involved in teaching tasks to take advantage of those same improvements.

A teacher's awareness of students, of the socio-educational context, and of the inherent dynamics within classroom groups is important in the definition of contents and in curricular development and design. The timely identification of structures, hierarchies and subgroups in a group of students means the teacher can focus follow up work and make individual or group changes so as to optimize the learning/teaching process. It is not an easy task, especially with large groups and with study modules that have few teaching hours. As an objective contribution to that awareness, conventional assessment tools are available to the teacher, which are complemented by subjective observations based on professional experience and "wisdom" (classroom time, personal consultation, tutorials, etc.). Quality improvement systems are fundamentally based on objective measurements generated by conventional assessment models or generalizations drawn from student satisfaction surveys. All of these are conducive to positive outcomes in the teaching/learning process, but lack an immediacy that is desirable for decision-making in the classroom.

Also within that same quality perspective, indicators are used in programming development methodologies to follow up projects. Programming languages can easily incorporate the application of measurement systems or metrics given that they use reduced grammars. Practical programming assignments performed by students of Computer Science could be candidates for this type of objective measurement.

Thus, in this study, projection techniques have been applied to multivariate data to obtain a 2D representation, simplifying the dataset but looking for the "most interesting" directions, in so far as those directions highlight specific aspects in the dataset. Principal Component Analysis (PCA) (Hotelling, 1933), (Friedman & Tukey, 1974) was used, as well as a neuronal model of Exploratory Projection Pursuit (EPP), Maximum-Likelihood Hebbian Learning (MLHL), which is described in (Fyfe & Corchado, 2002), (Corchado & Fyfe, 2003), (Corchado et al., 2004).

The analyses done target discovering of student groupings, based on the source code from their assignments, which may not be easily perceivable by means of quotidian contact in the classroom nor

conventional assessment techniques. These observations may reveal individual or group non-desirable discordant practices so that teachers could focus on them and determine different adaptive teaching strategies based on their own experience. In the studied case it was also checked if the observed groupings might have an academic origin, with negative results. A comparative study was done on the results obtained from classic code metrics and no valuable observation was obtained from those graphs.

The rest of this paper is organized as follows. The high-dimensionality data analysis techniques applied in this study are discussed in Section 2. In Section 3, the source and the data collection methods are described. Section 4 presents the data processing and the results. The main conclusions are presented in Section 5 as well as proposals for future lines of work.

2 DIMENSIONALITY REDUCTION VISUALIZATION FOR DATA ANALYSIS

Projection methods project high-dimensional data points onto lower dimensions in order to identify "interesting" directions in terms of any specific index or projection. Such indexes or projections are, for example, based on the identification of directions that account for the largest variance of a dataset (such as Principal Component Analysis (PCA) (Hotelling, 1933), (Pearson, 1901), (Oja, 1989)) or the identification of higher order statistics such as the skew or kurtosis index, as in the case of Exploratory Projection Pursuit (EPP) (Friedman & Tukey, 1974). Having identified the interesting projections, the data is then projected onto a lower dimensional subspace plotted in two or three dimensions, which makes it possible to examine its structure with the naked eye. The remaining dimensions are discarded as they mainly relate to a very small percentage of the information or the dataset structure. In that way, the structure identified through a multivariable dataset may be visually analysed with greater ease.

A combination of these types of techniques together with the use of scatter plot matrixes constitute a very useful visualization tool to investigate the intrinsic structure of multidimensional datasets, allowing experts to study the relations between different components, factors or projections, depending on the technique that is used.

2.1 The Unsupervised Connectionist Model

The standard statistical EPP method (Friedman & Tukey, 1974) provides a linear projection of a dataset, but it projects the data onto a set of basic vectors which best reveal the interesting structure in data; interestingness is usually defined in terms of how far the distribution is from the Gaussian distribution.

One neural implementation of EPP is Maximum-Likelihood Hebbian Learning (MLHL) (Corchado et al., 2004), (Corchado & Fyfe, 2003), (Fyfe & Corchado, 2002), which identifies interestingness by maximising the probability of the residuals under specific probability density functions that are non-Gaussian.

Considering an N-dimensional input vector (x), and an M-dimensional output vector (y), with W_{ij} being the weight (linking input j to output i), then MLHL can be expressed (Corchado & Fyfe, 2003), (Corchado et al., 2003) as:

1. Feed-forward step:

$$y_i = \sum_{j=1}^{\mathbf{N}} W_{ij} x_j, \forall i \tag{1}$$

2. Feedback step:

$$e_j = x_j - \sum_{i=1}^{M} W_{ij} y_i, \forall j \tag{2}$$

3. Weight change:

$$\Delta W_{ij} = \eta . y_i . sign(e_j) | e_j |^{p-1} \tag{3}$$

Where: η is the learning rate and p a parameter related to the energy function (Corchado et al., 2004), (Fyfe & Corchado, 2002), (Corchado & Fyfe, 2003).

3 COMPARISON AND MEASUREMENT OF PROGRAMMING ASSIGNMENTS

The objective of the study is to classify practical computer programming assignments completed by university students. It seeks to facilitate the

identification of divergent or non-desirable situations in the educational process. Students following the "Programming Methods" study module in the 2nd year of *Ingeniería Técnica en Informática de Gestión* [Technical Engineering in Computer Science] complete practical assignments using the programming language Java. Throughout the four months of the study module, students have to develop two assignments - P1 and P2 - either individually or in pairs, following the design specifications as proposed by the teachers.

The first, P1, is collected in December and the second, P2, at the end of the first four months, in January. The second assignment entails making improvements to the first, includes new functions and applies the techniques learnt during the final stages of the study module. The practical assignment for the study module consists in the partial implementation of games.

3.1 Comparison of Practical Assignments

The primary datasets were constituted by comparisons of source code written in Java that were extracted by the "JDup" tool (Marticorena et al., 2008). The JDup tool generated the relevant comparisons, crossed by pairs from the 60 P1 and the 50 P2 practical assignments (1800 and 1250 respectively). JDup comparisons are made by establishing a minimum match length of 7 tokens.

The software tool compares tokens, snippets of code, and evaluates their percentage similarity. It was designed to detect plagiarisms (measured similarity in the region of 100%). The analysis of the entire spectrum of values of the set of comparisons was attempted in this work. Although in the first sample examined (December 2007), duplicate practical assignments could be identified, and the results were corroborated by direct checks (reviewing the code, personal interviews, etc.), neither the validity of the method nor the validity of the possible approximations used in the tool to improve the performance of the algorithm were formally tested. As opposed to the trivial possibility of a normal distribution, the detection and reiteration of clear groupings in the present work was taken as proof of the tools effectiveness.

3.2 Code Metrics

There are a series of measures that are widely used as evaluation indicators of software programmes. In this work, code metrics taken from a freeware tool called SourceMonitor were used (Campwood Software, 2007). SourceMonitor values are actively and effectively used for the characterisation and quantification of development effort in Computer System projects in the final year of Computer Engineering; projects that are much more diverse and very different. They allow objective comparisons, even between student intakes over recent years.

Table 1: Metrics calculated by SourceMonitor.

Statements
Percent Branch Statements
Method Call Statements
Percent Lines with Comments
Classes and Interfaces
Methods per Class
Average Statements per Method
Maximum Method Complexity
Maximum Block Depth
Average Block Depth
Average Complexity

The metrics, listed in Table 1, assess the size, the structure and the complexity of the code, although in our case, as the students all work on a shared design set by the teachers, some of the above metrics did not initially appear relevant. It was expected that the measurements of branch statements and complexity, or even the total number of lines, would be the most discriminatory when distinguishing between the practical assignments and the programming models proposed by the students.

These measurements were used alongside the representations generated by the comparison of the projects, and at the same time were independently treated with the same analytical techniques.

3.3 Data Preparation

The first group of practical assignments was corrected in December 2007, after the students had handed them in. The list generated by the JDup tool from the 60 assignments generated a longer list of 1800 comparisons which were ordered by degree of similarity. The reference solution prepared by the course teachers was included in the analysis. Having detected cases of plagiarism subject to sanctions, which appeared at the top of the list, the rest of the data were not directly interpretable by the teachers.

In a search for analogies with other datasets under study, the list was transformed into a symmetrical matrix. The comparisons were arranged

by pairs as a Cartesian product, forming a symmetrical matrix that constitutes the dataset to be treated. By lines, each input variable may be understood as a distance from a practical concrete model, with values in the interval [0, 1].

These datasets, along with the corresponding labels, were recorded in a CSV format text file that was used as input data in the programme that applies the previously described reduction treatment and that generates the graphic representations. Alternative labels were also included in the file as well as other comparative or contrasting values that were solely used, after processing, in the representation and the final colouring of the graphs. Data preparation, performed on a conventional spread sheet, was a time consuming task, as a great amount of data had to be reordered and associated with academic management information taken from various sources: names, number of students completing the practical assignments, qualifications, etc.

3.4 Labelling of the samples

With a view to facilitating the interpretation of the graphs, each assignment was identified by a label. The use of the full names of each pair of students that performed the practical work would have taken up too much space and produced overlaps, without forgetting that the publication of student data of a personal nature should be subject to rigorous guidelines. Accordingly, the real names were delinked, and a two-letter code was assigned to the student that allowed the name to be easily localized between the two different data treatment stages and that also enabled a more compact on-screen visualization of the graph. It should be remembered that cases arise of one or more students that leave the course, in which case the student code that remains on file can also be quickly found. It is in the case of plagiarism where overlap is inevitable and reading is made more difficult; but it was assumed that these cases had been urgently investigated and sanctioned at an earlier stage.

Table 2 shows the codes assigned to the first assignment P1. The assignation of a special code “xx” to the teachers' reference solution proved very effective when observing and attempting to interpret the graphs.

The actual index of the assignment could be made to appear on the data table, although it is not especially relevant as the order of the table roughly corresponds to the order in which the assignments were handed in, which differed on both occasions.

Table 2: Labels used for the first practical assignment.

ey	af	fr	cq	bp+dd	fk
bb+cf	ax+bs	cv+du	dx+ft	ds	aw
ay+ef	cb	ar	aq+dk	cw	bw+cx
cp+fy	an+er	by	fd+fm	ee+eg	bd
ak+ap	ev	cc+eq	cu	bv+ep	dw+ek
cd+eu	bu+dn	cy+fw	bg+db	be+ch	ec+fb
dm	bc	bf+ew	dr	dp	ba+fe
cm+dg	br+en	as+et	bt	av+fs	ce+fc
ca+fh	cr	dh+ff	at+fa	au	bk
ac+ag	cs+eb	bm+fq	cg+dq	dc+dv	ad
xx					

Processing and labelling was repeated when analyzing and comparing the second practical assignment at the end of the four months, maintaining the same codes even though students might have changed partners.

4 DATA ANALYSIS

The model described in section 3.3 emerged due solely to other coinciding academic works along with the production of an extensive report on plagiarism. When the data corresponding to the first practical assignment had become available, PCA analysis identified the two clearly separate groups in Figure 1 that prompted ongoing study of the data gathered in this way. The position in the central band, towards the edge of the graph that is occupied by the teacher's reference solution was also significant (“xx” in Figure 1).

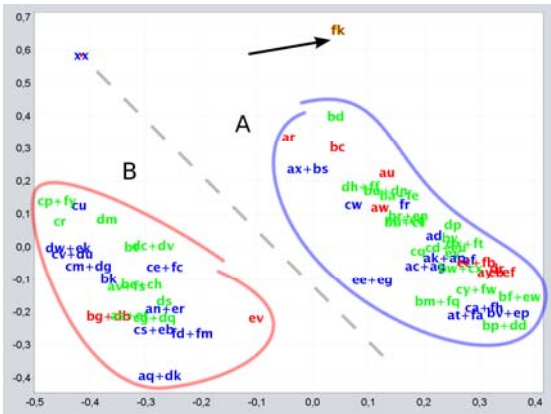

Figure 1: PCA analysis of P1 (academic marks are colour-coded).

Regardless of the researcher's discipline, the graph appears to awaken some concern from a

teaching perspective. The evident polarization (the two large groups marked out as A and B in Figure 1 and Figure 2) might reflect some weakness in the teaching process, for example:

- Different approaches between the two teachers responsible for the practical assignments.
- Insurmountable weaknesses in half of the group.
- Students repeating the course, from different years.
- Class timetabling.

The possibility that these groupings were simply due to social relations in the group that leads to different influences or styles of programming, was also evaluated without this being of concern from an educational perspective. Whatever the cause might have been, it was thought that the study should continue to find out whether it could lead to some corrections or improvements in the teaching/learning process.

4.1 Initial Projection

The first observation was made using an earlier development applying both PCA and MLHL techniques. Codification of the students' names took place at a later point in time. Figure 1 (PCA) and Figure 2 (MLHL) were subsequently recreated using the same analytical techniques and labels already described. Shading (in grey on the printed graph) represents the marks awarded for each assignment.

A non-uniform, random distribution was observed (Figure 1 and Figure 2) regardless of which technique was used:

- The practical assignments that were copied occupy the same position.
- The assignments are distributed in two large, very different, separate groups. A further two subgroups could be identified within these two large groups.
- The reference solution offered by the teachers is found outside the groups, at an equidistant point some distance from them both.
- Some students may be seen in situations that are isolated from the groups. The most prominent is the case of a student on an international exchange programme (indicated with an arrow Figure 1 and Figure 2)

The two groupings may be clearly appreciated with both techniques. There is a notable separation and the definition of the two subgroups improves in the MLHL projection.

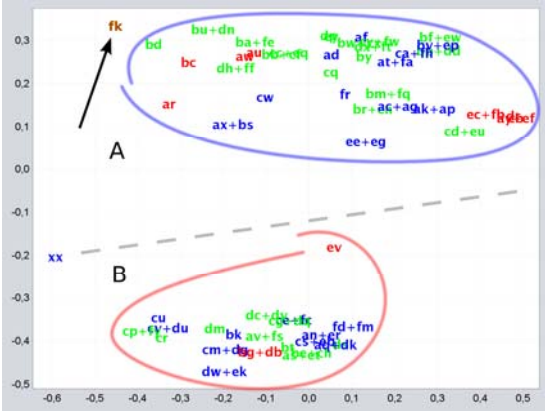

Figure 2: MLHL neural networking analysis of P1 (academic marks are colour-coded).

4.2 Variables in the Local Setting

It was subsequently investigated whether the polarization observed in the P1 projection (A and B in Figure 1 and Figure 2) might be due to some known and "non-desirable" cause. Possible causes of an academic origin are:

- Teacher.
- Group/timetable of the practical classes.
- Individual work or work in pairs.
- Students repeating the module.
- Mark awarded for the practical assignment.

The corresponding values were introduced into the CSV file and applied to the final graphs as colour-coded points and as text labels. In no case was a conclusive relation appreciated between the two visible groupings.

4.3 Treatment of the Second Assignment

Following treatment of the first assignments, the analysis of the second assignments was awaited, in which possible ratification and evolution of the pattern would be observable.

Whatever the case, two determining factors should be considered prior to arriving at any conclusion:

- It was not a matter of separate exercises, as the second practical assignment was an extension or an improvement of the first. As their starting point, each student began with the code handed in for the first practical and a major part of the entire code would remain unchanged or have only minimal modifications.

- Students were aware of the monitoring being carried out and had been informed of the sanctions for plagiarism. Logically enough, greater honesty might be expected in terms of reasonable collaboration between students throughout the development of their assignment.
- Students abandoned the course. This in turn meant lower numbers of samples and practical assignments in pairs being transformed into individual assignments.

During the break between assignments, improvements were made to the usability of the tool by incorporating a configuration window that facilitated repetition and adjustment of the tests. The same general treatment as in the case of P1 was repeated.

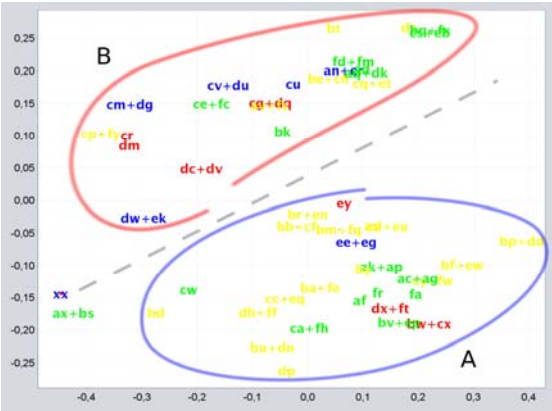

Figure 3: PCA analysis of P2 (academic marks are colour-coded).

In Figure 3, the persistence of two groups, although less separately, may be seen. The composition of the groups appears to be the same.

- Within the two groups, movements may be seen between the subgroups that are to some extent relevant.
- Greater dispersion. The number of practical assignments in peripheral positions increased, and notably some practices may be seen in zones close to the reference solution.

Although practical assignments are found in the four marking bands in both groups, a greater density of higher marks appears to be evident in one of the groups and in the other, a greater density of lower marks. It is not considered conclusive.

3.2 Code Metrics

The composition of the two groupings was contrasted with information on the groups and from students; likewise, the SourceMonitor code-metric measurements, described in section 3.2, were applied. No conclusive relation was observed, but these data were used to perform an independent analysis that generated the representation in Figure 4. The distribution was much closer to a normal distribution than that obtained from the comparisons and the only significant factor was the presence of samples at the extreme periphery. These “extreme” practices also occupied the prominent positions in the representations that were evident in the earlier analyses.

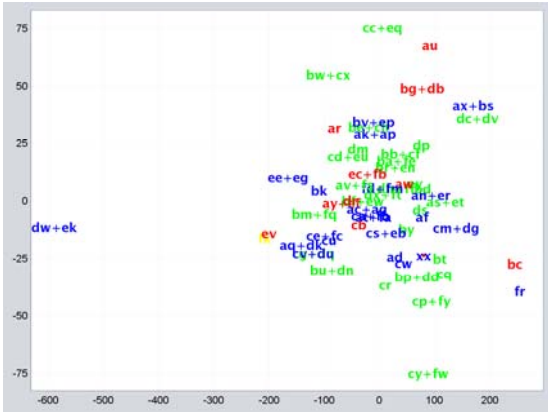

Figure 4: PCA analysis of P1 Metrics.

4.5 Evolution of the Distribution

Having conducted a separate, parallel analysis of the two datasets, the evolution between both was closely examined, and the observable groups and subgroups were defined. Tracing a line around the groupings (P1, B1, etc.) may be done on sight as shown in Figure 5.

Two large zones (A and B) are identifiable and various subzones may be perceived in each one. A1 and B2 correspond to the densest areas of the two groupings. Separated from these groups, an individual, isolated practical assignment (belonging to the exchange student, labelled “fk”) and the reference solution “xx” may be identified, at some distance, though on the axis of the representation. Some points approach that zone (such as "ax+bs" or "bd") in Figure 6 that corresponds to the second of the practical assignments. The assignment completed by the exchange student does not appear in this image, as he did not hand in this second assignment.

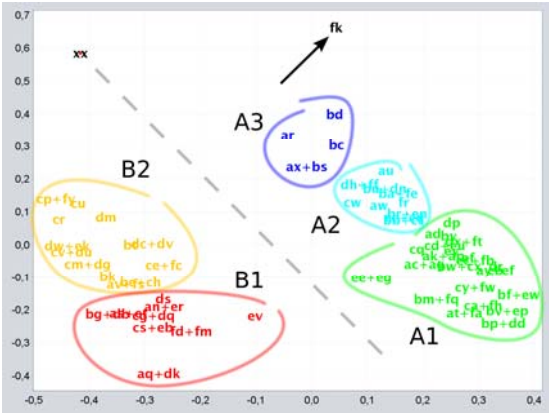

Figure 5: Classification of groupings in P1.

A separation of the groups may also be seen. Let us remember that the students were by that point aware of the analysis that was underway and had probably modified some of their practices relating to an occasional exchange of code. The closest points to "xx" are marked in Figure 6, as well as a unique case in which a clear change was detected between groups A and B. Informal contact was made with this student who explained that she had made significant transformations in order to resolve an important error discovered after handing in the first assignment. Another case of movement was also detected, but in this case it was associated with a change of partner.

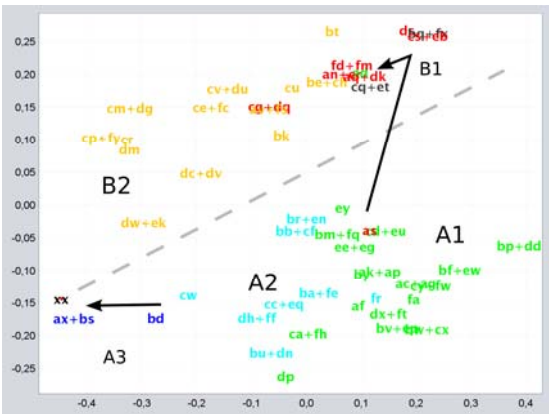

Figure 6: Classification of groupings in P2.

4.6 Experience Gained

Applying different dimension reduction techniques to the dataset produced by the JDUP tool, two clear groups were observed as well as some individuals in peripheral positions. The observation was mostly reproduced in a second dataset from a second assignment to the same students and some evolutions were observed. No coincidence was found to common academic settings, but the case of a foreign exchange student.

Same techniques were applied to code metrics obtained using the SourceMonitor tool to the same assignments in order to compare both, but results were quite poor. A common centred distribution was plotted.

These representations are not intended as a conclusive categorization and in no case are they proposed as evaluation tools. However, it is considered that they might be a valid tool to provide the teacher with insight into the group of students. Peripheral situations or pronounced changes can centre attention on certain students, whom the teacher might try to observe more closely during the practical sessions, and where necessary, a proposal for more personalized attention, provision of support, providing support and adaption of the proposed assignments.

5 CONCLUSIONS AND FUTURE LINES OF WORK

The set of values obtained by the JDup tool is considered a valid means of characterizing a set of practical assignments developed in separate ways on the basis of a common design. This was not the case of the values corresponding to the shared metrics obtained with SourceMonitor, which were shown to have a much more limited discriminatory capacity.

A model based on differential data is proposed, which is more easily generalizable than other theoretical measurements (metrics), the representative nature of which will vary according to the problem under study. The crossed-comparisons model contributed a rich description of the dataset, and allowed its dynamic to be observed, but did not allow us to identify the factors that caused these structures.

PCA and MLHL dataset visualization allowed an important polarization to be detected in the group of students under study. A search was made for matching elements, although it was not possible to associate this polarization with any defect or failing in the academic organization of the course, in the teaching methods, or even with the resulting set of marks.

The impression formed by the teachers was corroborated; students had learnt about the use of the JDup tool to detect plagiarism in the first mandatory practical assignment, had commented on it, and had

taken it into account. It is believed that this is the reason for greater diversity and dispersion in the second assignment, without forgetting the logical and expected impact of the group's progress in the subject matter.

The use of statistical (PCA) and neuronal (MLHL) models applied to the work developed by students studying computer programming allowed information to be obtained on group dynamics in the classroom and its evolution over time; something that is difficult to achieve by direct observation and that might be useful for planning timely changes to teaching methods.

This work has sought greater knowledge of teaching/learning processes in the context of computing, thereby highlighting the spirit of improvement and the interest that form part of everyday teaching tasks; continuous improvement with a view to training qualified professionals.

The following future lines of work are proposed:

- Apply the method to other groups and subjects.
- Apply the comparisons model to other fields and to evaluation techniques where the representation generated by the model may be objectively contrasted with the curricular competence under evaluation.
- Propose improvements that facilitate portability of the JDup tool data.
- Improve the user interface of the analysis tool or integrate it into other tools.
- Apply other classification techniques that can improve the definition of the graphs and the automatic generation of groupings.

ACKNOWLEDGEMENTS

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LEARNING THROUGH NFC-ENABLED URBAN ADVENTURE
User Experience Findings

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Keywords: Near Field Communication (NFC), Mobile learning, Urban adventure track, Context-sensitiveness, Teenagers.

Abstract: This paper presents a mobile context-sensitive learning concept called the Amazing NFC, and reports the findings and results of a field study where 228 students experienced the Amazing NFC urban adventure during spring 2008. The Amazing NFC concept is an Amazing Race -style survival game for teenagers for learning skills and knowledge essential to everyday life and familiarising them with their hometown. During the Amazing NFC lessons, students were guided through an urban adventure track with the help of NFC mobile phone, site-specific NFC tags located at eleven control points and related mobile internet content. Trial aimed to analyze touch-based interaction paradigm directed to specific users in a defined context as an implementation technique for mobile learning. User experiences and added value evoked by the service concept were investigated via a variety of data collection methods. Findings revealed that students experienced the NFC technology as easy and effortless to use. However, users hoped to see more challenges and activity in the track in the future. Our analysis indicates that one main benefit of the urban adventure concept was moving the learning experience from the traditional classroom to a novel context-sensitive learning environment that includes social interaction between students.

1 INTRODUCTION

Traditional classroom learning is what we are all most familiar with. It usually awards credits based on student performance, which is measured through assignments, tests and exams. Traditional learning typically takes place in an identifiable classroom space during pre-defined hours. A classroom usually has a number of specific features, including a teacher who delivers information to students and a number of students who all are physically present in the classroom and regularly meet at a specific time. Many learners favour traditional learning while others find that it is more restrictive and lacks flexibility. (Learn-Source, 2008)

However, new ways of learning are emerging. New learning approaches suggest that imaginative and innovative approaches are needed to bring about improvements in learning new skills and adopting new information (Espoir Technologies, 2007). The best learning occurs in a stimulating, active, challenging, interesting and engaging environment when you move at least some part of your body and when you learn things by doing and by experience (ibic). The best learning occurs when you are actively involved in co-constructing knowledge in your own head, not passively reading or listening or taking notes. Forcing people to sit in a chair and listen (or read) dry, formal words (with perhaps only a few token images thrown in) is often considered to be the slowest, least effective, and most painful path to learning (ibid). Yet it is the approach you see replicated in everything from K-12 to universities.

Mobile phones have now evolved into pocket-sized computers and as such have the ability to deliver learning object and provide access to online systems and services. Mobile learning is unique in that it allows truly everywhere, anytime, personalized learning, and offers opportunities to integrate learning technology into student's daily activities (Laroussi, 2004). Mobile devices belong to a learner's personal sphere, which means that the learner can take learning opportunities directly in the situation where they occur, because the learner has his learning environment always at hand (ibid). Mobile learning can also be used to enrich, enliven or add variety to conventional lessons or courses (Attewell, 2005). Thus, the educational potential of

mobile learning contents, both as learning and teaching tool, is widely acknowledged, and various initiatives have been undertaken to encourage the integration of educational mobile resources in school practice (Avellis et al., 1999).

Portable technologies have been explored in the context of m-learning to provide literacy and numeric learning experiences for young adults (aged 16-24) who are not in a full-time education environment (Attewell, 2005). The m-learning project running 2001-2004 intended to develop some of its learning materials using a gaming philosophy to make their use attractive to young adults. In the project 62% of learners reported they felt keener to take part in future learning after trying mobile learning. 82% of respondents felt the mobile learning games could help them to improve their spelling and reading, and 78% felt these could help them improve their maths. Study's evidence suggests that mobile learning can make a useful contribution to attracting young people to learning, maintaining their interest and supporting their learning and development. It was also observed that loaning equipment to young adults has resulted in other benefits not directly related to the learning experience. In particular, some of the learners were surprised and proud to be trusted with such expensive and sophisticated technology.

Wyeth et al. (2008) have used mobile technology as a mediator within science learning activities in a trial where 11-year-old children completed in pairs an outdoor treasure hunt activity using a combination of two mobile phones and a video camera. During the trial was discovered that all the children treated the treasure hunt as a competitive activity and were highly motivated to make discoveries based on the clues. However, the side effect of the racing nature of the treasure hunt was that it detracted from more focused learning and considered reflections on what had been observed. Study findings also revealed the importance of context in learning: new understanding emerged as children moved through the treasure hunt environment. Productive and creative aspects included in the trial appeared also to provide an intrinsically motivating platform for learning.

Chang et al. (2006), in turn, have introduced the treasure hunting learning model that extends Computer-Aided Learning systems from web-based learning to mobile learning. In their model the system will provide students suitable instructions or quests according to students' learning results on web, students can use the mobile phone to get the guidance messages or quiz when they are moving around in the field, and what concepts students obtained and did not understand during the mobile learning phase will be posted on the website in order to let teacher and students do further discussions.

The effective use of mobile learning resource depends to a large extent on how enjoyable students find the learning experience. Some students may be motivated by an element of competition (Becta, 2006). Also to cater the academic needs of students, the service needs to be at the appropriate intellectual level. Avellis et al. (2003) state that the effectiveness and pedagogical soundness are very important to evaluate in mobile contents. Some of the factors that encourage a positive response from students to mobile learning have been identified as (Becta, 2006):

- Attractive presentation
- Interactivity
- Feedback
- Appropriate skill level(s)
- A 'fun' element
- Clear focus
- Use of different types of media
- Versatility
- Non-threatening environment
- A feeling of progression and achievement
- Intuitive design and interface
- Challenge.

In the Amazing NFC trial, an Amazing Race - style game was created for teenagers for learning skills needed in everyday life and learning facts about the city of Oulu in Finland. An objective was to trial a context-sensitive educational service for the target group by utilising NFC technology. Our urban adventure concept acknowledged the importance of context within the learning experience by focusing on situated learning (Brown et al., 1989): enabling learning in real-life contexts, outside the confines of a conventional classroom (Tétard et al., 2008).

The aim of the trial was also to investigate user experiences evoked by the touch-based interaction paradigm and the mobile learning concept itself. In addition, the educational aspects concerning the new learning environment and the suitability of the touch-based user interface and the related interaction technique for the target group, i.e. the teenagers was explored. In the trial was also examined the added value the concept brings to learning.

2 NFC TECHNOLOGY

Touching with a mobile terminal has been found to be an intuitive, natural and non-ambiguous

interaction technique that does not incur much cognitive load for users (Rukzio et al., 2006). Välkkynen et al. (2006) state that touching is an effortless way to select objects in the environment and it is easy to learn and use.

NFC (Near Field Communication) technology is designed to make communication between two devices very intuitive, and NFC suits the requirements for physical mobile interactions very well. Objects can be augmented with NFC tags and mobile devices can be equipped with NFC readers. Tags in the environment may be used to provide fast, zero-configuration service discovery (Isomursu et al., 2008), and they can be attached to virtually any object or surface. When a tag is touched, the tag reader integrated into the mobile phone reads the information embedded by the tag and is then able to perform predefined actions. Tags are also small and inexpensive, which makes tags suitable for embedding the user interface into the everyday living environment of the user.

The main advantages of NFC are the simple and quick way of using it and the speed of connection establishment, and even though people may have to learn how to use touch-based interaction, it still offers possibilities to be much simpler and quicker than classical screen-based user interfaces on mobile devices (Falke et al., 2007; O'Neill et al., 2007). In our concept an URL to the web content was transferred from the tag to the mobile phone when the user touched the tag. The browser available in the mobile phone could then directly access the URL.

3 RESEARCH SETTING

Amazing NFC field trial was implemented in the city of Oulu in May 2008. The total of 228 students between the ages of 14 and 15 from the schools located in the Oulu district participated in the trial. The mobile learning concept used in the trial was called "Amazing NFC" after the well-known TV series called "Amazing Race". During the Amazing NFC lessons that took place in downtown Oulu, the students were guided through an urban adventure track with the help of mobile phone and related mobile internet content. Eleven locations, that we called "control points", around Oulu were marked with NFC tags.

In the beginning of the Amazing NFC lesson, the students were grouped into small groups of two. Each student was provided with Nokia 6131 NFC-enabled mobile phone for the duration of the lesson and each student pair received an individual route with a designated departure point. Upon arrival at a control point, the student touched the NFC tag and a web-page concerning information about the place where the control point was located (e.g. a museum) was sent to the student's phone. First the student read the text relating to the control point, watched a video or listened to an audio file, and then answered to a question related to the site. In some locations, the question required the user to do some tasks to acquire the information needed to answer the question. After completing the assignment, students received instructions and a map guiding them to the next NFC control point. The control points, with the exception of zoological museum, were located in the city centre within a couple of kilometres distance, and the students were expected to travel from one control point to another with bikes (although some used mopeds against instructions).

During the lesson, the teachers were able to follow in real time via a web-based user interface how the pairs of students proceeded through the adventure track. Also, the students were advised to use the mobile phone to call the teacher in case of problems or questions. In Figure 1 is described the overall view of the urban adventure concept.

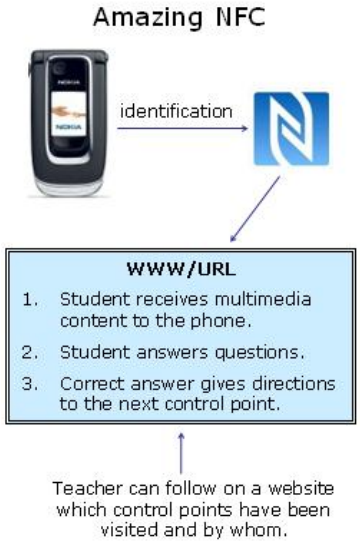

Figure 1: Overall view of the trial.

The educational goals of the Amazing NFC lesson were to provide the students with knowledge related to landmarks, public buildings and offices in their hometown, and practical skills related to dealing with public authorities in mundane everyday tasks. The locations chosen as control points were city information centre, fire station, swimming hall,

police station, museum, city hall, youth and culture centre, zoological museum at University of Oulu (requiring a bus journey to the museum and back, and ticketing was done with an NFC phone), city library, theatre and the social insurance institution. During the bus journey to zoological museum, the students became familiar with, among other items, the "Initiative for Oulu" service, i.e. sending an electronic initiative to city authorities by touching information tags in the bus. In Figure 2 the student is touching the Amazing NFC tag at the control point inside the social insurance institution.

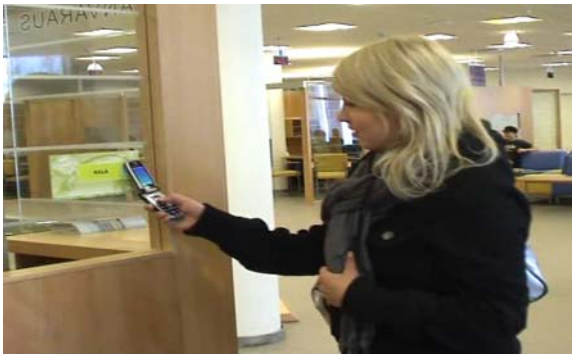

Figure 2: Student visiting the Amazing NFC control point located at the social insurance institution.

The Amazing NFC lesson was planned and designed in close cooperation of teachers, service and technology providers, and researchers. During the design phase was especially emphasised the ultimate goal of integrating the concept into the normal practices of the schools, so that the trial would not to remain as a single occasion related to the research project. The aim was to create a viable concept that could be adopted as a learning instrument to be used also after the research trial. This required tight involvement of teachers and school administration in planning and implementing the applications, and organizing and supervising the trials. During the trial, the researchers were only involved in the data collection activities; teachers took full responsibility for organizing and supervising the actual Amazing NFC lessons.

4 DATA COLLECTION

Dutton and Aron (1974) have stated that humans are not very good at analysing what actually caused an experience, so it can be difficult for users to identify if the experience was caused by the technology under evaluation or the user experience evaluation method (or any other event in the life of the user). Human memory about experiences is also unreliable thus affecting our ability to recall past experiences so that we could compare them with other experiences (Schooler and Engstler-Schooler, 1990), or to describe them reliably after time has passed. Also, our ability to predict our own experiences in a hypothetical or future setting is very limited (Wilson et al., 2000; Gilbert and Wilson, 2000). Therefore, in order to achieve the most reliable understanding of user experience, the data during the Amazing NFC lessons was collected in three phases: before use, during use and after the use.

Since describing and understanding user experience are complex as user experience is always multifaceted and difficult to verbalise and describe, the combining of different data collection methods increases the reliability and validity of the results (Isomursu et al., 2007). Therefore, we decided to utilise a variety of data collection methods that were highly complementary (Yin, 2003). The methods used and data collected in different phases of the experiment were as follows.

Before the start of the trial, two teachers were interviewed in order to investigate their expectations, doubts, thoughts and attitudes towards the evaluated technology and learning concept. Before the Amazing NFC lesson we also observed how the students learned to use NFC technology, and what kind of spontaneous reactions and discussion took place in introduction of the concept. A mobile questionnaire was used to capture information about the expectations and attitudes towards the mobile learning experience before the lesson. Unfortunately, there were some technical problems with the mobile questionnaire during the very first trial lessons. Additionally, some teachers forgot to provide the NFC tag used for accessing the mobile questionnaire for their students. Therefore, not all students were able to report their experiences through the mobile questionnaire (we received 133 valid responses from 228 participants).

User experiences during the Amazing NFC lesson were collected through video recordings, and through automatic creation of log data about how the pairs of students progressed on the track. Video recordings were made by placing video cameras at fixed spots to record students while they were visiting the NFC control points, and by providing students video cameras that they could use to record their experiences during the lesson.

After use, the students filled out a second mobile questionnaire collecting data about the user experience immediately after use. The data received

from both mobile questionnaires was used to survey how students' expectations and attitudes changed during the trial; whether their expectations were met and attitudes altered. The students and teachers were also requested to fill out a web questionnaire within two weeks after the trial. For this purpose we created two separate questionnaires (resulting in a total of 81 responses from students and 8 from teachers). In addition, we arranged a workshop with twelve students to explore the experiences with the Amazing NFC. The workshop included participatory features, i.e. the students participated in designing how to iterate the concept for future use.

5 FINDINGS

5.1 Before Use

Evaluation before use was done for gaining insights into the attitudes, expectations and doubts of the user groups regarding the upcoming Amazing NFC lesson. Technology training situation was observed to see how the students coped with learning to use new touch-based interaction technique.

5.1.1 Interviews with Teachers

In general, teachers had a positive attitude toward the learning concept. They found the trial trustworthy; students could not get lost or get into trouble as the teachers could follow their progress on the track in real time through a web interface and contact them if needed. Teachers felt it was good that learning could be taken out from the traditional classroom and 45-minute teaching style. They saw the concept as an excellent way to familiarise the students with their hometown and for students to learn life-skills and to gain more courage to visit different public buildings and offices in the city. However, teachers thought that urban adventure track needs to provide students a sufficient amount of challenge in order to maintain their interest and motivation during the Amazing NFC lesson. Thus, in order to make a concept to succeed and to create real experiences students must be offered more activities, such as competitions and tasks. Teachers expressed a doubt of NFC technology having the taint of decoration; that in practice NFC would not bring any added value for the learning concept. Teachers' stressed that the technology itself is not enough to surprise and amaze students; it is the content and activities that need to generate real experiences.

5.1.2 Observation of the Training

Before the Amazing NFC lesson, students were given an introduction to NFC technology and they had their first visual and physical encounter with the learning concept and their first hands-on experience on using the novel interaction paradigm. Therefore, it is not surprising that learning touch-based interaction required some practicing. Students needed some practice to find the comfortable personal reading distance between the tag and the phone. Also, finding the right touching spot both from the phone and from the tag, and learning the response times required some practice. However, as teenagers are nowadays very technological-savvy and familiar with mobile technology, they adopted the new technology and touch-based interaction fast: all students were able to learn to use touch-based interaction with a few repetitions.

5.1.3 Mobile Questionnaire

Students' preliminary feelings were explored with a mobile questionnaire just before the Amazing NFC lesson: general attitudes toward the lesson, the biggest expectations of and the major doubts about the lesson. We received 133 responses from 74 boys and 59 girls. A three-point Likert scale ranging from 1 (positive) to 3 (negative) was used to measure the question concerning the attitude. 54.1% of students had positive feelings about participating in the lesson, and only 10.5% of students expressed negative attitudes towards the lesson (see Figure 4).

In order to investigate the correlations that stemmed from the student's gender, data was also analysed by doing the dependency tests between the questionnaire parameters. Between the student's gender and attitude towards the Amazing NFC concept was found a direct correlation (see Figure 4). 16.2% of boys had negative attitudes towards the lesson, whereas only 3.4% of girls expressed the same opinion. In contrast, 72.9% of girls thought it was nice to attend the lesson, the corresponding proportion of boys counting only to 39.2%.

Students were expecting most eagerly (see Figure 3) to spend time with their friend (21.8%), to try out new technology (21.8%) and to get out of the school (19.5%). They were least expecting to learn new information at the control points (9.8%) and to get to know new places (8.3%). Correlation was also discovered between the gender and expectations (Figure 3). 32.2% of girls were most expecting spending time with their friend while only 13.5% of boys were expecting that. Whereas 29.7% of boys and only 6.8% of girls were expecting getting away

from school the most. Quite surprisingly, more boys (13.5%) than girls (5.1%) were waiting "learning new information", whereas girls (15.3%) were more waiting "getting to know new places" when compared to boys (2.7%).

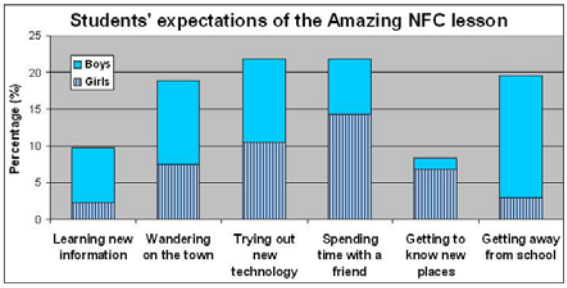

Figure 3: Students' expectations of the Amazing NFC before the lesson (n=133; 74 boys and 59 girls).

Over half of the students (66.2%) reported having no doubts regarding the Amazing NFC lesson. Of those 33.8% students that reported having some doubts, 16.5% identified the most important reason to be the anticipated problems with new technology, 7.5% considered it to be the difficulty of finding the control points and moving around the city and 3.8% feared bad weather during the day. Student's gender had also effect on whether or not something daunted him or her before the lesson: 41.9% of boys had some doubts whereas the figure with girls was lower (23.7%).

5.2 During Use

Collecting information about user experiences at the time they happen requires in situ data collection methods which can be applied during the use of technology (Consolvo et al., 2007). This means that the tools and methods used for collecting user experience data need to be integrated into the everyday practices of the trial users, just as the technology under evaluation. Experiences show that the user experience evaluation method may actually "steal the show" (Isomursu et al., 2007) if it is more visible and needs more attention and cognitive processing from the user than the actual technology under evaluation.

5.2.1 Video Recording

Video cameras were set at fixed spots to record students while they visited NFC control points. This solution was chosen in order to minimise the interruption of the videotaping, and to prevent it from having an influence on the user's behaviour and user experience formation (Yin, 2003). However, when the student's head was down while he was watching the mobile device, it was difficult to see all the facial expressions. Students also often turned their backs to the camera or even moved out of the reach. Thus, videos recorded by students themselves proved to be a better information source. Videos showed, for example, that students commonly asked for help from passers-by if they had trouble finding the control points. During the lesson they also called and send text-messages to their classmates to find out how they were doing and how many control points they still had to go.

5.2.2 Log Data

User experiences were also collected by monitoring the log data that was automatically recorded from the control points by the Amazing NFC backend system. For example, from the log data could be seen that some pairs coincided with each other at some control point and continued their way from then on together, which resulted in some students going through part of the track in bigger groups.

5.3 After Use

After-use evaluation was utilised to investigate user experiences after the lesson and to identify possible changes in students' attitudes by comparing situations before and after use. Also the future use of the concept was inquired of students and teachers.

5.3.1 Mobile Questionnaire

Students' experiences were explored with a mobile questionnaire immediately after they had finished the Amazing NFC lesson. The questionnaire explored the general feelings after the lesson as well as the best things and the downsides experienced during the lesson. A three-point Likert scale ranging from 1 (positive) to 3 (negative) was used to measure the question concerning the emotions. 51.9% of the students reported that they had enjoyed participating in the lesson, whereas 13.5% described their feelings as negative (see Figure 4). A direct correlation between student's gender and feelings after the lesson was revealed: 20.3% of boys had negative feelings when only 5.1% of girls were in the same opinion. As much as 66.1% of girls but only 40.5% of boys had enjoyed the lesson.

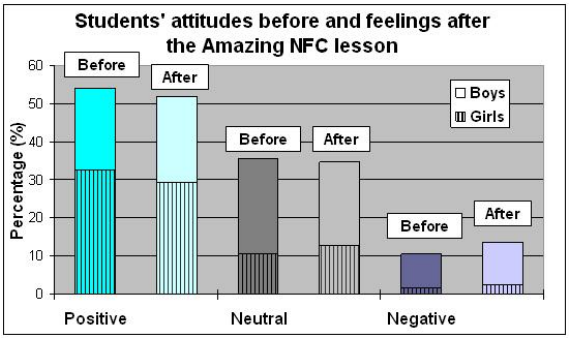

Figure 4: Students' attitudes towards Amazing NFC before the lesson and their feelings towards Amazing NFC after the lesson (n=133; 74 boys and 59 girls).

There was also discovered correlation between students' attitudes before and feelings after the lesson. 60% of the respondents who reported having negative feelings after the lesson had also had an unfavourable attitude towards the lesson. Correspondingly, as much as 72.9% of those having positive feelings after the lesson had also had a favourable, positive attitude before the lesson.

The best things in the lesson were considered to be spending time with a friend (30.8%), wandering on the town (22.6%) and trying out new technology (19.5%). Over half of the students (64.7%) stated that in their opinion there were no downsides in the Amazing NFC lesson. Those 35.3% that had experienced some negative things felt that the most important reason was related with finding the control points and moving around the city (12.8%).

5.3.2 Web Questionnaires

After the trial, students and teachers answered to the web questionnaire that aimed for evaluating their experiences about the lesson and finding improvement ideas for Amazing NFC. Unless stated otherwise, a four-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree) was used to measure the questionnaire variables.

The total of 81 students (42 girls and 39 boys) answered to the web questionnaire. The majority of the respondents reported that they liked the urban adventure track (av. 3.741, where the scale was from 1 (boring) to 5 (nice)). Students mostly agreed that it was easy (av. 1.691) to discover the tags located at the NFC control points. The navigation from one control point to other by using the map and instructions received on the mobile phone was considered easy (av. 1.838). The usage of NFC phone and touching the tags was also experienced as effortless and natural (av. 1.457).

However, the students somewhat disagreed (av. 2.432) that the information provided at the control points was interesting. Students did not think they had learned lot of useful information during the lesson (av. 2.346) nor considered the questions presented at the control points having been challenging (av. 2.951). Nevertheless, they preferred (av. 1.704) the learning through Amazing NFC to learning in the classroom, but did not think (av. 2.346) that participating in the trial had given them more courage to visit the public buildings and offices in their hometown.

Students found it nice (av. 1.469) that they could go from one control point to other on their own and at their own pace. In the trial, the learning experience was rather social, as the students were instructed to work in pairs. Working in pairs was preferred by almost all (97.5%). In addition, many participants (59.5%) reported that they had formed bigger groups during the Amazing NFC lesson. The time it took from the students to go through the adventure track and the distances between the control points were perceived as suitable by 76.5%.

In the web questionnaire were also explored students' preferences between the eleven control points. Students had most liked about the control point that was situated inside the zoological museum (32.1%), next best was the bus journey to the museum (25.9%), the third best being the police station (9.9%). So, clearly the most interesting control point for Amazing NFC participants was the visit to zoological museum. The visit started with a bus journey, where the students were able to use their NFC phones for ticketing. Inside the bus the students were able to use informational NFC tags offering e.g. news from the local newspaper. For other transitions, students used bikes in all weathers. During some lessons, weather was cold, rainy and windy. Also, as the lesson lasted approximately three hours, some students started to get tired. Therefore, the bus ride was experienced as a welcome change. At the zoological museum, the students were instructed to see the animals on display, and consume content about the animals through tags attached to the displays. When compared to other control points, there was clearly required more activity and offered more interaction with the environment.

Students reported that they would be willing to participate in the Amazing NFC lesson also in the future (av. 2.123), but were not especially eager to go through the adventure track on their own outside the school (av. 2.716). In students' opinion NFC technology suited the learning concept well (av.

1.605) and they would be glad (av. 1.815) to use NFC technology also in other situations and environments. The average grade students gave to the concept was 8, on a scale from 4 to 10.

The total of eight teachers answered to the web questionnaire after the Amazing NFC lesson. Teachers experienced that the new learning concept exceeded their expectations (av. 1.5) and somewhat agreed that students had learned and received new information to expected extent (av. 1.75). All the teachers thought that the adventure track served well getting to know ones hometown, and 75% of the teachers were in the opinion that the lesson had also served students becoming independent and learning life-skills, whereas only 25% thought that the lesson had served informational learning. They also agreed that the monitoring of students' progress on the track was easy (av. 1.375) through the web-based interface and had received all the necessary information through it (av. 1.625). All the teachers were ready to exploit the learning concept in the future. The average grade the teachers gave to the concept was 8.9 on the scale from 4 to 10.

Teachers gave also many ideas for the future utilisation of Amazing NFC concept. For example, different kinds of adventure tracks could be planned based on art works, nature, history or different theme days such as Easter and Christmas, and in those occasions tags could be placed in locations that suit the theme. Teachers also hoped to see the concept to be used for teaching of different school subjects, e.g. in language learning clues and tasks at the control points could be given in English. NFC tracks could also be created for new students starting the secondary school in autumn. On their first day at new school students could go through the adventure track located on the school premises and would thus have an opportunity to familiarise themselves with the new school and its surroundings. Getting to know unfamiliar cities with the help of NFC technology would also be useful for example during school trips. Teachers were in the opinion that the adventure track should be mainly directed for a bit younger students, because students around the age of 15 already have so advanced knowledge and skill levels that they comprise a difficult target group when you want to dazzle them with new information.

5.3.3 Workshop

In the workshop twelve students were asked to give ideas on how the Amazing NFC concept could be improved and developed further. In their opinion, tags at the control points should be hidden and located in more difficult places. Students also thought that the tasks should be longer, and more effort should be required to find answers to questions, because now all just guessed the answers. There should be someone supervising at the control points to check that all tasks would be performed correctly. Students hoped to see more physical and problem-solving tasks and activities at the control points and if they could also compete with each other on the adventure track it would bring along more motivation and excitement.

6 DISCUSSION AND CONCLUSION

The Amazing NFC learning concept provides a learning experience on a mobile phone – which many young people are comfortable using and enthusiastic about. Mobile technology was used to encourage both independent and collaborative learning experiences, to help to battle against reluctance to use ICT in learning, to help to remove some of the formality from the learning experience, to engage reluctant learners, to aid learners to remain more focused for longer periods and to help to raise learners' independence and self-esteem. In our concept an objective was to have learning content, pedagogical methods and technological tools all functioning in a harmony (Tétard et al., 2008).

Teenagers are a tough target group for designing mobile services. The experience and high knowledge in using mobile devices means that this user group is hard to amaze or even satisfy. NFC promises a novel and intuitive user interface to mobile devices but the novelty of the technology is not enough to ensure the success and interest of the concept. The teenagers who attended the trial had high expectations concerning the new technology and the content and quality of the service. One factor contributing to negative attitude towards the content provided and related tasks may be the association made by naming Amazing NFC after the popular TV show "Amazing Race". The naming might have set expectations and mental impressions that were not fulfilled. For example, searching and finding the tag at the control points was part of the excitement of the urban adventure. This is illustrated in the following improvement idea expressed by one of the students: *"Tags should be somehow hidden so it would be more interesting to search for them."* The

excitement and challenge level of the TV show was not obviously reached during the lesson.

Observation of students showed that none of them had problems in learning to use touching as an interaction technique within a couple of minutes of hands-on training. Intuitiveness and naturalness of this interaction technique made adopting effortless. In NFC technology survey (O'Neill et al., 2007) was discovered that users were concerned with how the use of NFC readers in public spaces made them appear to other people around them. Many participants of that survey noted that they felt awkward at first using NFC due to the very explicit public act of reaching out and touching a tag embedded in the environment. However, many participants lost their reservations about using NFC over the course of the trial. In Amazing NFC trial, none of the students reported that touching tags would make them feel uncomfortable.

Even though the students attending the Amazing NFC lessons mostly reported that context-based mobile learning experience was better than classroom learning and they enjoyed participating in the lesson, they criticized the provided content strongly. Majority of students reported that the tasks and the information provided were not interesting and challenging enough to make the urban adventure truly motivating and thrilling. Students expressed their need for getting more challenging tasks, for example by including physical and competitive activity and increasing the variety of tasks. For example, the following student comment reveals the need for improvement: *"There should be more challenge at control points. Now the maps were not actually needed and the questions were too easy."*

Clearly the most interesting control point for Amazing NFC participants was the visit to the zoological museum. When compared to other control points, there was more activity required from the students and more interaction offered with the environment. The average time used for the visit was the longest during the lesson, and the content and related questions integrated seamlessly with the physical activities required and the context of use. In most control points, the students just quickly visited the entrance hall of a public building for reading the content and to answer the question. In these cases, the physical experience and social context of the location did not successfully integrate with the content provided, as the students did not really interact and experience the space and environment they visited.

Thus, in future development the Amazing NFC urban adventure needs to be more carefully combined with intrinsically motivating attributes (Malone and Lepper, 1987) such as challenge, curiosity and competition. However, when adding the element of competition in learning, one has to be aware of the possible pitfalls associated with racing (Wyeth et al., 2008).

Teachers brought up an idea that in the future the students themselves could act as content creators and providers by offering them a possibility to create their very own tags and to place these tags at the control points. In general, teachers identified that the main benefit of the Amazing NFC lesson was moving the teaching situation and learning experience from the traditional classroom to real-life contexts that also included social interaction between students.

Within this mobile learning concept the threats mostly concern to ensure the safety of students while they are independently going through the urban adventure track. However, students participating in the trial were already older and more independent and used to move around the city by themselves. Also, students could not get lost in the city because teachers were able to follow in real time their progress on the track through a web interface, and the students were advised to use the NFC phone to call the teacher in case of problems or questions. Throughout the pilot, the students coped very well on their own. However, the city of Oulu is relatively small (130 000 inhabitants). In bigger cities safety could be more of a problem.

Also, in this kind of concept a password protection is a necessary requirement to gain access to the web interface that contains status information of the students (which control points have been visited, at what time and by whom) while they are on the urban adventure track. Tags at the control points need also be protected against rewriting.

After this Amazing NFC trial, the project arranged a cultural/historical track where students became familiar with the city of Oulu's culture and history. The route consisted of seven NFC control points located at the local cultural and historical sites in the Oulu, such as statues, monuments and historically meaningful buildings.

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CONSTRUCTING STRATEGIES FOR PROGRAMMING

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Keywords: Strategies, Intelligent tutoring systems, Programming, Feedback.

Abstract: Learning to program is difficult. To support learning programming, many intelligent tutoring systems for learning programming have been developed. Research has shown that such tutors have positive effects on learning. However, intelligent tutors for learning programming are not widely used. Building an intelligent tutor for a programming language is a substantial amount of work, and utilising it in a course is often hard for a teacher. In this paper we illustrate how to construct strategies for solving programming exercises and how these strategies can be used to automatically support students using an intelligent programming tutor to incrementally develop a program. Using strategies for programming, specifying an exercise becomes relatively easy, and more flexible.

1 INTRODUCTION

Learning to program is difficult. A first course in programming is often a major stumbling block. To support learning programming, many intelligent tutoring systems for learning programming have been developed. Studies show the positive effects of various tutors on learning programming. However, intelligent tutors for learning programming are not widely used. Building an intelligent tutor for a programming language is a substantial amount of work, and using an intelligent tutor in a course is often hard for a teacher. Most teachers want to adapt or extend an intelligent programming tutor to their needs, which is often hard or impossible.

Part of the reason why it is hard for a teacher to adapt or extend an intelligent programming tutor to his needs, is that it is often a lot of work to specify a new exercise, together with the desired behaviour upon errors. In this paper we show how we can construct strategies for solving programming exercises, and how these strategies can be used to automatically give feedback and hints to students using an intelligent programming tutor to incrementally develop a program. We restrict ourselves to a tutor for learning the functional programming language Haskell (Peyton Jones et al., 2003). We believe, however, that our approach based on programming strategies is also applicable to other programming languages and programming paradigms.

This paper has the following contributions:

- We present a strategy language and some program refinement rules, and we discuss how these can be used in an intelligent tutoring system for learning programming.
- We show how strategies can be derived automatically from model solutions.
- We develop special programming strategies for higher-order functions, and suggest a taxonomy for classifying programming tasks.

The last two contributions are somewhat technical in nature, and we illustrate these by means of some concrete examples.

This paper is organised as follows. Section 2 discusses how students learn programming and how intelligent tutoring systems for programming can help students. We then introduce strategies in Section 3, and we discuss the role strategies play in programming. Section 4 shows how we derive strategies from model solutions, and how strategies for common higher-order functions are specialised. These

specialised strategies lead to a taxonomy, which can be used for classifying programming tasks. Examples of how our strategies can be used are given in Section 5. The last section discusses related work and concludes.

2 LEARNING TO PROGRAM

Programming is a complex cognitive skill (Merriënboer et al., 1992). Especially novice students encounter difficulties when trying to translate a problem description into a series of solution steps to solve the problem. A first course in programming is often a major stumbling block (Proulx, 2000).

The topic of how students learn to program has been studied extensively, by computer scientists, educational scientists, and cognitive psychologists. How do students acquire a complex skill like programming? When a student has to write a program that takes a list of integers as argument, and returns the sum of the integers, one of the first steps is to distinguish the empty list from the non-empty list case. Distinguishing these two cases can be viewed as a *production rule*. Anderson (1993) and his colleagues have developed the ACT-R theory, which says that the knowledge underlying a skill begins with an elaborated example, followed by problem solving by analogy. By applying the skill, the student internalises the production rule used in the exercise. With practice, production rules acquire strength and become more attuned to the circumstances in which they apply. Learning complex skills can be decomposed into learning individual production rules, and strategies for combining them. A similar approach to learning programming is taken by Merriënboer et al. (1992). They present a four-component instructional design model for the training of complex cognitive skills. For learning computer programming, the design model emphasises the importance of worked-out examples. In a later stage steps are removed from the worked-out examples. These missing steps have to be added by a student. Only after these stages should students work out complete programs themselves.

2.1 Intelligent Tutoring Systems for Programming

There exist intelligent tutors for Lisp (Anderson et al., 1986), Prolog (Hong, 2004), Pascal (Johnson and Soloway, 1985), Java (Sykes and Franek, 2004; Kölling et al., 2003), Haskell (López et al., 2002), and many more programming languages. Some of these tutors are well-developed tutors extensively tested in classrooms, others have not outgrown the research prototype phase yet. Evaluation studies have indicated that:

- working with an intelligent tutor supporting the construction of programs is more effective when learning how to program than doing the same exercise “on your own” using only a compiler, or just pen-and-paper (Anderson and Skwarecki, 1986);
- students using intelligent tutors require less help from a teacher while showing the same performance on tests (Odekirk-Hash and Zachary, 2001);
- using such tutors increases the self-confidence of female students (Kumar, 2008);
- the immediate feedback given by many of the tutors is to be preferred over the delayed feedback common in classroom settings (Mory, 2003).

Despite the evidence for positive effects of using intelligent programming tutors, they are not widely used. An important reason is that building an intelligent tutor for a programming language is difficult and a substantial amount of work (Pillay, 2003). Furthermore, using an intelligent tutor in a course is often hard for a teacher. Most teachers want to adapt or extend an intelligent programming tutor to their needs. Adding an exercise to a tutor requires investigating which strategies can be used to solve the exercise, what the possible solutions are, and how the tutor should react to behaviour that does not follow the desired path. All this knowledge then has to be translated into the internals of the tutor, which implies a substantial amount of work. For example, completely specifying feedback in (much simpler) mathematical exercises results in exercise files of hundreds of lines (Cohen et al., 2003).

In comparison, intelligent tutors for mathematics such as ActiveMath (Melis et al., 2001), APlusix (Chaachoua et al., 2004), MathPert (Beeson, 1990), to mention just a few, are much more widely spread and used than intelligent programming tutors. Mathematics has a number of advantages compared with programming: the mathematical language of expression is much more stable than most programming languages, many mathematical problems are relatively easy compared with programming problems, often there is a unique solution to a mathematical problem, and, finally, checking correctness of intermediate steps is much easier because many mathematical problems are solved by applying meaning-preserving transformations or rewrite steps to an expression. These properties of mathematics make it easier to give

feedback to users of an intelligent tutor, both at intermediate steps as at the end.

3 STRATEGIES FOR PROGRAMMING

Procedural skills can be described by production systems. Anderson (1993) shows that many of the characteristics of such systems are similar to how students solve problems, and hence that they are psychologically plausible. However, psychological plausibility does not imply ease of usability. Models in ACT-R are rather low-level, and tend to get quite large.

A procedural skill is often called a strategy, and there exist programming languages supporting the formulation of strategies (Visser et al., 1998; Borovanský et al., 2001). Using such a language for defining procedural skills is much easier than using production systems, since common programming language techniques, such as abstraction, modularity, and typing are readily available. As long as the feedback students get is psychologically plausible, the form of a language for describing procedural skills can be optimised to make it as easy as possible to specify such skills, and to make it easy to produce the desired feedback.

Heeren et al. (2008) have developed an embedded domain-specific language for specifying strategies for exercises. The strategy language can be used for any domain based upon rewrite rules, and can be used to automatically calculate feedback on the level of strategies, given an exercise, the strategy for solving the exercise, and student input (Heeren and Jeuring, 2008). The specification of a strategy and the calculation of feedback is separated: the same strategy specification can be used to calculate different kinds of feedback.

We can use this strategy language to specify exercises in programming: the only additional concept we have to add to this language is refinement rules, which refine programs. For example, we can split a problem into two subproblems, solutions of which constitute a solution to the original problem.

Using this strategy language for specifying programming exercises offers the possibility to efficiently calculate feedback while incrementally developing a program, and to significantly reduce the effort in adding new programming exercises to an intelligent tutor for programming. In practice, all programs are developed incrementally, so we think incremental development is a realistic assumption. A program that is developed incrementally contains parts that are undefined, or holes, and replacing these holes by 'more defined' programs are the steps a student takes when solving a programming problem. Replacing holes can be done by means of applying refinement rules offered by the programming tool, or by typing in the part of the desired program at that point. The exact input method is immaterial for our approach.

Using strategies for programming we can track the progress of a student solving a programming problem. We can detect deviations from the strategy, and supply hints what to do next. How we react to a deviation is not part of the strategy, but of the didactic model, which determines how strategies are used. We might not be able to recognise all steps from beginning to end, but the longer we can, the better our feedback options are. We argue that the first steps in program development are the most important steps, which require detailed and good feedback. It is at this point where programming techniques have to be selected and applied.

4 CONSTRUCTING PROGRAMMING STRATEGIES

Before we explore strategies for programming exercises, let us first have a look at an incremental construction of a solution for the programming task of implementing insertion sort in Haskell. This is an example of a small, stand-alone exercise, typical for learning how to program in the language. This exercise can also be found in popular textbooks on Haskell (Hutton, 2007).

4.1 Insertion Sort

We assume that the type of the function is given as part of the exercise:

$$isort :: Ord\ a \Rightarrow [a] \rightarrow [a]$$

This type declaration expresses that lists of arbitrary types (the type variable a) can be sorted as long as an ordering is defined on the elements of the list (the type class constraint $Ord\ a$). We start with an empty definition:

$$isort = \ldots$$

The ellipsis in the line above indicates that the definition is not yet complete. A possible first step is to assign a name to the function's first argument of type $[a]$, which results in:

$$isort\ xs = \ldots$$

Now that the list to be sorted has a name (xs), we have to decide what to do with it. The important step in

```
isort :: Ord a ⇒ [a] → [a]
isort []       = []
isort (x : xs) = insert x (isort xs)

insert :: Ord a ⇒ a → [a] → [a]
insert a []       = [a]
insert a (x : xs)
  | a ⩽ x       = a : x : xs
  | otherwise = x : insert a xs
```

Figure 1: Model solution for insertion sort.

completing the definition is to realise that we have to distinguish the empty list from the list with at least one element. This step is part of the insertion sort algorithm, and a standard technique for processing lists.

$$\begin{aligned} &\mathit{isort}\ [\,] &&= \ldots \\ &\mathit{isort}\ (x : xs) &&= \ldots \end{aligned}$$

By discriminating these cases, we now have two parts that have to be completed. We focus on the more challenging definition for $x : xs$ (x is the first element of the list, xs is the remaining part). Here, the insight is that xs needs to be sorted first by applying the function *isort* recursively.

$$\begin{aligned} &\mathit{isort}\ [\,] &&= \ldots \\ &\mathit{isort}\ (x : xs) &&= \ldots \mathit{isort}\ xs \ldots \end{aligned}$$

After completing the base case for the empty list, and introducing a helper-function for inserting an element into a sorted list (*insert*), we arrive at the definition given in Figure 1.

4.2 Program Refinement Rules

The basic steps for constructing a solution for a programming task are program refinement rules, or rewrite rules. These rules typically replace an unknown part (ellipsis) by some expression. A program refinement rule can introduce one or more new unknown parts. We are finished with an exercise as soon as all unknown parts have been completed. The insertion sort example contains several program refinement rules: assigning a name to a function's argument, distinguishing the empty list from the non-empty list by means of pattern matching, and making a recursive call to the function. These rules are the basis for programming strategies. They are reusable and not specific for the insertion sort exercise.

4.3 Strategy Combinators

The simplest strategies consist of a single rewrite rule. We use a collection of standard combinators to combine strategies, resulting in more complex strategy descriptions (Heeren et al., 2008). We briefly describe the combinators most relevant for this paper. The *sequence* combinator applies its argument strategies one after another, thus allowing programs that require multiple refinement steps. The *choice* combinator makes it possible to have multiple, possibly different refinement paths. The *parallel* combinator expresses that the steps of its argument strategies have to be applied, but that the steps can be interleaved. The last combinator, *label*, marks a position in the strategy, allowing us to customise this part of the strategy later on.

4.4 Automatically Deriving Programming Strategies

A programming strategy describes sequences of refinement steps: applying all the steps of such a sequence results in a solution for the programming task. We could specify all allowed sequences that solve a programming task by hand, but it is less labour intensive to automatically derive a programming strategy from model solutions. The advantage of using model solutions is that it becomes relatively easy for a teacher to add new programming tasks to the tutoring system, since he will be familiar with the programming language. In fact, there is no need to learn a new formalism, or to change the implementation of the system. With the strategy combinator for choice, we can combine multiple model solutions. Figure 1 contains a model solution for the insertion sort programming task.

A model solution can be compiled into a programming strategy by inspecting its abstract syntax tree (AST), where each language construct is mapped to its corresponding refinement rule. By introducing choices in the strategy for certain language constructions, we gain some flexibility in the sequences of refinement steps that we accept. For example, the two definitions for the two cases for *isort* can appear in any order since swapping the two does not change the meaning of the function. If two unknown parts are introduced by a refinement rule, we use the parallel combinator by default to leave the order in which these holes are completed unspecified. We apply this principle, for instance, for the right-hand sides of *isort* that are introduced by pattern matching.

4.5 Strategies for Higher-order Functions

The function *isort* presented in Figure 1 is not the standard solution that an expert would give. Figure 2 contains an alternative, much more concise definition

```
isort :: Ord a ⇒ [a] → [a]
isort = foldr insert []
```

Figure 2: Model solution for insertion sort with *foldr*.

```
foldr :: (a → b → b) → b → [a] → b
foldr cons nil = rec where
  rec []       = nil
  rec (x : xs) = cons x (rec xs)
```

Figure 3: The higher-order function *foldr*.

for *isort* that is based on the higher-order function *foldr* (also known as a catamorphism). The definition of this function can be found in Figure 3. The function *foldr* captures compositional computations over lists, and is a highly reusable function defined in the Haskell standard Prelude library. In fact, the definition for *isort* in Figure 2 formulates at a very high level what is essential about insertion sort: we start with the empty list (*foldr*'s second argument), and the helper-function *insert* is used for each element (*foldr*'s first argument).

Remember that we can automatically derive strategies from the model solution's AST, with which we can recognise the steps of a student solving a programming task. One approach would be to combine the strategies derived for the two model solutions. Instead, we specialise the strategy that we derive for the *foldr* function such that it recognises solutions with explicit recursion (as the code in Figure 1), and also solutions in terms of *foldr*. We can even let the strategy accept alternative solutions in terms of *foldr*, such as a definition that gives a name to the argument list (η-expansion):

```
isort :: Ord a ⇒ [a] → [a]
isort xs = foldr insert [] xs
```

The advantage of this approach is that the specialised strategy for *foldr* has to be defined only once, but it can be reused for several programming tasks involving lists. For instance, the task of merging a list of lists by appending all the lists, or computing all the permutations of a list, are tackled by the same strategy for *foldr*. In classroom settings, we often experience that students find it difficult to define a function using *foldr*, and prefer to use explicit pattern matching and recursion. This is not always desirable, and it could even be a goal of a programming task to use functions such as *foldr*, just to become familiar with these higher-order functions. With the specialised strategies we can easily support these kinds of tasks, or provide help in rewriting a definition with explicit recursion into an application of *foldr*.

4.6 A Taxonomy of Strategies

The function *isort* is a catamorphism because it can be defined as a *foldr*, but what about the helper-function *insert*? Here too we use pattern matching on lists, and recursion on the tail of the list. Carefully inspecting the definition in Figure 1 reveals that there are two cases for the non-empty list. For one, we use recursion, but in case $a \leqslant x$ we use *xs* without calling *insert* recursively. Technically, this means that we cannot (conveniently) use *foldr*, but that we have to define it as a paramorphism instead. The function *para* captures another class of useful computations on lists, just as *foldr*, but in a more general way:

```
para :: (a → [a] → b → b) → b → [a] → b
para cons nil = rec where
  rec []       = nil
  rec (x : xs) = cons x xs (rec xs)
```

We give an alternative definition for *insert*, which is based on *para*:

```
insert :: Ord a ⇒ a → [a] → [a]
insert a = para f [] where
  f x xs rs
    | a ⩽ x       = a : x : xs
    | otherwise = x : rs
```

The recursion pattern of *insert* is nicely captured by *para*: the definition for *insert* and its helper-function *f* are not recursive.

The new definition for *insert* is not shorter than the original definition, nor is it more intuitive. Still, this version is to be preferred as a model solution as it separates the recursion pattern (*para*) from the instantiation that is specific for the programming task at hand (the local function *f* and the empty list). In Haskell, it is possible to specify recursion patterns as higher-order functions (such as *foldr* and *para*). Programming tasks that are expressed with the same higher-order function essentially belong to the same problem class. Identifying these problem classes helps with providing detailed feedback on (partial) solutions in an interactive way.

We have introduced the functions *foldr* and *para* for our insertion sort problem, but more of these functions exist that characterise the structure of a computation. An anamorphism, for instance, helps in constructing lists from values, and has yet another recursion pattern. Augusteijn introduces various morphisms for defining other sorting algorithms (Augusteijn, 1998). The functions *map* and *filter* from Haskell's standard library are specific instances of

foldr but they are equally useful in classifying programming tasks. The higher-order functions give us a taxonomy of programming tasks.

The examples may give the impression that our approach only deals with computations involving lists. It is not accidental that we use lists in our examples: lists are frequently used by functional programmers, they are well supported by the language, and they are a popular subject for programming tasks. The technique we present here, namely specialising strategies for higher-order functions that capture a programming pattern, can also be applied to other data structures, such as binary trees. The same holds for other programming techniques, such as accumulating parameters, or divide and conquer algorithms.

5 USING PROGRAMMING STRATEGIES

Now that we have programming strategies available, we want to use these strategies to support a student with the stepwise construction of a program. A strategy describes the order of the refinement steps that a student has to take to construct a program. This organisation of steps enables feedback when solving a programming task.

Given a strategy, we can give various types of feedback. Gerdes et al. (2008) give a list of feedback services derived from existing exercise assistants. This list includes different levels of feedback. In addition to feedback on the strategy level, we can also provide feedback on more basic levels. If a student makes an error on the level of syntax or types, this mistake is reported. Another basic form of feedback is to verify whether or not a refinement step is correct. The following paragraphs explain how programming strategies can be used to provide strategy related feedback.

Hints. At each point in the construction of the insertion sort function we can check whether the step taken by the student is expected, and we can give hints, in increasing specificity. For example, suppose a student asks for a hint when he is at the point of pattern matching:

$$\mathit{isort}\ \mathit{xs} = \ldots$$

The tutor starts with ‘apply pattern matching on the argument’, in this case *xs*. When a student asks for more detail we go down in the strategy, and give the two components of which the pattern matching consists, namely the empty list $[\,]$ and the non-empty list $(x : xs)$.

The steps in a strategy do not necessarily have to be sequential. As mentioned in subsection 4.3, it is also possible to do steps in parallel or to make a choice between different steps. For example, after applying the pattern matching refinement rule, the cases for the empty and non-empty list can be constructed in arbitrary order. When asking for a hint, both of these steps can be presented to the student.

Deviation from the Strategy. Since a strategy outlines the steps to take, we can check if a step is in line with the strategy. If a student deviates from the strategy, there are two possibilities:

- a known refinement rule that is not part of the strategy has been applied,
- or we cannot explain the step made by the student, but cannot prove the program to be wrong.

In both cases we can either let the student go on, or report that we want the student to follow the strategy. An example of a deviation, from the *isort* strategy, is introducing three cases when pattern matching on the input list:

$$\begin{aligned}
&\mathit{isort}\ [\,] &&= [\,] \\
&\mathit{isort}\ [x] &&= [x] \\
&\mathit{isort}\ (x : xs) &&= \mathit{insert}\ x\ (\mathit{isort}\ xs)
\end{aligned}$$

This is a correct program that meets the requirements, but the second case is superfluous. We want to report this to the student.

Buggy Strategies. Besides the correct strategy, we also specify known inappropriate (‘buggy’) strategies for solving the problem. Buggy strategies are used to catch common mistakes, which we use to explain what a student has done wrong. Consider the following definition:

$$\begin{aligned}
&\mathit{isort}\ [\,] &&= \ldots \\
&\mathit{isort}\ (x : xs) &&= \mathit{insert}\ x\ xs
\end{aligned}$$

Although this is a valid and type correct program, it does not have the expected behaviour. This is an example of a buggy strategy in which a student forgets to call the function recursively on the tail of the list (*isort xs*).

Every expected deviation from the strategy can be turned in to a buggy strategy. The deviation presented before, in which a superfluous third case is given to implement *isort*, could just as well be an example of a buggy strategy. Buggy strategies make it possible to give more detailed feedback.

Customising Strategies. We can calculate many types of feedback from a programming strategy specification. The implementor of an exercise assistant decides what feedback to use. For example, an exercise assistant may want to give feedback at each intermediate step or let a student complete an exercise and give feedback afterwards, by showing a complete derivation of the program.

From a didactic point of view it might be desirable to force a student to take a specific route towards the complete definition of a program. Strategies help to allow or disallow certain solution paths. Possible variations are:

- The order in which the main function (*isort*) and its helper-functions (*insert*) are developed is constrained, reflecting top-down versus bottom-up development styles.
- It is optional to enforce a student to give explicit type signatures (e.g. $isort :: Ord\ a \Rightarrow [a] \rightarrow [a]$) of the (helper-)functions he needs to define. We can ask to give the signatures in advance, at some point, or after completion.
- For functions with multiple cases (e.g., the empty list and non-empty list), it is possible to express the order in which the cases should be completed. For example, the simplest case first.

These examples give an indication of the kind of feedback that can be constructed from a programming strategy.

6 CONCLUSIONS, RELATED AND FUTURE WORK

Conclusions. We have shown how we can use strategies for programming to give students feedback while incrementally developing programs for introductory programming problems. Strategies and feedback are separated, so that users (teachers) can tune the feedback the intelligent programming tutor gives to students. Recursion combinators play a fundamental role in our approach, and offer the possibility to easily add flexibility to an intelligent tutoring system for programming, because they can capture many different forms of strategies in abstract terms.

We have developed a proof-of-concept implementation of an intelligent tutoring system for introductory programming tasks. This system supports the strategies that are described in this paper.

Related Work. The Lisp tutor (Anderson et al., 1986) is an intelligent tutoring system that supports the incremental construction of Lisp programs. The interaction style of the tutor is a bit restrictive, and adding new material to the tutor is still quite some work. Using our approach based on strategies, the interaction style becomes flexible, and adding exercises becomes relatively easy.

In tutoring tools for Prolog, a number of strategies for Prolog programming have been developed (Hong, 2004). Strategies are matched against complete student solutions, and feedback is given after solving the exercise. We expect these strategies can be translated to our strategy language, and can be reused for a programming language like Haskell. Soloway (1985) describes programming plans for constructing Lisp programs. These plans are instances of the higher-order function *foldr* and its companions. Our work structures the strategies described by Soloway.

Automatic grading of student programs cannot be used to obtain feedback on partial programs at intermediate steps in the development of programs. But we use the work of Xu and Chee (2003), in particular their approach to abstract syntax tree construction from model solutions, to generate first approximations for program construction strategies. We then add development order and/or type-based strategies, several abstractions, and possibly buggy strategies to the strategies thus obtained.

Future Work. Strategies constructed from model solutions might be rather strict, and enforce particular solutions. We can add more flexibility by specifying programming problems by means of *contracts* (Meyer, 1992), and then check at each intermediate step that the contract is not violated. We can then offer all possible refinement rules to the students, and give feedback at steps that violate a contract. We have yet to investigate how we can statically, incrementally, check contracts.

A model solution must be expressed in terms of higher-order functions to take advantage of the specialised strategies for these functions. Alternatively, we can try to recognise recursion patterns in model solutions. We also plan to investigate how well our approach works for other programming languages, such as Java. Although Java has no support for higher-order functions, we can use strategies to capture common, high-level programming techniques.

The proof-of-concept implementation has to be extended with contracts and further developed to be used in tests in class-rooms. Only when we have a well-developed prototype can we investigate how our work scales. The primary goal is to support introductory programming; so our approach need not scale to full-blown software engineering projects.

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WRITING SUPPORT SYSTEM DEALING WITH NOTATIONAL VARIANT SELECTION

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Abstract: In Japanese, there are a large number of notational variants of words. This is because Japanese words are written in three kinds of characters: Kanji (Chinese) characters, Hiragara letters, and Katakana letters. Japanese students study basic rules of Japanese writing in school for many years. However, it is difficult to learn which notational variant is suitable for official, business, and technical documents because the rules have many exceptions. From the viewpoint of information retrieval, a considerable number of studies have been made on notational variants, however, previous Japanese writing support systems were not concerned with them sufficiently. This is because their main purposes were misspelling detection. Nondominant notational variants are not misspelling, but often unsuitable for official, business, or technical documents. To solve this problem, we developed a writing support system which detects nondominant notational variants in students' reports and shows dominant ones to the students. This system is based on the idea that suitable notational variants are used dominantly in official, business, and technical documents. In this study, we first show the diversity of notational variants of Japanese words and how to develop notational variant dictionaries by which our system determines which notational variant is dominant in official, business, and technical documents. Finally, we conducted a control experiment and show the effectiveness of our system.

1 INTRODUCTION

In English, there are few words which are spelled in several different ways, such as, color and colour. In contrast, in Japanese, there are a large number of notational variants of words. This is because Japanese words are written in three kinds of characters:

- Kanji (Chinese) characters,
- Hiragara letters, and
- Katakana letters.

For example, *sakura* [cherry blossom], one of the symbols of Japan, is written in three ways, as shown in Figure 1. Basic rules of Japanese writing are announced by the Cabinet, and Japanese students study them in school for many years. However, it is difficult to learn the rules because they have many exceptions. In fact, we often find the confusion of notational variants in Japanese university students' reports, including unsuitable notational variants for official, business, and technical documents. As a result, it is important for students to learn which notational variant is suitable for official, business, and technical documents. To solve this problem, we developed a writing support system which detects unsuitable notational variants in students' reports and shows suitable ones to the students. In this study, we assumed that suitable notational variants are used dominantly in official, business, and technical documents, on the other hand, unsuitable ones are inferior or not found in these documents. If the assumption is proper, unsuitable notational variants can be detected by con-

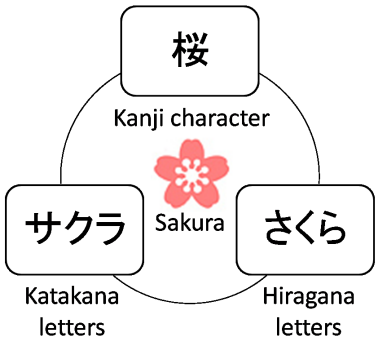


Figure 1: Notational variants of *sakura*.

names of plants	Hiragana	Katakana	Kanji+
sakura [cherry blossom]	184	39	736
bara [rose]	0	217	0
himawari [sun flower]	42	8	0
tsubaki [camellia]	9	25	83
tsutsuji [azalea]	5	15	0
ringo [apple]	8	71	10
mikan [orange]	66	37	2

Figure 2: The frequencies of notational variants of nouns (plant names) in the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].

firming whether they are used dominantly in official, business, and technical documents. In this study, we will use the term *dominant notational variant* of a word to refer to the most frequent notational variant of the word. Furthermore, our system shows the frequencies of notational variants to the students because they are objective and concrete measures. As a result, the system gives the students chances to consider the reasons why they used nondominant notational variants. There are two reasons why our system does not replace nondominant notational variants to dominant ones automatically.

- it is not appropriate to restrict the use of nondominant notational variants because the use of notational variants is one of the sources of the richness of Japanese expressions.
- it is important to consider the reasons why they used nondominant notational variants and choose suitable ones, especially, in educational institutions.

From the viewpoint of information retrieval, a considerable number of studies have been made on notational variants (Kubomura 03) (Kouda 06) (Bamba 08), however, spell checkers in Japanese word processor, such as Microsoft word 2007, and previous Japanese writing support systems were not concerned with notational variants sufficiently (Shimomura 92) (Araki 93) (Murata 01). This is because their main purposes were misspelling detection. Nondominant notational variants are not misspelling, but often unsuitable for official, business, or technical documents. In contrast, Yokoyama dealt with variants of Kanji characters (Yokoyama 06), but not with variants of words. Furthermore, he did not consider this variant problem from the viewpoint of document domains. Dominant notational variants may vary with document domains. For example, in newspaper articles, *sakura* is dominantly written in a Kanji character, on the other hand, in documents in biology, it is dominantly written in Katakana letters. Our system can deal with this problem flexibly by switching dictionaries of notational variants, which were developed by using official, business, and technical documents in several domains.

connection words	Hiragana	Kanji+
tatoeba [for example]	273	570
shitagatte [consequently]	21	26
tadasi [however]	343	0
ippou [on the contrary]	1	2879
mata [also, in addition]	4895	8
sarani [furthermore]	2677	24

Figure 3: The frequencies of notational variants of connection words in the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].

2 NOTATIONAL VARIANTS OF JAPANESE WORDS

In this section, in order to show the diversity of notational variants of Japanese words, we will show notational variants of nouns, connection words, and declinable words.

2.1 Notational Variants of Japanese Nouns

In case of Japanese nouns, notational variants can be classified into three types:

- words consist of Hiragana letters,
- words consist of Katakana letters, and
- words consist of Kanji characters and occasionally Hiragana and Katakana letters.

Figure 2 shows the frequencies of notational variants of plant names in the Mainichi newspaper articles (Jan. 2006 – June 2006). As shown in Figure 2, dominant ways of writing plant names are inconsistent.

2.2 Notational Variants of Japanese Connection Words

Connection words are important words in students' reports because they make the relationships between sentences and ideas smoother and clearer. In case of Japanese connection words, notational variants can be classified into two types:

- words consist of Hiragana letters, and
- words consist of Kanji characters and occasionally Hiragana letters.

Figure 3 shows the frequencies of notational variants of connection words in the Mainichi newspaper articles (Jan. 2006 – June 2006). As shown in Figure

declinable words	Hiragana	Katakana	Kanji+
yasashii [easy]	188	0	9
muzukashii [hard]	21	0	1524

(a) The frequencies of antonymous words: *yasashii* [easy] and *muzukashii* [hard].

declinable words	Hiragana	Kanji+ (1)	Kanji+ (2)
mijikai [short]	*mijikai*	**mijika**-*i*	**miji**-*kai*
	0	362	0
okonau [conduct]	*okonau*	**okona**-*u*	**oko**-*nau*
	15	9	2152
kawaru [change]	*kawaru*	**kawa**-*ru*	**ka**-*waru*
	15	9	2152
arawasu [show]	*arawasu*	**arawa**-*su*	**ara**-*wasu*
	7	283	1

(b) The frequencies of declinable words with declensional Kana ending. Declensional Kana endings of Kanji+(1) are shorter than those of Kanji+(2). Bold letters represent Kanji characters.

Figure 4: The frequencies of notational variants of declinable words in the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].

3, dominant ways of writing connection words are inconsistent.

2.3 Notational Variants of Japanese Declinable Words

In case of Japanese declinable words, notational variants can be classified into three types:

- words consist of Hiragana letters,
- words consist of Katakana letters with Hiragana letters "*suru*", and
- words consist of Kanji characters with declensional Kana (Hiragana) ending.

Figure 4 (a) shows the frequencies of notational variants of antonymous words, *yasashii* [easy] and *muzukashii* [hard], in the Mainichi newspaper articles (Jan. 2006 – June 2006). *Yasashii* [easy] is dominantly written in Hiragana letters, on the other hand, *muzukashii* [hard] is dominantly written in Kanji characters with declensional Kana (Hiragana) ending. In other words, the contrast between *yasashii* [easy] and *muzukashii* [hard] is broken from the viewpoint of the dominant way of writing. [1] Both *yasashii* [easy] and *muzukashii* [hard] have one type of declensional Kana ending: -*shii*. As a result, they have one variant with declensional Kana ending, **yasa**-*shii* and **muzuka**-*shii*, respectively. [2] However, considerable

[1] One of the authors dislikes this violation of the contrast and always writes *muzukashii* [hard] in Hiragana letters in his works.

[2] Bold letters represent Kanji characters.

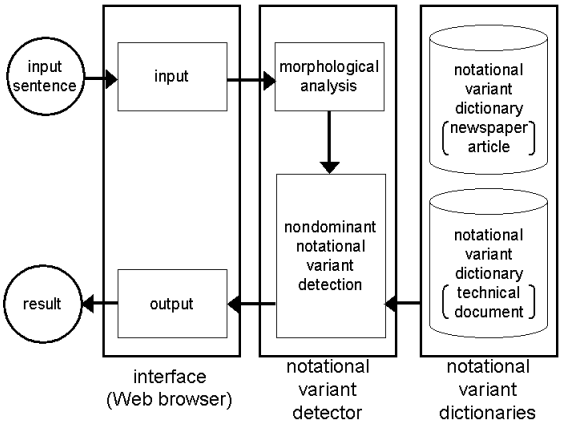


Figure 5: System overview.

number of declinable words have two types of declensional Kana ending, and as a result, two variants with declensional Kana ending. For example, *kawaru* [change] has two types of declensional Kana ending, -*ru* and -*waru*. As a result, *kawaru* [change] has two variants with declensional Kana ending, **kawa**-*ru* and **ka**-*waru*. Figure 4 (b) shows the frequencies of notational variants of declinable words with declensional Kana ending in the Mainichi newspaper articles (Jan. 2006 – June 2006). It also shows that dominant ways of writing declensional Kana ending are inconsistent. Declensional Kana ending is one of the most troubling aspect of notational variants. Japanese students often feel confusions about declensional Kana ending. As a result, we are often confronted with the confusion of declensional Kana ending in their reports.

3 WRITING SUPPORT SYSTEM BASED ON NOTATIONAL VARIANT DICTIONARIES

3.1 System Overview

Figure 5 shows the overview of our system. Our system is based on the idea that suitable notational variants are used dominantly in official, business, and technical documents. Figure 6 shows an example of how to use our writing support system. As shown in Figure 6, users can access and send input sentences to the system via web browsers by using CGI based HTML forms. Input sentences are segmented into words by using a Japanese morphological analyzer, JUMAN (Kurohashi 05). Then, by using notational variant dictionaries, the system confirms whether notational variants of the words are used dominantly in official, business, and technical documents. When

(a) An input sentence, *tabako wo yameru no ha muzukashii* [it is hard to stop smoking], is given to the system.

(b) The system detects a nondominant notational variant, *muzukashii* [hard], in the input sentence and shows the frequency information of the word in the newspaper articles and technical documents.

Figure 6: An example of how to use our writing support system. English system messages are inserted ad hoc for convenience of non-Japanese readers of this paper.

the system detects a nondominant notational variant of a word in an input sentence, it is underlined and turns red, and the system shows the frequency information of notational variants of the word and gives users chances to consider the reasons why they used nondominant variants. In Figure 6 (a), a user gives an input sentence, *tabako wo yameru no ha muzukashii* [it is hard to stop smoking], to the system. Then, as shown in Figure 6 (b), the system detects a nondominant notational variant, *muzukashii* [hard], in the input sentence. *muzukashii* [hard] is underlined and turns red, and the frequency information is shown. In this way, the key to detecting nondominant notational variants is notational variant dictionaries. In section 3.2, we show how to develop notational variant dictionaries.

3.2 Development of Notational Variant Dictionaries

In this study, we assumed that suitable notational variants are used dominantly in official, business, or technical documents, on the other hand, unsuitable ones are inferior or not found in these documents. If the assumption is proper, unsuitable notational variants can be detected by confirming whether they are used dominantly in official, business, or technical documents. In order to confirm whether notational variants are used dominantly, we extracted examples of notational variants from

- 296364 newspaper articles published in the Mainichi Newspaper from January 2006 to June 2006 (Mainichi 07).
- 319 technical reports published in the 12th Annual Meeting of the Association for Natural Language Processing (2006).

and developed notational variant dictionaries. In this study, we used newspaper articles because we aimed to acquire notational variants of words which used in various domains. On the other hand, we used technical reports because we aimed to acquire notational variants of words in specific domains and develop domain specific dictionaries of notational variants. The reason why we developed domain specific dictionaries of notational variants was that dominant notational variants may vary with document domains. By switching domain specific dictionaries of notational variants, our system can confirm whether notational variants are suitable to compose documents in the specific domains. In this study, we acquired notational variants in a specific domain from technical reports published in the Annual Meeting of the Association for Natural Language Processing (2006). Some of the technical reports were given to the students, who took part in the experiment described in Section 4, as reference works. This is one reason why we extracted examples of notational variants from the technical reports. Sentences in these documents were segmented into words by using a Japanese morphological analyzer, JUMAN (Kurohashi 05). When JUMAN finds a notational variant, it gives a variant label to the variant. The same variant label is given to notational variants of a word. By using these variant labels, we extracted notational variants and developed two dictionaries of

- notational variants in newspaper articles, and
- notational variants in technical reports of natural language processing.

Table 1 shows the results of the notational variant extraction from newspaper articles and technical documents. The most frequent notational variant of each word was considered as the dominant notational variant.

As shown in Table 1, notational variants of 27988 and 9211 words were extracted from the newspaper articles and technical documents, respectively. These words can be classified into two types:

TYPE I a word of this type has actually two or more notational variants, however, only one of them was found in the newspaper articles or technical documents.

TYPE II a word of this type has two or more notational variants which were found in the newspaper articles or technical documents.

Table 2 shows the unique and total number of notational variants of TYPE II words in the newspaper articles and technical documents. In order to show how much the dominant notational variant of a word is used dominantly, we introduced *dominant degree*. Suppose that a word has notational variant i $(i = 1, \cdots, N)$. The dominant degree of the word is calculated as follows:

$$d = \frac{f_d}{\sum_{i=1}^{N} f_i}$$

where d is the dominant degree of the word, f_i and f_d are the frequencies of notational variant i and the dominant notational variant of the word, respectively. Figure 7 shows the histograms of the dominant degrees of TYPE II words in the newspaper articles and technical documents. In Figure 7, the broken lines show the histograms of the dominant degrees of all the TYPE II words in the newspaper articles and technical documents. On the other hand, the thick lines show

Table 1: The results of the notational variant extraction from the newspaper articles and technical documents.

part of speech	unique # of words (variant labels)	unique # of notational variants	total # of notational variants
noun	20603	26747	3656574
verb	3897	6403	1283024
adjective	2120	2830	280787
adverb	1125	1607	115609
conjunction	87	100	30850
interjection	80	97	2643
attributive	75	98	10946
prefix	1	3	10891
Total	27988	37885	5391324

(a) The results of the notational variant extraction from the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].

part of speech	unique # of words (variant labels)	unique # of notational variants	total # of notational variants
noun	6458	7154	310980
verb	1548	2093	101398
adjective	706	825	22952
adverb	376	459	13037
conjunction	60	71	4465
interjection	30	33	148
attributive	32	39	1192
prefix	1	3	302
Total	9211	10677	454474

(b) The results of the notational variant extraction from the technical documents [the Annual Meeting of the Association for Natural Language Processing (2006)].

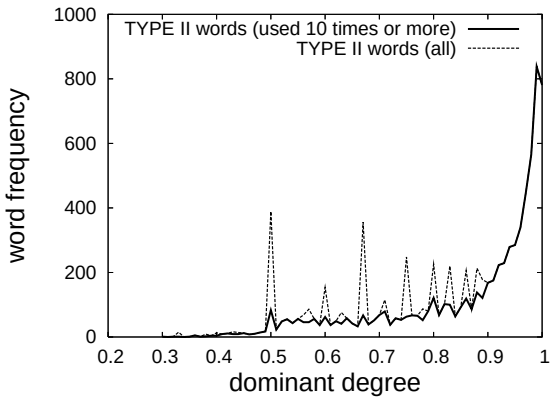
Table 2: The unique and total number of notational variants of TYPE II words in the newspaper articles and technical documents. A TYPE II word has two or more notational variants which were found in the newspaper articles / technical documents.

part of speech	unique # of words (variant labels)	unique # of notational variants	total # of notational variants
noun	5328	11472	1817055
verb	2135	4641	916302
adjective	628	1338	176374
adverb	440	922	72251
conjunction	13	26	12980
interjection	15	32	593
attributive	22	45	8853
prefix	1	3	10891
Total	8582	18479	3015299

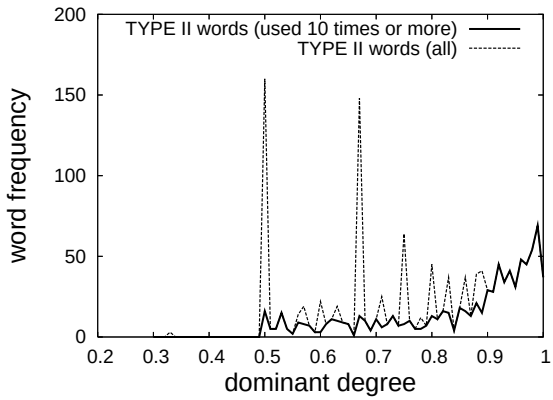
(a) The unique and total number of notational variants of TYPE II words in the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].

part of speech	unique # of words (variant labels)	unique # of notational variants	total # of notational variants
noun	644	1340	62848
verb	508	1053	56058
adjective	110	229	6253
adverb	78	161	5617
conjunction	11	22	1330
interjection	3	6	13
attributive	7	14	941
prefix	1	3	302
Total	1362	2828	133362

(b) The unique and total number of notational variants of TYPE II words in the technical documents [the Annual Meeting of the Association for Natural Language Processing (2006)].



(a) The histograms of the dominant degrees of TYPE II words in the newspaper articles [Mainichi Newspaper (Jan. 2006 – June 2006)].



(b) The histograms of the dominant degrees of TYPE II words in the technical documents [the Annual Meeting of the Association for Natural Language Processing (2006)].

Figure 7: The histograms of the dominant degrees of TYPE II words in the newspaper articles and technical documents.

the histograms of the dominant degrees of TYPE II words the notational variants of which were used 10 times or more in the newspaper articles and technical documents. The reason why we eliminated words the notational variants of which were used less than 10 times in the newspaper articles and technical documents is that it is difficult to confirm which notational variant is used dominantly because there were too few samples. As a result, we thought that dominant notational variants were credible when they satisfy the following conditions, and gave credibility labels to them.

- in case of a TYPE I word, the notational variant of the word was used 10 times or more in the newspaper articles or technical documents. 11825 and 2285 TYPE I words in the newspaper articles and technical documents, respectively, satisfied this condition.
- in case of a TYPE II word, the sum of frequencies of all the variants of the word was 10 or more, and the dominant degree was 0.8 or more. 5270 and 590 TYPE II words in the newspaper articles and technical documents, respectively, satisfied the above conditions.

4 EXPERIMENTAL RESULTS

To evaluate our method, we conducted a control experiment. We gave 10 problems of notational variant selection to 20 subjects, university students in computer science. Each problem consisted of two sentences. The differences between the two sentences were only notational variants. For example, the following sentences mean that it is hard to stop smoking:

- *tabako wo yameru noha muzukashii*
- *tabako wo yameru noha* **muzuka**-*shii*

the differences between the two sentences above are *muzukashii* and **muzuka**-*shii*. The former is written in Hiragana letters and the latter is written in Kanji Characters (in Bold letters) and Hiragana letters. The subjects were requested to choose one of the sentences, which seemed to be suitable for them to use in official, business, and technical documents. Subjects were classified into two groups, group A and B.

- subjects in group A were given only 10 problems and no more information.
- subjects in group B were given the same 10 problems and frequency information of the notational variants in the test materials.

The frequency information of the notational variants were retrieved by our experimental writing support system. As shown in Figure 6 (b), when our system detects a nondominant notational variant of a word in an input sentence, it shows the frequency information of notational variants of the word. For example, the frequency information of *muzukashii* and **muzuka**-*shii* was shown as follows:

newspaper articles	*muzukashii*	**muzuka**-*shii*
	21	1524
technical reports	*muzukashii*	**muzuka**-*shii*
	0	155

Table 3: Experimental results.

group	κ value	rate of choosing dominant notational variants
group A	0.261	74%
group B	0.623	87%

Table 4: Interpretation of κ values.

κ	Interpretation
< 0	no agreement
0.0 - 0.20	slight agreement
0.21 - 0.40	fair agreement
0.41 - 0.60	moderate agreement
0.61 - 0.80	substantial agreement
0.81 - 1.00	almost perfect agreement

To evaluate the experimental results, we introduced two measurement: κ values and the rate of choosing dominant notational variants (Table 3). κ values are statistical measures for assessing the reliability of agreement between subjects. κ values are generally thought to be more robust than simple percent agreement calculation, in this case, the rate of choosing dominant notational variants, because κ values take into account the agreement occurring by chance. Table 4 shows the interpretation of κ values (Landis 77). As shown in Table 3 and 4, in this experiment, there was fair agreement of notational variant selection in group A. In other words, we were confronted with the confusion of notational variants in their answers. In each problem, some students chose a nondominant (unsuitable) notational variant for no reason and they were totally unaware of doing it. It shows that the notational variant selection is a serious problem. On the other hand, there was substantial agreement in group B. In addition, we obtained 13 % increase of the rate of choosing dominant notational variants when the frequency information was given to subjects. It shows that the frequency information of notational variants is promising. It also implies that students do not have confidence in their notational variant selection and flexibly change their decisions when the reasons are given to them. Actually, three subjects in group B changed their decisions, and three other subjects did not change but felt sure of their decisions. Some of them said that they can obey sys-

tem's advices more simply than teacher's instructions without concrete evidences. The other four subjects in group B reported that the frequency information is not necessary. Actually, one of them could choose dominant variants correctly in all the problems, on the other hand, the others could not. This is because they obeyed a peculiar writing rule: they must use as many Kanji characters as possible in their official, business, and technical reports. This is the limitation of our writing support system, and where a human instructor comes in.

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MATHPORT
Web Application to Support Enhancement in Elementary Mathematics Pedagogy

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Keywords: Web application, Open-source software, Genetic algorithm, Elementary school mathematics, Pedagogy enhancement.

Abstract: The paper presents a Web application MatPort that is aimed to support enhancement in elementary mathematics pedagogy. In Slovenia, there is a lack of e-Learning courses on elementary school mathematics that would provide teachers and students with verified mathematics problems in Slovene language. The MatPort offers a databank of verified mathematics problems that may be solved on paper or at a computer, or combined into a paper and pencil form of tests. In this paper, we describe the structure and the functionality of the application, providing an insight into the MatPort decision system that supports automatic search of math problems so that students may reach a certain level of knowledge in a thoughtful way. The decision support system is based upon the genetic algorithm. The application has been evaluated by a group of teachers and students, who have been actively involved into the MatPort development.

1 INTRODUCTION

One of modern ways of education delivery is *e-Learning*, which is a broad term used to describe learning done at a computer, usually connected to the World Wide Web. It is widely accepted that e-Learning can be as rich and as valuable as the classroom experience or even more so. With its unique features e-Learning is an experience that leads to comprehension and mastery of new skills and knowledge, just like its traditional counterpart.

Instructional design for e-Learning, which is the systematic process of translating general principles of learning and instruction into plans for instructional materials and learning, has been perfected and refined over many years using established teaching methods, with many benefits to students.

1.1 Learning Styles

There are three predominant learning styles (Donovan, 2000):

- Visual;
- Auditory;
- Tactile/kinesthetic.

Broken down further, people learn by reading and seeing (visual style), listening and speaking (auditory style) and doing (tactile/kinesthetic style). Reading, listening and seeing are *passive types* of learning, while speaking and doing are *active types* of learning. How much we tend to remember is a function of the type of learning we prefer and our level of involvement in the learning. People often learn through a combination of the ways described above. To a lesser degree, environment is a factor too.

Given a good learning environment, most people tend to understand and remember (i.e., learn) best when practicing the real thing. Being actively engaged in hard and challenging activities strongly supports them to construct knowledge for themselves. Next, a combination of observing people we respect, doing and speaking about what we learn produces a high retention rate, followed by speaking alone.

In e-Learning, it is important to provide a variety of activities supported by human intervention. A lot

of passive learning may be done through reading text, listening to audio clips, and seeing graphics, while the active mode should be stimulated through practising, e.g., solving mathemathics problems.

1.2 Unique e-Learning Features

There are several unique features of e-Learning:

- e-Learning is self-paced and gives students a chance to speed up or slow down as necessary;
- e-Learning is self-directed, allowing students to choose content and tools appropriate to their differing interests, needs, and skill levels;
- Designed around the learner;
- Geographical barriers are eliminated, opening up broader education options;
- Enhances computer and internet skills.

1.3 Mathematics e-Learning Support in Slovenia

Učiteljska.net (http://uciteljska.net/) and *e-um* (http://www.e-um.si/) are good examples of Slovene Web applications aimed to support e-Learning of elementary school mathematics. While the first one is intended to support exchange of teacher experience and information, the second one provides interactive online courses for students.

However, there is a lack of online courses in Slovene language on solving verified mathematics problems for children under 15 years of age. For this reason, we have developed a new Web application for e-Learning of elementary school mathematics in an active learning mode, called *MatPort* (http://sinica.ijs.si/matport/).

The rest of the paper is organized as follows: Section 2 describes the content and the technology aspects of the Web application. Section 3 outlines the concept of the decision support system that may be used as an automatic search facility. The experimental work is presented in Section 4. Conclusions and directions for further work are given in Section 5.

2 WEB APPLICATION MATPORT

The Web application MatPort is based upon the national curriculum for elementary school mathematics and upon verified mathematical problems.

2.1 Web Content Aspect

For the pilot stage of the project, we decided to use a collection of verified sets of mathematics problems in Slovene language, published in the form of flash cards, which have been used for many years in our schools. These problem solving items already passed through many steps of evaluation, therefore, they are valuable. Some of the real life items needed to be updated for the present time. By this stage, we have focused on the grades 6 to 9 or the age group 12 to 15 years old students.

With the help of experienced teachers we classified the items into subgroups with respect to the knowledge required for problem solving by content and three difficulty levels.

Finally, we designed and developed the MatPort Web application with the following modules for:

1. Entering math items, their solutions and teaching instructions into a database for teachers and administrators;
2. Solving math items;
3. Preparing a paper and pencil form of test;
4. Providing other information relevant for teaching the elementary school mathematics.

The first and the third module are aimed for teachers, the second one for students and the last one for teachers and parents.

2.1.1 Entering Math Items

A user registered as a teacher may enter his/her items into the MatPort database (Fig. 1). Each item is described with a problem definition, solution(s) in terms of values and units, content area, difficulty level, source or author, and teaching instructions. The user may copy an already validated math item and adapt it to its needs.

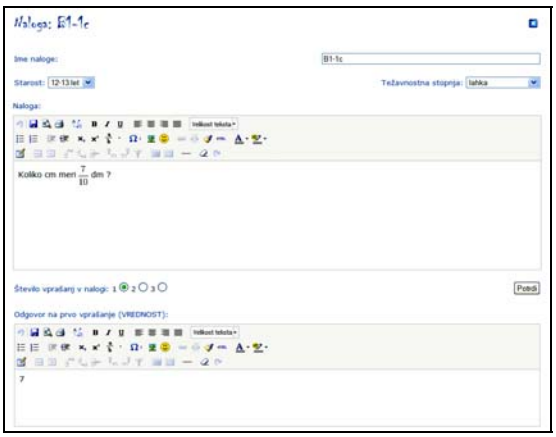

Figure 1: Entering Math Items.

The math items saved in the database are accessible only to the user. However, (s)he can outbid any of his/her items to other MatPort users. Before publishing this item as a public one, experts verify it and suggest modifications if required.

Teachers are informed of their activities through a simple statistics on math items collected in the MatPort database.

2.1.2 Solving Math Items

A user registered as a teacher or a student may solve any public or his/her own math item from the MatPort databank. The application provides *manual* and *automatic search* of math items in content areas defined by the national curriculum for elementary school mathematics. The automatic search is provided by a decision support system that is described in detail in Section 3.

Ones an item is selected, the user can print it and solve the problem in a classical paper and pencil way, or directly provide solution(s) to the MatPort. The application evaluates the answer(s) and denotes the item as correctly or incorrectly solved problem by this user.

Users are given information on the progress in solving math items through graphycal symbols and stimulative words (Fig. 2). More specifically, if the user correctly solves more than 45%, 60%, 75% or 90% of dealt items, respectively, (s)he is rewarded with one, two, three, four or five stars, respectively.

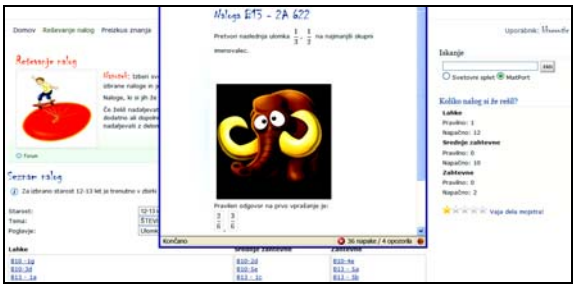

Figure 2: Solving Math Items – information.

If required, users may get teaching instructions for math items (Fig. 3). They can also use a forum integrated into the application to communicate with other users or experts.

2.1.3 Preparing Tests

The MatPort supports design of paper and pencil form tests to examine the students' knowledge in a classroom. A user may select a set of items, modify them if needed, define the test's header and print the test. The application also offers a printout of solutions to the selected math items.

Figure 3: Solving Math Items - teaching instructions.

2.1.4 Providing Information

We support teachers and parents with information on elementary school mathematics, such as (Fig. 4):

- Results on the *IEA (International Association for the Evaluation of Educational Achievement) TIMSS Advanced Assessment Frameworks*, which – carried out every four years at the fourth and eighth grades provides data about trends in mathematics and science achievement over time;
- The national curriculum for elementary school mathematics;
- Practical advices to parents on helping students learning mathematics at home;
- Education debate on motivation methods and tools for engaging students in the process of active learning mathematics.

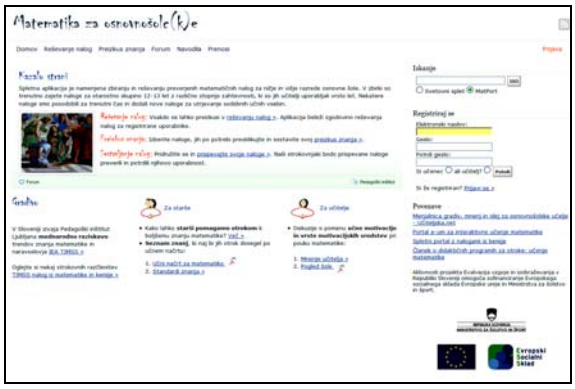

Figure 4: MatPort web application.

2.2 Web Technology Aspect

The MatPort was designed and developed using state-of-the-art technologies. We applied a *UML* (Unified Modelling Language) based model-driven

methodology (http://www.uml.org/) to cover the life-cycle of the Web application development.

2.2.1 Design

To design the application sympathetically with the way students, teachers and parents actually use the Web, not how we think they should, we directly involved experienced teachers into the project.

The MatPort **database** was designed as a rational database, consisting of tables that store data on:

- User profiles;
- Math items;
- Knowledge required for solving items;
- Relations between the content areas;
- History of items' solving.

The database structure is given in Fig. 5.

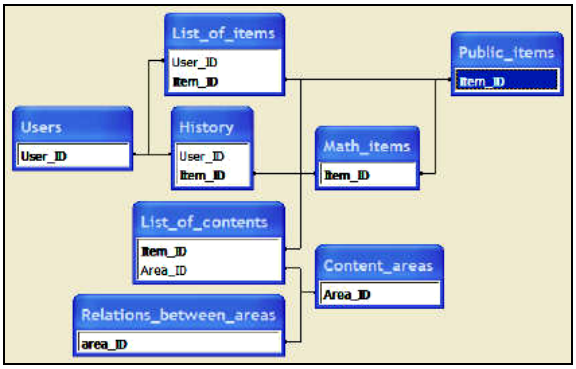

Figure 5: Rough draft of the MatPort database structure.

The application consists of several dynamic and static **modules**, such as:

- Module for providing math items;
- Math item solver module;
- Test generator module;
- Informer module;
- Forum;
- Download center.

The informer module has a static content that is managed by a content management system, while the others may change their content in a dynamic way. The Web application structure is shown in Fig. 6.

2.2.2 Development

As the project's budget was low and we needed to minimize the cost, we decided to make good use of open-source and freely available software. We applied:

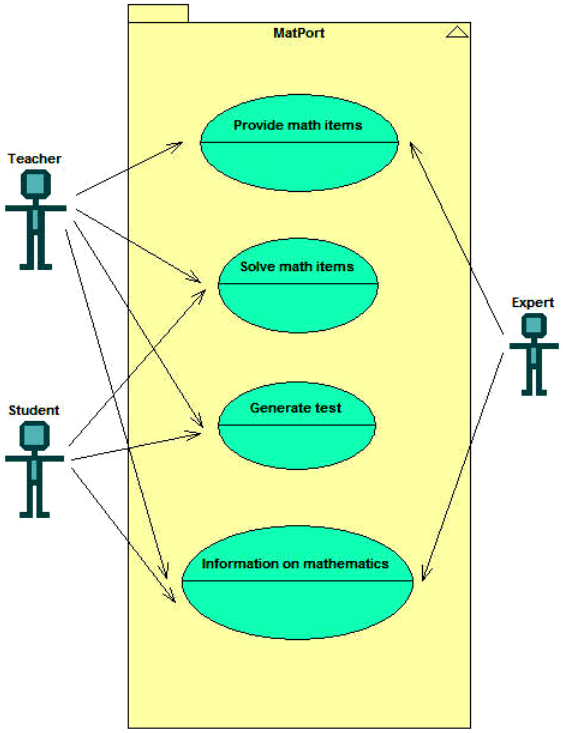

Figure 6: Rough draft of the MatPort use case.

- *Apache* (http://www.apache.org/) as a **Web server** that replies to Web clients' requests via HTTP (HyperText Transfer Protocol);
- *MySQL* (http://www.mysql.com/) as a **database management system** that is based on the relational model;
- *PHP5* (HyperText Preprocessor) (http://www.php.net/) as a server-side technology. This is also a **scripting language** that has evolved to include a command line interface capability and can be used in standalone graphical applications. PHP5 offers standardized means for specifying the variety of property scopes typically offered by object-oriented languages (Hayder, 2007);
- *JavaScript* (Darie *et al*, 2006) as a client-side technology. This is another **scripting language**, whose code is written in plain text and can be embedded into HTML (HyperText Markup Language) pages to empower them.

The MatPort is aimed for doing mathematics, which means that mathematical symbols need to be supported. For this reason, we integrated *TinyMCE* (http://tinymce.moxiecode.com/) as a platform independent JavaScript **WYSIWYG editor**. It has the ability to convert HTML TEXTAREA fields or other HTML elements to editor instances. Because

TinyMCE supports only standard HTML math symbols, we extended its library with a module for handling mathematical expressions. Once entered, these are rendered into images using the *LatexRender* scripts (http://www.mayer.dial.pipex.com/tex.htm).

All MatPort printouts have the standard *PDF* (Portable Document Format) format.

The MatPort forum is based upon the *PHPBB™* (http://www.phpbb.com/) open-source forum solution.

Last but not least, we set formatting MatPort visual options in a centralized document that is referenced from PHP files by using *CSS* (Cascading Style Sheets).

3 DECISION SUPPORT SYSTEM

We are aware of the fact that only providing a dataset of math items is not enough. We need to incorporate an *extrinsic* motivation system to "bribe" the 6th to 9th grade students to practice mathematics. There are rare children who are *intrinsically motivated* to do repetitive, boring tasks.

3.1 How to Motivate Children?

A student who solves a MatPort math item receives information on the progress through graphical symbols and stimulative words (Fig. 2).

In addition, the application provides information on math items that need to be further solved to receive a higher score. These can be supplementary or additional items to help strengthen or increase knowledge, respectively. The information is provided by the MatPort decision support system, when the automatic search facility is used.

3.2 Genetic Algorithm

The MatPort decision support system that motivates students to continue solving exercises is based upon an evolutionary computation method, i.e., the *genetic algorithm* (GA) (Goldberg, 1989; Bäck, 1996).

The GA is based on a heuristic method, which requires little information to search effectively in a large search space. The algorithm employs an initial population of chromosomes, which evolve to the next generation by probabilistic transition rules (randomized genetic operators) such as selection, crossover and mutation. The objective function evaluates the quality (fitness) of solutions coded as chromosomes. This information is used to perform an effective search for better solutions. There is no need of other auxiliary knowledge. The GA tends to take advantage of the fittest solutions by giving them greater weight and by concentrating the search in the regions of the search space with likely improvement. The GA mechanism is presented in Fig. 7.

```
Initialize the population of
chromosomes;
While stop condition not met do:
  ▪ Calculate the fitness for each
     member in the population using the
     fitness function;
  ▪ Select and reproduce individuals
     according to their fitness;
  ▪ Perform genetic operators
     (crossover and mutation) on the
     population.
```

Figure 7: The GA's pseudocode.

The GA is a population-based evolutionary approach that allows searching within a broad set of solutions from the search space simultaneously. Namely, because there are many math items (few hundreds or even more than thousand math items per a grade) and interrelated content areas (more than 100 content areas per a grade), the student may continue solving items in many possible ways that may or may not lead to a higher score. Moreover, math items are dynamically generated by teachers (i.e., the item dataset expands with time) and the student may start solving them anywhere in the dataset. In the GA, there is a risk of converging to a local optimum, but good results of various research work obtained in other optimization problem areas (Papa and Koroušić Seljak, 2005; Koroušić Seljak, 2006; Tušar et al, 2007; Korošec and Šilc, 2008) encouraged us to consider the GA approach as a promising approach to the decision making problem.

The idea is to **find a set of math items within different content areas that, when solved correctly, improve the user's knowledge** and increase his/her score as much as possible. The set of items should consist of math problems from all poorly scored content areas and the areas that precede these areas. Therefore, before start searching, the system identifies all the feasible items, i.e., math problems from the poorly scored content areas. These items form some kind of a pool of relevant items *P* for current score improvement.

3.2.1 Encoding

The suggested list of math items needed to improve the score is encoded into a chromosome, where each

gene represents the identification (ID) number of the item in the MatPort database. The chromosome length has been fixed to 15, while this number represents a reasonable number of items to perform, in order to significantly improve the score. Fig. 8 presents the chromosome with such number of genes and the IDs of the items to be performed in the order as encoded in the chromosome.

1	2	3	4	5		14	15
45	124	33	79	186	...	247	31

Figure 8: Chromosome of length 15 that represents a set of items to be solved to increase the current score.

3.2.2 Population Initialization

The initial population consists of *n* chromosomes. Each chromosome is initialized with randomly chosen items from the pool of relevant math items.

3.2.3 Genetic Operators

In the selection process, the elitism strategy is applied through the substitution of the least-fit chromosomes with the equal number of the best-ranked chromosomes.

With the one-point crossover scheme, chromosome mates are chosen randomly and with a probability p_c all values after randomly chosen position are swapped, which leads to two new solutions that replace their original sources. Fig. 9 shows a crossover example.

45	124	33	79	186	...	247	31
12	14	233	56	228	...	269	41

⇓ ⇓

45	124	33	56	228	...	269	41
12	14	233	79	186	...	247	31

Figure 9: One-point crossover.

In the mutation process each value of the chromosome mutates with a probability p_m. If the value of the chromosome needs to be changed, than some new value from the pool of relevant math items is chosen. However, since a high mutation rate resulted in a random walk through the GA search space, p_m has to be chosen to be somewhat low. Fig. 10 shows a mutation example.

45	124	33	79	186	...	247	31

⇓ ⇓

45	137	33	56	12	...	269	41

Figure 10: Mutation.

3.2.4 Fitness Evaluation

After the recombination operators modify the solutions, the whole new population of chromosomes is ready to be evaluated. In the evaluation process the set of math items is assumed to be solved correctly and the score improvement is calculated. The calculated score improvement is used as a fitness value of each chromosome. Here all the items are weighted with their difficulty grade; the order of items is relevant when the problems belong to different content areas that derive from each other.

3.2.5 Parameter Settings

In order to ensure optimal solutions in a reasonable response time robust parameter settings need to be found for the population size, number of generations, selection criteria and genetic operator probabilities:

- If the population size and the number of generations are too small, the GA converges too quickly to a local optimal solution and may not find the best solution. On the other hand, a large population and too much iteration require long time to converge to a region of the search space with significant improvement. In our case, we have used the population size n=15 and number of generations n_g=30;
- Applying the elitism strategy, fitter solutions have greater chance to be reproduced. But when the number of worse solutions to be exchanged with better ones (the selection criteria) is too high, the GA is trapped too quickly in a local optimum solution. Our selection rate has been 20%;
- Too low crossover probability preserves solutions to be interchanged and longer time is required to converge. This probability should be large enough to crossover almost all mated solutions. In our case, efficient setting for p_c has been 70%;
- Too high mutation probability may introduce too much diversity and takes longer time to reach an optimal solution. Too low mutation

probability tends to miss some near-optimal solutions. Again, the efficient setting for p_m has been 5%.

3.2.6 Termination

When a certain number of populations are generated and evaluated, the system is assumed to be in a non-converging state. A chromosome with the highest score improvement is chosen as a final result.

On average, the GA finds an optimal selection of math items that need to be further solved by the user to receive a higher score in order of few seconds. As it is implemented as a background process, it does not slow down the application.

4 EXPERIMENTAL WORK

During the current pilot stage of the MatPort application, we have involved a group of elementary school teachers and a group of the 8th grade students to test the application facilities.

We have examined the MatPort effectiveness for delivery of elementary mathematics e-Learning. In the group of teachers, we have been interested in:

1. The number of new math items provided by the teachers;
2. The number of copied and modified already validated math items;
3. The number of written tests designed by the MatPort.

In the group of students, we have been interested in:

1. The time spent in each content area;
2. The number of correctly and incorrectly solved exercises in each knowledge field;
3. The correlation between the MatPort scores and school marks before and after the period of testing the MatPort;
4. Frequency of using the MatPort automatic search (decision support system) facility.

Both groups have been asked to complete a survey that includes an assessment of likeability, intention to use exercises and information, and demographic indicators.

The main aim of the study is to prove a predicted hypothesis that participants keep or even increase their level of knowledge in elementary mathematics by practising math problems provided by the MatPort. In this way, we could conclude that the MatPort actually supports enhancement in elementary mathematics pedagogy.

5 CONCLUSIONS

In this paper, the instructional design of the MatPort Web application, which is aimed for elementary mathematics e-Learning in the active way, were presented. We upgraded this design by incorporating a high-performance evolutionary computation method to support automatic search of relevant math items. In this way, the MatPort may lead its users toward higher scores in a thoughtful way. Finally, we described the method for evaluation of the application's effectiveness.

After the pilot stage of the project, we are planning to expand the dataset of math items to other elementary school grades. We will increase its efficiency through additional motivation tools, such as winner lists or computer games, which will be activated as soon as a student will gain a certain score. Much work needs to be done to find an adequate level of human intervention. In cooperation with teachers, we will try to improve the way of providing teaching instructions and intermediate solutions. Last but not least, we will discuss the problem of cheating.

In addition, we will do some experimental work on the application of the efficient parameter-less evolutionary search method (Papa, 2008) as a substitution for the currently implemented genetic algorithm.

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c&d-LEARNING IMPLEMENTATION ARCHITECTURE
Adapting e-Learning to Developing Countries

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Keywords: Educational methods, e-Learning, Thin clients, Cooperation for the development, Satellite connection, Internet access, Teleconference, Videoconference, Off-line courses.

Abstract: From the educational point of view, the most widespread method in developing countries is on-site education. Technical and economic resources cannot support conventional distance learning infrastructures and it is even worse for courses in universities. They usually suffer a lack of qualified faculty staff, especially in technical degrees. The literature suggest that e-learning is a suitable solution for this problem, but its methods are developed attending to educational necessities of the First World and cannot be applied directly to other contexts. The proposed methodology is a variant of traditional e-learning adapted to the needs of developing countries. E-learning for Cooperation and Development (c&d-learning) is oriented to be used for educational institutions without adequate technical or human resources. In this paper we describe the c&d-learning implementation architecture based on three main phases: hardware, communication and software; e.g. computer and technical equipping, internet accessing and e-learning platform adaptation. Proper adaptation of educational contents to c&d-learning is discussed and a real case of application in which the authors are involved is described: the Ngozi University at Burundi.

1 INTRODUCTION

Modern research in cooperation for development is led toward innovative solutions for (institutions and people's) problems at developing countries. Traditional technical problems at educational institutions in these countries have been identified. There are many proposals to use e-learning tools at developing countries, but in general they are only affordable for the most advanced universities in the Third World. A crucial goal of cooperation is to improve education at developing countries. Research on learning, and specifically on e-learning, is one of the most productive research fields at occidental universities. Nevertheless, advances in these areas are made regarding educational needs of developed countries, where the situation is quite different from developing countries. Those differences are not only technical, but also at the human and communication level.

Universities of developed countries have a number of agreements with universities of developing countries, but these collaborations are with the most important universities of those countries. In general, cooperation is oriented to improve the teaching or develop research. It is difficult to find relationships of occidental universities with poor and small developing countries universities to help with their main deficiencies. Many e-learning collaborations arrangements are established between universities of the North and the South, but they are based on north e-learning tools and conventional requirements. In general, they are not suitable for small universities with low resources from developing countries.

The cooperation group TEDECO[1] has been studying the necessities of a group of universities of Central Africa (Ngozi, Mwaro and Bujumbura universities at Burundi; and Bukavu University, Peace University, High Pedagogy Institute at Congo Democratic Republic). Some common problems have been identified such as damaged wires, irregular electric supply, outdated hardware, lack of internet connection, lack of specific software, lack of technical faculty staff and, of course, economic problems. In addition, the situation is completely different to occidental universities. In conventional e-learning the professor is

[1]Technology for the Development and the Cooperation, http://tedeco.fi.upm.es/

working full time at the university and the students have Internet connection at their houses. They may study in an asynchronous timetable using e-learning platforms. At our target universities the situation is completely different. As the students do not have computers at home they need to go to the university facilities to get Internet access. Regarding the lack of teaching staff, students may attend to the university following a fixed schedule without professor guidance.

Attending to these differences it is quite obvious that conventional e-learning cannot be applied to developing countries universities. An adaptation of hardware and communication conditions is needed to use e-learning applications in a different way. Contents should be also adapted thinking about the specific context of the classes. This paper aims to cover the majority of these tasks.

During the last two years, TEDECO has been working with the University of Ngozi at Burundi[2] thanks to Technical University of Madrid funding (TESON, 2006; TICAMEN, 2008). We illustrate this proposal with some explanations related to our expertise implementing the architecture that we propose at the University of Ngozi.

2 ICT IN DEVELOPING COUNTRIES

In first world countries Information and Communication Technologies (ICT) are applied to the majority of daily life fields, in professional and scientific environments but also in social and cultural ones (figure 1). They are powerful tools, essential for modern development. However, specific necessities in developing countries produce that ICT are applied in a different way or with slightly different objectives (Blogs ICT, 2008). Although there exist other application scopes of ICT in developing countries, the main areas are health (e-health) and education (e-learning).

In a first approach, it may seem that these countries have other priorities related to "survival" before education. But from a long term perspective, the development enhanced by education produce these basic improvements. Any development concept is each day more relate to ICTs (Oswalder, 2003). Therefore it is necessary to apply sustainable actions to improve Internet and telecommunication accesses and to improve knowledge about information technologies in general, so the development of local Web content (UNCTAD, 2004). In fact, these infrastructures are growing at a faster rate than expected in developing countries. In some cases such as Internet access through mobile technologies, these countries are adopting cutting-edge technologies that developed countries do not implement yet, since traditional ones are still widely extended (UNCTAD, 2004).

[2]http://www.ung.bi/

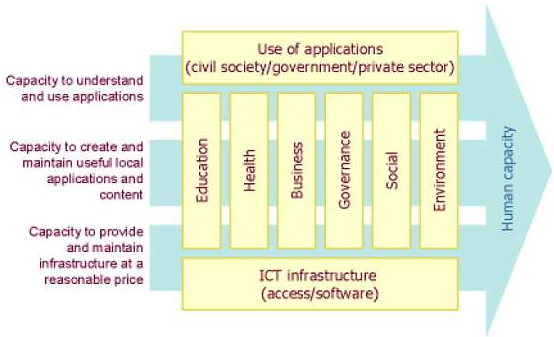

Figure 1: ICT cross-impact (Oswalder, 2003).

E-learning may be defined in its widest meaning as: "*electronic or based in technology learning*". This e-learning interpretation may lead to several applications, but nowadays, e-learning and TICs are generally used as tools for (Ardizzone and Rivoltella, 2004):

- make a more visible and modern University,
- as an extension of the learning offer,
- or as a learning virtualization.

Our proposal aims to take learning beyond a global market, heading towards the idea of a universal learning. The e-learning can be the tool that allows the multiplicity of professors, transporting their effort also to developing countries. Within the application of ICT in developing countries, e-learning is specially interesting, since it permit to overcome the physical limitations of traditional learning, promoting education as the main remedy for poverty. These countries lack of resources and infrastructures to implement appropriate learning methodologies, therefore, technologies that permit distance education are very important. There exist a special lack of human resources with skills in science and technologies, which together with an increment of students make e-learning suitable to be implemented in developing countries. Finally, as an added incentive, e-learning facilitates the technological transference from first world countries to developing countries.

An appropriate technological and economic infrastructure is required to exploit e-learning correctly. This infrastructure must cover three resources listed below (Kamel, 2006):

- **Financing**. In most cases, developing countries

governments have a limited budget for education, where usually, not every student has access to a free university education.

- **Infrastructure**. Closely related to financing problems is the lack of infrastructures: public works, teaching staff and communications among others.
- **Content**. It is essential to provide a teaching staff that evaluate the student learning and include adapted content to e-learning platforms.

As a result, to implement an e-learning application in developing countries a coordinated effort in these three requirements is needed. Many countries do not have a proper communication network, especially outside big cities. And where the communication network does exist, there is not financing resources to pay the connection. And when these two conditions are satisfied, there is usually a lack of educational contents. To solve the former problem, e-learning may profit from open course programs such as the MIT Open Course Ware (MIT, 2008). However, this content cannot be included directly, but after an adaptation to each situation. Although some basic subjects are universal, others include social and cultural aspects, or they must be adjusted to the educative level of these universities.

The e-learning is being disseminated more and more in developing countries through different project, such as:

- *Programa de Actualización de Maestros en Educación*, AME, funded by *Fundación Cisneros* in Latin America (Fundación Cisneros, 2008),
- the Global Learning Opportunities On the Web, GLOW (Challenge, 2008),
- and the African Virtual University, AVU (Wolff, 2002).

The former organization, AVU, use ICT to offer sub-saharan countries access to some academic resources over the World. The final goal is to alleviate the technological gap due to the lack of scientific, engineers, technicians, and other professionals that would facilitate the economic and social development of Africa through the information society.

In a real case where the authors are involved, a traditional distance educational method has been adapted to special necessities and limitations encountered during development at University of Ngozi. Due to innovative elements of the proposed method we refer to it as cooperation and development -learning (c&d-learning) (Escudero et al., 2008).

3 C&D-LEARNING IMPLEMENTATION ARCHITECTURE

We propose a three-phase architecture that should be implemented starting by the bottom one. We explain details about each phase in the rest of this section. Figure 2 provides a detailed representation of the implementation architecture (in particular, the one that is being introduced at the University of Ngozi).

TEDECO group has already finished the implementation of the first and second phase at the University of Ngozi during the execution of the TESON project (TESON, 2006). Nowadays the third phase is progressing thanks to funding through the TICAMEN project (TICAMEN, 2008). We illustrate each of following sub-section using our experience in these two projects.

3.1 Hardware Phase

Due to technical problems that target universities use to suffer, the implementation of the c&d-learning is extremely important to ensure that the hardware infrastructure would work properly. This process has been divided into three sub-phases listed below:

- electric current stabilization,
- installation of several computer classrooms for teaching (e-learning),
- installation of a local network (intranet) to connect computers within the university.

The hardware phase was finished with technical equipment adaptation and training of human resources. These resources were needed for a local network that should be built and maintained by qualified local staff.

3.1.1 Electric Supply

Frequent shutdowns and lack of power stability, are two facts that pose the following question: are developing countries ready for solutions designed at developed ones? The answer is probably no, but we may adapt these solutions and solve some of these problems developing alternative technologies. For example, one of the most promising solutions to palliate the electric supply problems is using solar energy.

Solar panels are a good alternative to common power supply in those regions where shutdowns are frequent. However we found a new limitation: the complete shutdown—the number of systems able to operate with a solar power supply is very small. However, solar panels may also be used to stabilize the

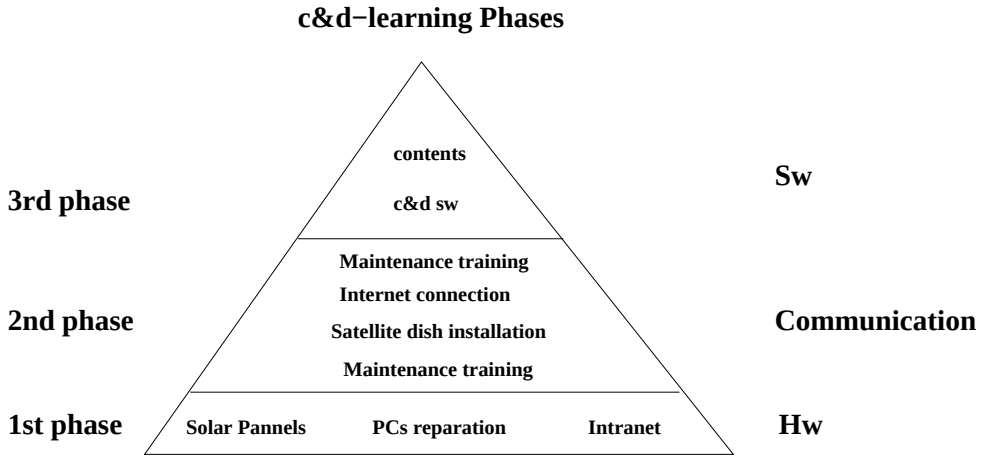

Figure 2: Detailed c&d-learning Implementation Phases.

power supply. The stabilization of the electric current is essential when the entire educational model depends on a technological infrastructure.

The main drawbacks when using technologies in development are the major constraints that appear implementing a solution that should be stable over time.

3.1.2 Computer Classrooms and Maintenance

A sustainable solution must be based on the use of available resources, so before purchasing new computers and other hardware, the analysis of the current state of the equipment at the University of Ngozi was carried out (Osin, 1998). The second major limitation of these countries arose then: outdated hardware—solution: *thin client* technology.

These two limitations, problems with the electric supply and outdated hardware, forced us to design a different strategy to rebuild the new computer-based classrooms. Following a thin client approach, outdated computers may be reused as terminals. This solution also allows a fast recovery of user computers after a power outage (Martínez et al., 2008). Actually this was our first work, computer reparation, selecting the most powerful computers to be used as servers in a thin client-based network. The sacrifice of a high performance computer —which in a developed country would be used as a simple PC[3]— allows reuse a number of old computers. The number of terminals connected to a single server (i.e. number of old computers reused per available server) will depend on the performance of it. The installation of a thin client-based solution requires the development of a special software for the resource sharing between client and server (Martínez and Pérez, 2008). Communication is accomplished by sending the desktop from the server to the client, which entails a mandatory network consumption, which will depend on the content displayed by the client.

[3]Personal Computer.

3.1.3 Intranet

The main purpose of a local network is to enable a shared access to Internet for employees and students at UNG. For general Internet access, the maximum bandwidth required by the local network is not a critical parameter (as will be shown later). The bandwidth provided by a local network is in any case far greater than the bandwidth available for Internet. Current networking technologies use gigabit connections, although 100 or 10 Mbps can be found yet. However, the implemented network is indeed a bottleneck due thin client technologies (exposed above) that require significant use of network traffic.

3.2 Communication Phase

Developing countries generally do not have a large deployment of conventional infrastructures for telecommunications, traditionally implemented by telephone networks. Non-standard connection technologies must be used to overcome connection problem in these countries. For this project with the University of Ngozi we have installed and tested a satellite connection.

3.2.1 Satellite Connection

The use of satellite communication implies some limitations that are important not only from a technical point of view, but also from an academic perspective regarding educational content preparation. The

most important characteristic of a satellite connection is the **asynchronous communication**, i.e. the information is sent and received through independent channels (downstream and upstream). The bandwidth of the upstream channel (or return channel) is quite lower than the bandwidth of the downstream channel. In addition, the return channel is limited by other — and more important— effect: the **latency**[4].

All these problems are predictable and known in advance, but there is an additional problem that cannot be always controlled: the performance of a satellite connection depends on **external factors**. Unsettled conditions may imply certain instability in the satellite connection—i.e. weather. The number of satellite connections in a region also affects these connections; in general, the total bandwidth of a territory is shared by all the connected users.

3.2.2 Connection Sustainability

It is crucial to guarantee the sustainability of the every infrastructure deployed in these developments. Otherwise the whole project will fail. The lack of sustainability in solutions adopted is one of the main causes of useless cooperation efforts. We included training for the local team to maintain PCs and intranet infrastructures. At this point a similar training process is necessary for the communication infrastructure.

However, the sustainability related to satellite connections includes an economic component. Satellite connection should be paid and the local institution (University) should make sure this payment. In the University of Ngozi case we encouraged the installation of a cyber within the campus to collect the satellite connection fee. A viability plan was prepared at the beginning of the implementation of the project to guarantee its sustainability.

3.3 Software Phase

Although some software applications have been already developed in two previous phases, a third and final phase is being carried out which works exclusively adapting and developing a learning platform.

3.3.1 Learning Platform

With several open and available learning platform, every day is more difficult to justify the development of this software from scratch. Free solutions such as *Moodle*[5] are suitable for multiple operating systems and are backed by a large community—i.e. forums, documentation, updates, etc. Consequently, these solutions can be adapted to every user requirements.

In our case we are currently working to adapt Moodle to developing countries requirements, optimizing an asynchronous education model with three new features:

- an automatic content synchronization avoiding the use of the Internet connection in periods with high demand of bandwidth (working hours);
- an enhanced off-line courses management system,
- and a new role, the local professor as a content facilitator to local students.

A learning platform adaptation is needed. First world countries demand other characteristics from these software tools and after review the state of the art, there are none that cover all these issues.

3.3.2 Support Software and Digital Ink

More and more applications are available on the market in relation to e-learning support software. Frequently, these tools are referred to as **digital ink** when they are used in a live environment, e.g. *Classroom Presenter*[6] (Anderson et al., 2007). The value of these applications seems fairly interesting for e-learning, but our experience —mainly in the communication channel— shows us that this software is still far from its application in developing countries.

4 CONTENTS ADAPTATION

Two main possibilities may be considered to present educational content to a group of students:

- using a single device visible by all the students (e.g. by using a projector) is the first approach to transmit educational contents,
- distributing the content to every student using a computer-based classroom.

Communication systems based on conferences cover the first option. The second one requires considering resources available at the institution. This paper describe a situation that face the former option together with *thin client* limitations.

4.1 Conference

Direct communication may be essential for some educational activities such as tutoring. Videoconference is certainly the best solution to transmit information

[4] Delay to transmit any information.

[5] http://moodle.org/

[6] http://classroompresenter.cs.washington.edu/

over long distances, but its requirements do not allow the use of this technology in several circumstances. Reduced bandwidth, a connection frequently interrupted or delayed because of network traffic are some issues that may prevent using videoconferences for teaching when scenarios with a minimum quality are required to transmit information properly.

The satellite communication cause the main limitation considered in our situation, i.e. asynchronous connection, high latency in the return channel, and shared bandwidth. Therefore, we are compelled to explore all possible alternatives for communication, such as teleconference or videoconference described below.

4.1.1 Teleconference

The minimum technology required for an on-line communication is teleconference, i.e. a communication where only audio is transmitted. Even for this simple communication, problems caused by an asynchronous connection and the delay of the return channels due to latency must be considered. However, it is not mandatory that the audio channel is synchronized, and can be transmitted following just one direction (the *downstream* direction). The return channel can be text-based, e.g. *chat*. The teleconference can be easily enhanced using a mixed system where audio is complemented with images updated by the speaker: slides, or a webcam picture of the professor among others.

4.1.2 Videoconference

Videoconferences only requires a higher bandwidth, so it is also affected by the same problems in communication: synchronization, latency, etc. For example, in a satellite communication the videoconference should be also transmitted in one direction. In fact, videoconferences are similar to enhanced teleconferences where images are updated in higher frequencies.

Using this strategy a priority management must be carried out ensuring audio rather than video, so the communication should be divided into two distinct channels. A reduction of bandwidth will cause a reduction of video quality, but not audio, essential to understand the communication content.

Nowadays, *Google Inc.*[7] offer a free solution with these two possibilities, teleconference and videoconference, with an acceptable quality, *Google Talk*. It is particularly interesting with asyncrhonous communications between sender and receiver, providing possibilities of sending audio and video only in one direction, using a written reply for the other direction.

[7] http://www.google.com/

4.1.3 Off-line Courses

When there is no guarantee in sending audio or video, it is strongly recommended the use of an alternative, such as the off-line exposure of a subject. This option is specially interesting in those partnerships where there is a significant **time difference**, such as in cooperation between universities in Europe and Latin America.

4.2 Content Presentation

Educational content adaptation has meet some technological limitations. For example, a solution based on thin client technology has remarkable limitations inherent to its structure, mainly focused on network usage. This should be also taken into account when different options for e-learning are considered. For example, the graphic below (figure 3) shows two curves with the bandwidth consumed by thin clients in different scenarios:

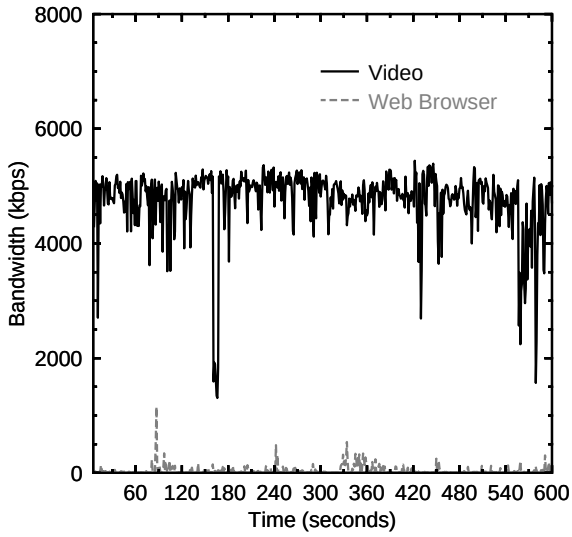

Figure 3: Bandwidth consumption in a thin client-based network.

- In the first scenario, the terminal is playing a video. The bandwidth consumed is shown by a continuous line, which appears at the top of the figure.
- In the other scenario, the terminal is visiting web sites through a web browser. The consumption is shown with a dotted line, which can be observed at the bottom of the figure.

The difference is quite significant suggesting that video, and multimedia content in general, should not be included within the information transmitted to every student. Since we have assembled computer classrooms with low-performance equipment, and the internal network does not allow the transport of a high bandwidth, there are some limitations that suggest some rules to create educational content, such as:

- remove multimedia contents (video, animations, etc.) to avoid permanent desktop updates consuming the bandwidth,
- slide resolution reduction, i.e. less content by slide and more slides.

In summary, any bandwidth reduction is an improvement in these situations. Specially those related with unnecessary visual effects.

5 CONCLUSIONS

During many years the survival of universities with our means at the south depends on the charity of foreign professors that travel to these countries to teach. Depending on help received it may be an unsustainable solution, so it is not acceptable.

A number of universities at developing countries are in a difficult situation for economic problems. E-learning could be widely used at these universities to overcome some economic issues. Nevertheless, the minority of centers that use e-learning in south countries are the most advanced ones. It is a paradox, but classical e-learning is not adapted to these countries due to specific needs and technical characteristics. E-learning is oriented to facilitate things to occidental students with technological possibilities but it is not oriented to help students without means.

We have proposed (Escudero et al., 2008) a variant of e-learning adapted to developing countries limitations. In this paper we provide an architecture to implement the so-called c&d-learning. It is a complete proposal that cover from hardware details to software adaptation issues or communication infrastructures. The most important characteristic of these implementation should be always the sustainability.

Our architecture is backed by our experience at the University of Ngozi. Where the two first phases have been completed within TESON project (TESON, 2006) obtaining promising results, and we are currently working in the third phase in the framework of the TICAMEN project (TICAMEN, 2008).

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SERVICES FOR EDUCATION IN THE METROPOLITAN RESEARCH AND EDUCATION NETWORK

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Abstract: Over the recent years Poland has been very successful in deploying advanced ICT infrastructure for use by the public sector. This infrastructure includes fiber-based metropolitan research and education networks interconnected with the backbone optical network PIONIER, and a vast amount of advanced services that provide interesting resources and tools also for the education sector. Today Poland gains a big opportunity of innovating its education system to a novel ICT supported classroom immersed in an integrated education environment. Creating an educational service network based on research and education network links would bring a new, better learning and teaching experience for the education system participants. However, it also sets a big challenge before designers of such an educational service network. In this paper, we discuss the current opportunities and our approach at creating such a network.

1 INTRODUCTION

Poznan Supercomputing and Networking Center has been the operator of the metropolitan research and education network in Poznan since early 1990s. This network (POZMAN) was originally founded to interconnect academic and research centers such as universities and research institutes. It later became the means of interconnecting offices of various public domain services such as municipality offices, hospitals or public schools. Today, this metropolitan network provides fiber to 23 schools in Poznan, thus creating an opportunity to draw a roadmap for integrating them into one educational corporate network also on the service level.

An attempt to create an educational service network is also justified by the existence of various advanced services that may either deliver interesting educational content for use during the educational process or provide a new quality to this process. These services include regional digital libraries that provide access to rare library resources, the public television educational programme offer and archive delivered through an Internet-based system, educational portals that provide a vast ammount of articles, educational resource directories and online tools, e-learning platforms with materials in the form of e-courses, videoconferencing services or virtual laboratories.

Last but not least, also the analysis of the needs of the education community in Poznan shows that the delivery of innovative educational tools based on advanced services available in the metropolitan research and education network is highly required by the education community itself. In October 2008 we conducted a questionnaire among 42 public high schools which showed that various activities in this field were already being undertaken by schools and that there was a high demand for training teachers in ICT utilization in the educational process.

In this paper we present the value that a research and education network with its advanced services may bring to the educational system. In section 2 we shortly present an example metropolitan research and education network (MAN) and the wider context of its interconnection with other such networks in Poland, Europe and beyond. Section 3 describes various services currently deployed in the public optical network and accessible through the MANs. Section 4 draws a roadmap for building a service network for education with the use of available ICT infrastructure. We end with a presentation of related initiatives in section 5 and a summary in section 6.

2 RESEARCH AND EDUCATION NETWORK

The metropolitan research and education network POZMAN has been operated by Poznan Supercomputing and Networking Center since 1993. It started as FDDI-based network linking major universities and research institutes in the city. Later, the base technology was changed to ATM, and other types of institutions such as, for example, municipality offices and hospitals were being connected to the network. Today, the network is based on 10 Gigabit Ethernet technology and connects over 100 institutions, including all academic institutions in Poznan, all municipality offices, most hospitals and 23 public schools.

Figure 1: PIONIER Polish Optical Internet.

Further on, the metropolitan research and education network of our city is interconnected with 20 other similar networks around Poland through a nationwide backbone research and education network called Polish Optical Internet PIONIER as shown in Figure 1. This allows for wide cooperation between institutions connected to metropolitan research and education networks at the national level. Such cooperation takes place in the research and academic community, where common projects are conducted with the vast utilization of the optical networking advantages. Some of the most important initiatives that can be mentioned here include access to remote instrumentation in the form of virtual laboratory (Lawenda at al., 2004), provision of country-wide multimedia content delivery system (Czyrnek at al., 2006) or organization of the national Federation of Digital Libraries (Lewandowska, Mazurek and Werla, 2008).

Moreover, the PIONIER network provides access to the European research and educational services through the optical interconnection to the European academic research network Geant2. PIONIER also has optical links to all Poland neighboring countries. This international connectivity is also used to facilitate cooperation between fiber-enabled institutions, with a majority of this cooperation taking place within the scientific community. Access to CERN's facilities, integration with the European digital library Europeana, performing high definition videoconference sessions or delivering broadband channels to a vast amount of research projects is not a problem at the international level.

It is also important to mention that local, province-wide initiatives to create broadband province networks connected to PIONIER take place in various parts of Poland. For example, the Swietokrzyskie Province is currently in the process of building a province-wide broadband with the use of wireless technologies. In other regions, such as our province Wielkopolska, the plan is to build local fiber connections to all counties. The existence of broadband links in the counties gives the local governments an opportunity to interconnect institutions they are responsible for, including public schools. This process has already begun. Pila, one of the biggest towns in Wielkopolska, has recently invested in a fiber connection to one of their primary schools. Further investments are planned in the future.

The optical network, operated by a research center as ours, creates a good opportunity for delivering a new type of educational materials and a new type of educational tools to public schools. The optical link provides schools with a new quality in the education process they maintain. It is at the same time received at a reasonable monthly cost of 400 zlotys (about 100 euros) for a 100 Mbps connection. However, this reasonable cost becomes especially attractive when the optical link is delivered in a package including also a set of advanced services that enable real access to the above-mentioned educational materials and tools. Examples of such services already existing today in the PIONIER network and accessible through metropolitan research and education networks are presented in the next section.

3 EDUCATIONAL SERVICES IN THE RESEARCH AND EDUCATION NETWORK

The broadband network link such as the optical connection to a metropolitan research and education

network is a must for the environment aiming at innovating the educational process with the use of ICT tools. While this constitutes the necessary start and a required infrastructure, the core of this environment are services that are capable of delivering vast amounts of new educational materials and tools. In this section we present examples of such services, currently used in other contexts than an integrated educational service network.

Examples of the above-mentioned services that could enrich the options that schools have at hand when maintaining their day-to-day work with students include the following:

- digital libraries;
- multimedia content archives;
- high definition videoconferencing;
- virtual laboratories;
- e-learning platforms;
- and educational web portals.

We discuss the value of each of these services for the education processes conducted at schools in the following subsections.

3.1 Digital Libraries

Over the recent few years many digital libraries holding lots of valuable resources have emerged in Poland. This includes 14 regional digital libraries with such libraries as, for example, Wielkopolska Digital Library (http://www.wbc.poznan.pl/), Lower Silesian Digital Library (http://www.dbc.wroc.pl/) or Kujawsko-Pomorska Digital Library (http://kpbc.umk.pl/) that were built with the use of the standards-based dLibra framework (Dudczak et al 2007). What is more important these libraries are interconnected with each other through OAI-PMH mechanisms thus creating a nation-wide Federation of Digital Libraries, which was already mentioned in section 2. Overall 38 digital libraries are part of this Federation giving access to a total of over 180 thousand digital objects. One should also not forget about efforts aiming at integrating the Polish Federation with the Europeana digital library.

The constantly growing number of digital objects held by Polish and European digital libraries may be already accessed today by teachers and students at schools. These objects constitute a great value especially for such classes as history, literature, arts and culture. Some of the objects that can be found in the Wielkopolska Digital Library, for example, include rare manuscripts dating from the 15th century, a collection of local newspapers from the 19th and early 20th centuries and other regional artifacts, dating back to 13th century. Example Wielkopolska Digital Library publications of educational value are shown in Figure 2.

Figure 2: Example publications in the Wielkopolska Digital Library bringing educational value for schools.

3.2 Multimedia Content Archives

Another example of digital content with a great educational value to the teachers and students at schools are multimedia found in online archives such as, for example, the digitized archive maintained by the Polish public broadcaster TVP (http://www.itvp.pl/). What is important to note here is that this multimedia content is distributed within the PIONIER network with the use of thoroughly tested, intelligent content delivery system, already mentioned in section 2.

The TVP online archive holds around 1200 educational audio-visual assets. This includes older programmes digitized recently, and the current production which is being digitized and put into the online archive straight away. These programmes hold a great value to a number of classes and courses, including physics, chemistry, nature, science or history. Example resources are shown in Figure 3.

Figure 3: The view at the educational multimedia archive of the Polish public broadcaster TVP.

3.3 High Definition Videoconferencing

Videoconferencing shows a great potential at enriching educational experience of students at school. Different types of videoconferencing techniques are used at schools already today. According to a questionnaire conducted among high schools in our city in October 2008, 8 out of 42 schools own dedicated videoconferencing rooms with equipment and facilities, that are used during classes. These are television quality videoconferencing terminals. However, as the HDViper project (http://www.hdviper.org/) findings show, high definition videoconferencing carries even greater educational potential.

The utilization of HD quality video requires much higher bandwidths, yet it is fully justified by the much better user experience. The latter is especially true for such educational performances as for example chemical experiments where the visibility of details is vital, or e-meetings of students from remote schools where high video quality constitutes a better feeling of presence. A questionnaire conducted within the HDViper project with a number of actual high school teachers showed that there is a widespread agreement that videoconferencing gives new possibilities in education. The teachers pointed to a number of uses of videoconferencing like cooperation on joint projects between schools, interviews with famous people, participation in seminars or scientific experiments and activities with individual students.

3.4 Virtual Laboratories

Virtual laboratory systems provide means of remote access to unique laboratory equipment from the comfort of one's desk. They are mainly used by scientists to access expensive and rare equipment, often in a collaborative manner allowing to perform observations on a scale unknown before. An example of such an infrastructure may be remote radio-telescope access which allows astrophysicists to use over 20 radio-telescopes distributed across 6 continents to achieve a high resolution image of a given fragment of the sky (Okon et al., 2009).

Virtual laboratories in the context of mandatory education will not involve access to expensive equipment and infrastructures such as the above-mentioned radio-telescopes. This concept can be used to access limited laboratory instrumentation at either selected schools in a given geographical jurisdiction or at university laboratories. However, virtual laboratory platforms come with advanced simulation and visualization tools which can be used by school with virtually no limit, thus giving access to results of actual scientific experiments performed with the use of the aforementioned expensive infrastructures such as radio-telescopes. This creates an opportunity for innovative educational scenarios and enrichment of traditional science, physics or chemistry classes.

3.5 e-Learning Platforms

e-Learning platforms such as, for example, the open source Moodle (Rice, 2008) have been known for quite a few years now. The emergence of the SCORM format enabled standardization of e-course creation thus facilitating its exploitation within the education sector. Many universities currently use some form of e-learning. In Poznan also the Teacher's Training Center (ODN – Osrodek Doskonalenia Nauczycieli) uses an e-learning platform to offer various e-courses aimed at upgrading skills of public school teachers.

The above-mentioned questionnaire we conducted in 42 high schools in Poznan showed that 8 of them are maintaining their internal e-learning platforms used to create and utilize educational materials for students in the form of e-courses. Furthermore, 80% of schools cooperate with various universities which provide valuable e-courses on selected subjects. With the emergence of optical

links at schools it is natural to think of enabling their internal e-learning resources together with the materials provided by universities to the totality of schools, thus equalizing access to these resources, reducing costs of their creation and enabling their sharing and reuse.

3.6 Educational Web Portals

A vast number of educational resources can also be found on the web, especially within educational portals such as the Polish Educational Portal "Interkl@sa" (http://www.interklasa.pl/). Such portals contain lots of useful educational materials and provide interesting tools for use within the educational process. For example, the above-mentioned "Interkl@sa" portal provides access to over 5500 articles catalogued within subject subpages. It also delivers various specialized tools such as web educational resource directory, "Virtual Classroom", chat or Frantice, a French language vortal.

Access to the resources of web educational portals does not require an optical link to the metropolitan research and education network. However, it constitutes a value that should be combined with the services mentioned above to deliver an integrated educational environment of resources and tools that enables to provide means for the application of an innovative classroom. We discuss how this should be done in the next section.

4 BUILDING AN EDUCATIONAL SERVICE NETWORK

Having the fiber-based broadband link to the Internet and a critical mass of digital resources and tools available online, schools may begin to organize improved education courses supported vastly by ICT use. To this end, two elements must get integrated into an educational service network. First, one must define an organizational framework for cooperation between schools and other educational institutions within the assumed educational scenarios. Second, an appropriate approach at the integration of ICT infrastructure should be assumed. We discuss both these issues in this section.

4.1 Organization of Educational Scenarios in the Service Network

When designing an organizational structure of the educational service network, one must first of all understand what types of relations may exist between actors participating in scenarios that can be supported with the use of this network. Our analysis and discussion with the education community, represented by the most active high school principals in the city, shows that there are 4 categories of actors delivering and/or utilizing the educational services in such a network. These are students (S), teachers (T), Universities (U) and methodological centers such as the aforementioned ODN (M). The relations between these actors are presented in Figure 4.

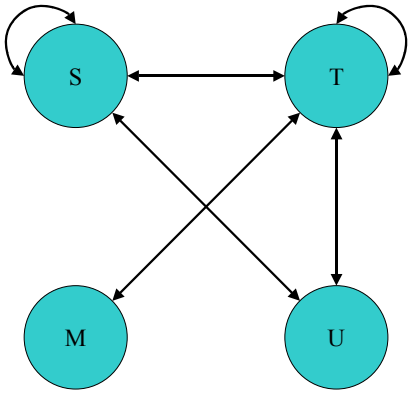

Figure 4: The relations between actors with the educational service net: S – students, T – teachers, U – universities, M – methodological centers.

Further on, these actors as listed above, may take different roles in five educational scenarios we found on the base of our discussions and the questionnaire we conducted in October 2008. These scenarios include:

- supporting traditional classroom with educational services of the network, for example, reaching to online resources as a teaching aid in the classroom;
- complementary education with the use of educational services of the network, for example, students preparing projects based on resources found within the network;
- utilization of university resources in high school education, for example, organization of special laboratory e-presentations;
- utilization of educational services of the network in out-of-classroom education, for example, for the most talented students or students that cannot participate in classroom activities for a given period of time;
- teacher improvement with the use of educational services of the network, for example, utilization of e-learning platforms to provide improvement e-courses.

In each of these scenarios not only passive utilization of services and resources takes place, but the actors may also actively cooperate with each other on the inter-institution level. That imposes important requirement of a careful design of the new processes that take place in this new environment. To this end key participants in the value-chain such as the local governments that administer the local education systems must undertake the role of designing the new process workflow. In the case of our activities aiming at establishing an educational service network, this role has been undertaken by the Department of Education of the Poznan City Hall.

4.2 Integration of ICT Infrastructure for the Delivery of Educational Services

When it comes to the integration of the educational service network at the technical level, three major requirements must be taken into consideration. These requirements are as follows:

- ease of service utilization;
- ease of resources and tools reuse;
- privacy and security.

In relation to the ease of service utilization two important issues are worth considering. First of them is the appropriately designed user gateway to the service network. This not only includes easy-to-use user interface but, more importantly, seamless integration of the underlying systems. The users should be able to access any of the services with the use of a single authentication mechanism in a single sign on manner. That imposes a requirement on the middleware layer of the service network to enable single sign on in the whole environment and to contain necessary interfaces to all heterogeneous underlying systems such as digital libraries, multimedia content delivery systems or virtual laboratories.

Reuse of resources and tools is especially important in this type of environment. This should be first of all addressed in the context of reusing the same resources in various scenarios and applications. It is also important that any new resource that gets created within the network is easily noted by other users. In the context of resource reuse semantic web technologies show a good potential. To this end the middleware layer of the educational service network infrastructure should get equipped with means of semantic description of resources and tools, and in mechanisms enabling automatic search for relations between documents according to the designed ontologies immersed in the educational service network. Appropriately defined ontologies will certainly help to facilitate reuse and sharing of resources in this network.

Finally, the privacy and security issue is connected with two important issues. First is to protect the personal data of actors involved in the utilization of services in the educational service network. This especially refers to the students various information on whom, such as the level of their skills, possible illnesses and/or disabilities, political and religious beliefs and others, may be found in the network. They should be protected with appropriate privacy protection techniques. The other issue refers to the protection of content provided within the network. This includes the content produced by each school, e.g. provided through their e-learning platforms, and the content enabled for use only within the educational service net, e.g. some specific content of television archives which could be enabled for educational purposes, while at the same time cannot be enabled for general public access. In both cases the existence of a coherent corporate network built on top of the metropolitan research and education network will help to achieve the goal of privacy and security protection.

5 RELATED WORK

One of the brightest examples of educational service networks is Glow (http://www.ltscotland.org.uk/glowscotland/), the Scottish part of the National Education Network (http://www.nen.gov.uk/) in the United Kingdom. Glow is “the world's first national intranet for education.” It delivers a trusted and safe environment where one can create personalized programmes, share resources, use a variety of online tools to enhance learning experiences and collaborate with others across the network. The resources come from different sources and can either be accessed from any place after a successful login or are available for access only from schools, e.g. in the case of a music archive. In the United States, the Utah Education Network (http://ww.uen.org/) connects Utah’s public schools with high speed links and provides various services such as interactive videoconferencing, e-trainings, e-learning or Internet television.

Important for our work are also advancements in the field of various applications and tools that could be utilized to improve the quality of education at schools. One of such advancements is the subject of

the VccSSe project (http://www.vccsse.ssai.valahia.ro/) which aims to adapt virtual laboratory techniques for utilization within education processes at school. The work of the project focuses mainly on mathematics, physics, chemistry and biology and involves schools from Romania, Poland, Spain, Finland and Greece. The use of high definition videoconferencing in education is the subject of the aforementioned HDViper project.

Finally, an important field of our attention is the use of semantic web techniques for facilitating access to resources and services. A very interesting work in this field is done within the OASIS project (http://www.oasis-project.eu/). This project develops the so called OASIS hyper-ontology, which aims to interconnect heterogeneous ontologies to achieve the sharing of contextual information between different objects and services (Kehagias et al., 2008). While the primary application of this hyper-ontology architectural concept is for seamless service provision to the elderly, it shows a potential for utilization also in other fields, such as, for example, an educational service network.

6 SUMMARY

In this paper we have presented a concept of building an integrated environment for the provision of services for education in a metropolitan research and education network. On the basis of a questionnaire we conducted in October 2008, we were able to draw a list of requirements for the initiative aiming to build such an educational service network. Furthermore, we found what usage scenarios are expected in this network and what is the necessary critical mass to start the work on the establishment of this environment.

An important message coming from the education community was also their need to utilize the resources already existing and available in the metropolitan research and education network that we operate. This becomes available today with the optical link directly reaching schools in our city and with useful technologies such as semantic web at hand. Our goal is to work in this direction with the relevant stakeholders in our region to deliver this sort of integrated environment where ease of use, reuse and sharing of resources, as well as privacy and security are main drivers of the innovative education experience.

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ONLINE EXERCISE SYSTEM
A Web-Based Tool for Administration and Automatic Correction of Exercises

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Keywords: CAT, CAL, Computer aided teaching, Computer aided learning, Online Exercise System (OnExSy), Web-based exercise tools, Submission, Automatic correction.

Abstract: We describe OnExSy, our online exercise system that allows our students in computer science to submit their solutions to exercises via a web form. The system is not only able to automate the administration of the student accounts as done by many other comparable systems. In addition, our system is even able to automatically check the correctness of the submitted solutions and is able to provide a counterexample in case the solution is wrong. This feature is provided by modern formal verification tools that have also been developed in our research group. As a result, our tutors do not waste time for checking the correctness of the solutions of many students, and instead, can spend the saved time for an individual support of students. Moreover, the tool is available not only during the time when lectures are held, but also during holidays which is very important for the final preparation of the exam.

1 MOTIVATION

In the Bachelor program in Computer Science at the University of Kaiserslautern, *'Computer Systems 1& 2'* is one of the required courses of the first two semesters. This course covers the basic principles of computer systems, especially the design of digital hardware circuits, the design of microprocessors including computer arithmetic and assembler programming, and the overall architecture of a computer system like the memory hierarchy and peripherals. The overall number of students in this course is about 200 students each semester including also students of other disciplines like mechanical engineering.

As most courses of our Bachelor programs, 'Computer Systems 1& 2' also offers exercises to provide a deeper understanding of the topics. The classical exercises arrogate the students to provide their solutions on paper that have to be submitted each week. After the correction of the students' solutions by a tutor, the tutor presents the correct solution in the lesson and may also talk about the students' solutions and their mistakes. Usually, the tutor himself is a student in higher semester.

In the past, we recognized an increasing failure rate of our students as a growing problem in our department. This may be traced back to the following reasons: The Bachelor program has a tight schedule of courses and the exams have to be passed within given deadlines. Although exceptions from these rules are allowed, most students try to meet these requirements. This leads to the fact that less students have time for jobs as tutors, so that the *number of engaged tutors decreases while the number of students grows*. This leads to a reduced individual support of our students, since the *available time per week of the tutors is consumed by the correction* of the submitted solutions.

A further problem is that a minimal amount of exercises have to be solved correctly to be able to apply for the exam in this course. Due to limited time during the week, it seems that students *cheat by copying the results of other students*, which however harms their preparation of the exam at the end. Detecting copies of submitted solutions of 200 students every week that are distributed over many tutors can not be done with reasonable effort.

In this paper, we describe how we support our students by improving their individual discussion with their tutors. Besides providing special courses for the preparation of the tutors in the future, we have to make sure that they can spend their time in the really important tasks, i.e., tasks that cannot be solved by a computer: The *submission of the students' solutions*,

the distribution to their tutors, and the maintenance of the students' accounts are typical tasks that can be done even better with a computer, and clearly, our tool OnExSy provides this functionality.

In addition to this, our tool OnExSy is also able to *automatically check the correctness of the submitted solutions and to immediately provide a feedback to the students in case their submission was wrong*. In many cases, checking the correctness of a solution is trivial, e.g., if the solution is a simple number. In other cases, e.g., if the solution is a digital circuit or a computer program, many correct solutions are possible, so that we cannot simply check for equality of a sample solution. Instead, the semantics has to be checked, which amounts to the *automatic verification of programs and circuits*. Fortunately, the research done by our group already considered this problem in great detail, so that we are happy to use the tools we originally developed for research also for teaching.

As a result, our tutors now have much more time to discuss potential problems with the students, since for most exercises, there is no longer a need for correcting the submitted solutions. This leads to an *improved individual support of each student with even less tutors*. Tutors can now even prepare the exercises of the next week instead of only explaining why a submitted solution was not correct. In many cases, the feedback of OnExSy was sufficient to solve this problem.

To get rid of copied solutions, we furthermore added the feature to OnExSy that *each student is given a different exercise*. This is either done by randomly generating an instance of an exercise, e.g. in computer arithmetic where two binary numbers of a certain bitwidth are randomly chosen, or by selecting an exercise from a data base. Copying a solution made by another student is therefore no longer possible (unless the rare case should occur that two students were given the same exercise).

The only problem that remains is that we do not yet check the *authentication of the students*, i.e., it is possible that another student provides the solutions. We do not believe that this is currently the case among our own students (at least not to a intolerable degree) as already reported by other Universities (Ross, 2005), where even students of other countries have been paid for submitting online solutions.

Automatic correction of exercises is also done by some other tools used in other areas for teaching like CalMæth (CalMæth, 2008). Clearly, there already exist a lot of tutoring tools starting with small tools for specific problems, e. g. JADE (Java Decision Diagram Package) (JADE, 2003), and ending with complex user interfaces for online learning that intent to provide flexible support of questionnaires, e. g. Lecturnity and Dynamic Power Trainer from IMC (imc.de, 2008). Inspired by these tools and our goal mentioned above, we decided to implement a compact and modular exercise system that is capable of

- creating individual exercises for each student to get rid of copied solutions
- online (web-based) submission of the students' solutions
- automatically checking the correctness of submitted solutions with immediate feedback, e.g. by counterexamples
- training tools to solve further exercises for preparing the final exam.

Concerning the latter point, we specify a maximal number of trials for each exercise. If this number of trials is exceeded, the sample solution is presented.

Note, that these tools are not intended to replace the course or even the lecturer. Instead, these tools are used to complement and guide the preparation for the final exam by providing 24h a day the opportunity for our students to train themselves on the required exercises.

The remainder of this paper is structured as follows: Our group developed two independent tool sets to achieve the mentioned goals. The first tool set is named Online Exercise System (OnExSy) and is described in the next chapter. This section is followed by the description of the second tool set, which is called Online Training Tools. Finally, we discuss the results and experiences of these tools and close this paper with a discussion of future enhancements.

2 ONLINE EXERCISE SYSTEM

The Online Exercise System (OnExSy) is a modular system that consists of a user interface and a collection of programs, which are necessary to create randomized exercises and to check provided solutions. OnExSy is built of independent modules (single subsequent tools). The modularity of OnExSy is one of the main features, keeping the system manageable and simplifying its extensibility for the future.

In the following, we describe OnExSy's modules, i.e., its user interface followed by a short description of the underlying programs.

2.1 User Interface

The user interface is the main part of OnExSy that provides the fundamental functions to run the system and to connect it to the graphical user interface,

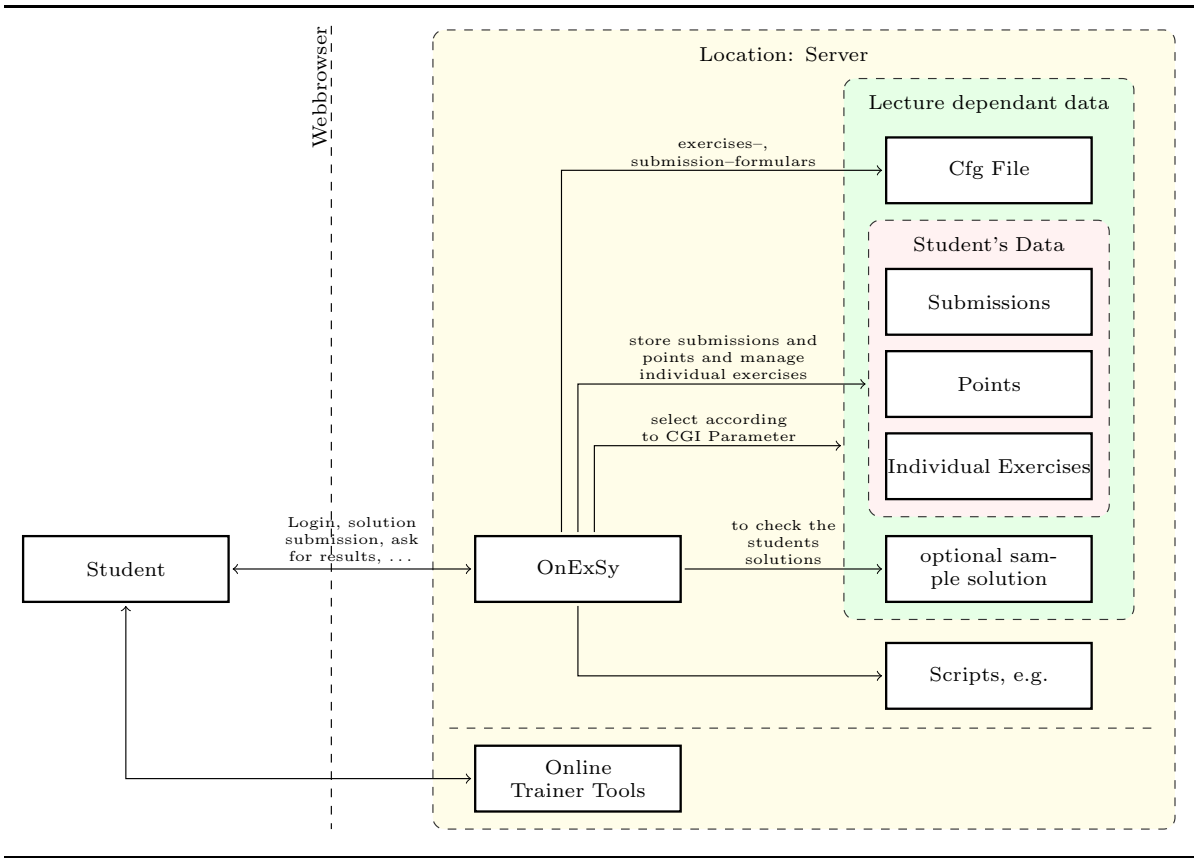

Figure 1: An overview of our Online Exercise System.

i. e. the web browser, and to the server. The basic functions implemented in the user interface are listed below and will be explained later in more detail.

- The *registration of students* including a fair *distribution to tutorials* (if more than one date is available) with an external program.
- The system also *publishes the group assignments on a web page*.
- It assigns new (individual) exercises to the students.
- Furthermore, the user interface checks the correctness of submitted solutions by external programs and the stores the achieved points of the student in a data base.
- Finally, it provides statistics of submitted solutions and achieved points of the students which can be seen by the tutors (for his class) or by the student (for his account).

The user interface is based on an Apache webserver(APA08, 2008). The system was written in Moscow ML[1], so that the system can be ported to different platforms like Linux, Windows and MacOS.

The registration is necessary to get the students' personal information like names and matriculation numbers. If the lecture offers more than one date for exercise lessons, the student has to choose three different dates with three priorities during the registration.

To give all students the same chance to get into their preferred group, the final classification to the exercise lessons is done after the registration deadline by an external program. This program tries to find a satisfying classification, i.e. usually, the students can be classified to their first or second selected exercise lessons. The result of this classification is also displayed by the system.

Each lecture that offers exercises has a configuration file that contains a description of its exercises. This includes descriptions for all exercise sheets and all exercises. A description for an exercise sheet can have a link, e. g. to a PDF file, a description in HTML or/and an arbitrary number of exercise descriptions. Each exercise description consists of an optional link or/and an HTML description and the description of the solution checking script. The latter is simply given

[1] http://www.itu.dk/ sestoft/mosml.html

as a command line. We will describe its functionality later.

To access the correct data and the available functions mentioned above, the user interface receives via a CGI interface the parameters defining the lecture, the semester and the function that has to be executed. Additionally, one can define additional CGI parameter, e. g. the language. However, in our implementation this parameter affects only the user interface, but basically it is possible to select an exercise with the specified language.

Of course, our system supports common exercises that have to be made by all students. These exercises can be put in a familiar way like publishing a link to an electronic version of the exercise sheet or distributing a printed version. The students calculate the results of the exercises as usual with paper and pencil or specific tools like Hades (Hades, 2007) (a design tool for digital circuits). Having calculated the results, the students can submit them via a web page. They just have to open the link on the corresponding page of the exercise lesson. In particular, after the student has opened the exercise site, he is asked for his name and his matriculation number to login. These informations are necessary to be entered at the beginning of the session to enable the assignment of individual exercises.

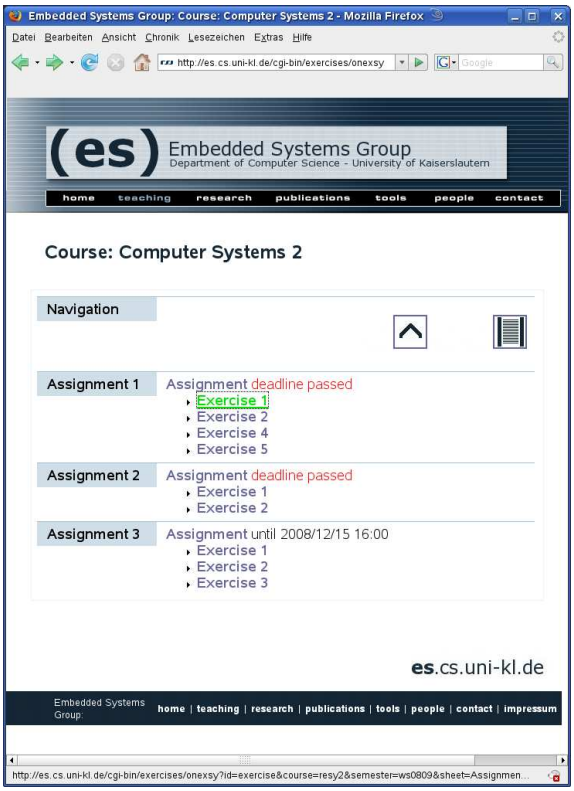

Figure 2: After the login, OnExSy presents an overview of all assignments.

After the login, the student sees an overview over the exercise sheets and the exercises (see Figure 2). After having selected an exercise, the submission form is opened (see Figure 3). The next step is to enter the calculated result (see Figure 4). After pressing the button for submission, the result is sent to our server and is automatically checked. The next screen shows whether the submitted result was correct (see Figure 5). The result window also shows the output of the solution checker, e. g. messages like 'syntax error', i.e. the submitted solution was given in a wrong format, or as can be seen, a counterexample if a submitted solution was not correct.

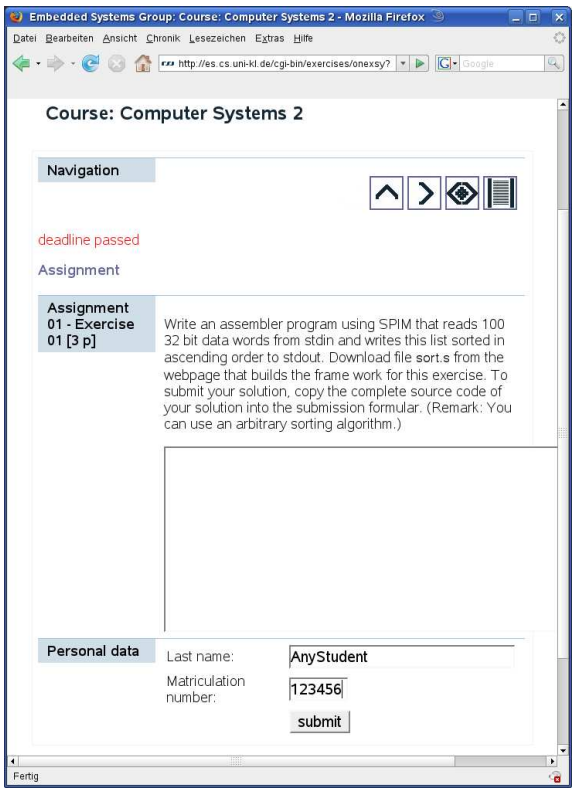

Figure 3: The students select an exercise and get the assignment. After having solved the exercise, the student enter their solutions into a submission form.

The students do not have to submit all exercises at once. They can even submit the solutions to parts of an exercise one after the other (at different points of time). If a solution is not correct, the student can submit a modified solution. The number of trials can be limited by the configuration program, but can also be set to infinity. Furthermore, it is important to know that all given solutions are stored and will not be overwritten by subsequent ones. In particular, correct submissions will not be invalidated by incorrect or empty ones.

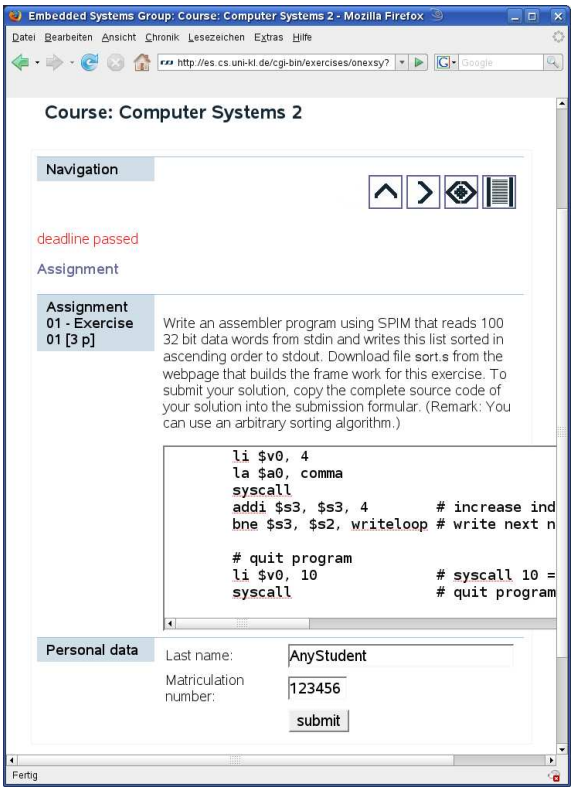

Figure 4: Students can also copy complete source code into the submission form.

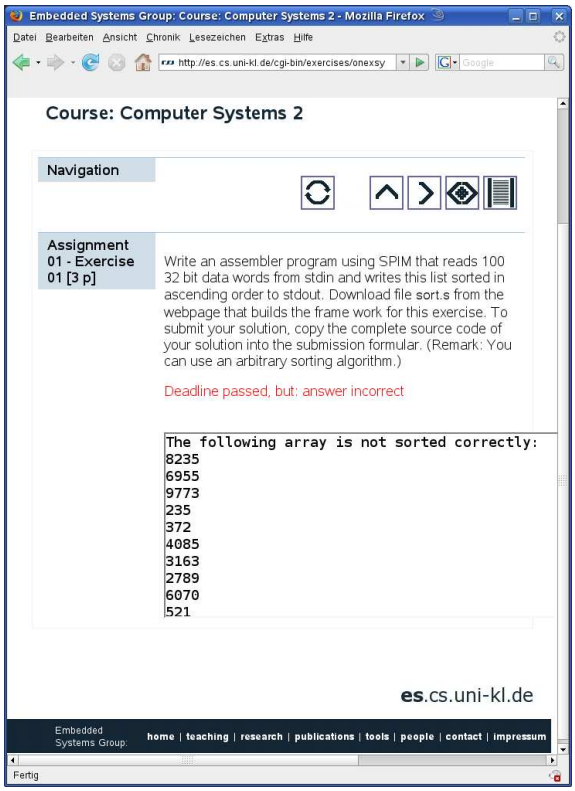

Figure 5: The solution is checked and the result is returned. In this case, the submitted solution was not correct and the student gets a counterexample. Remark: if the answer is correct and given within the determined deadline, the achieved points are granted.

However, in the last semester, we experienced that quite a lot of students reached nearly 100% of the points of the online exercises, but nevertheless failed in the final written exam. We believe that they copied the solutions of other students, which is very simple via email and other means of communication.

We reacted in two ways to this experience: First, we reorganized the classical procedure of exercise lessons. Instead of working out the sample solution of the previous exercise sheet, we focus more on preparing the solution of the next exercise sheet. In particular, the tutors are instructed to give useful hints and - most important - to clarify the exercises to avoid misunderstandings.

Second, OnExSy supports individual exercises for every student that are randomly generated. To this end, we can assign a particular program for each submission form that generates an exercise. When the user interface of OnExSy is instructed to dynamically generate the submission form for the selected exercise, it checks the configuration file for an exercise generator program. If no task has been created for the selected exercise, yet, the program is executed and a task is created. The information about the task is stored in the student's directory that is located on the server (see Figure 1). So he can go offline, work out the solution for the given task and whenever he logs in again, he can submit the solution of the previously stored exercise. After the correct solution has been submitted, or if the number of trials has been exceeded and no correct solution has been submitted, the generator program is called again and a new task is created. Independent of the result, the sample solution for the old task is given. Hence, we give the students the opportunity to check and to compare their solutions with a sample solution. Furthermore, we offer to train a specific type of exercise arbitrarily often without having any effort for the correction of these solutions.

2.2 Programs

The solution programs and the generator programs are independent of OnExSy's user interface. Hence, OnExSy is a flexible system with a solid user interface that can be extended by arbitrary solution checker and generator programs. The whole system can be extended to any kind of exercise that can be checked by a computer. Clearly, every exercise that has a canoni-

cal solution can be automatically checked. However, even though many correct solutions could exist, it is still possible to check the correctness of these exercises by means of formal verification tools. As an example, we verified digital hardware circuits for computer arithmetic that have been submitted by the students.

Note that 'verification' does not mean 'testing'. Instead, verification of a program checks that the program behaves according to the specification (given in the exercise) for all possible input traces. Using state-of-the-art verification tools based on symbolic model checking (Burch et al., 1990), it is possible to explore very large state spaces within some seconds, so that an immediate feedback to the student can be given (the circuits and programs required by the exercises are small enough to allow this immediate response). In our own research, we developed a synthesis and verification system (AVEREST, 2008) whose core techniques are now also used for teaching. The use of formal verification is a key feature of OnExSy that enables both automatically checking the correctness of solutions and the generation of counterexamples in case a solution should be wrong.

A positive side effect of applying solution checking programs to the students' solutions is the equal quality level for each student. While the correction by persons may naturally differ between different tutors, OnExSy provides a fair treatment for all students.

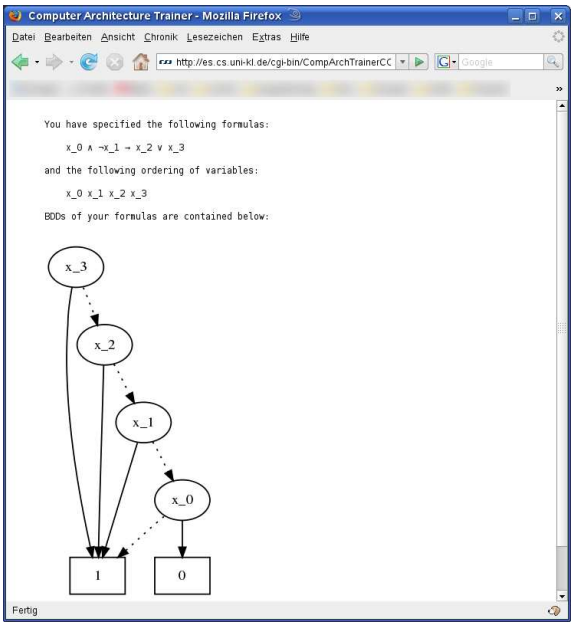

Figure 6: The Online Training Tool generated a BDD out of an user-defined propositional formula.

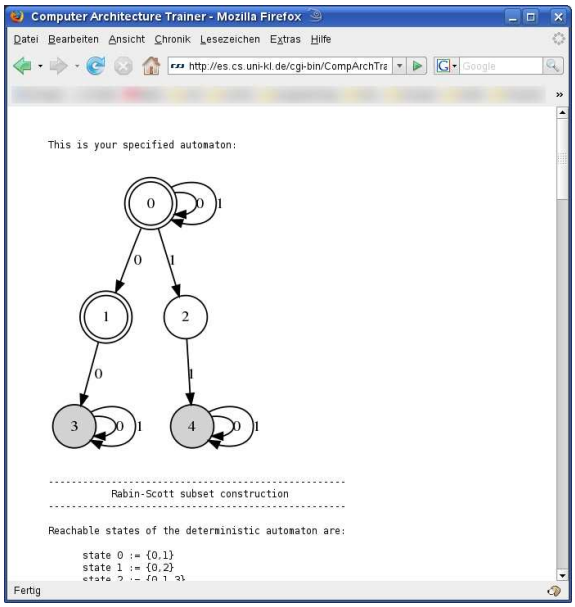

Figure 7: The Online Training Tool generated an automaton out of an user-defined description.

2.3 Online Training Tools

OnExSy is complemented with further training tools that are not used to correct solutions to exercises, but to allow our students to do some complex calculations on their own. For example, these tools can be used to calculate some normal forms like BDDs of a given propositional formula (see Figure 6), to compute minimal disjunctive normal forms, to minimize finite state machines (see Figure 7), etc.

The purpose of these tools is that the students can explore themselves many special cases that can not all be discussed within the course or the tutorial. Moreover, these tools are an important means for the final preparations for the exams when the lecture time is over.

3 CONCLUSIONS

We applied our OnExSy to the complete exercises of 'Computer Systems 1& 2'. The correctness of all submitted solutions have been automatically checked by the OnExSy alone without any further effort of our tutors. After eliminating some initial software problems, the feedback of the students was mainly positive. Currently, we are using the OnExSy for two further lectures that are also offered by our group. Due to the topics of these lectures, more complex programs are required for checking the correctness of the solutions.

We experienced another interesting effect: First, we did not limit the number of trials for an exercise. Due to this fact, some students tried to *guess a solution* instead of trying to solve the problem. One of our students even tried 417 solutions for one exercise. Obviously, he wrote a program that simply enumerated all possibilities. The short time intervals of his submissions noted by our system confirmed this suspicion. For this reason, a limitation of the number of trials became necessary. It forces students to think about a solution instead of starting a brute force submission of guesses.

The development of the programs for generating individual exercises and for checking the correctness of the solutions required a lot of work. The initial effort of creating these programs often reaches and sometimes exceeds the effort that would be necessary to correct the exercises manually. However, this effort will be clearly amortized in the near future, and also leads to a better service for our students.

We intend to improve OnExSy by further features like tools to generate more statistic analysis of the submitted solutions. This gives our students individually information about their success, and moreover helps us and our tutors to identify particular problems more quickly than before. This allows us to immediately react in the lecture and the tutorials to clarify potential misunderstandings.

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SPECIFICATION OF OBSERVATION NEEDS IN AN INSTRUCTIONAL DESIGN CONTEXT
A Model-Driven Engineering Approach

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Keywords: Instructional Design, Learning Scenarios, Observation, Model Driven Engineering, Meta-Modelling.

Abstract: Our works take place in the research field of distant learning situation observations. We want to help instructional designers to improve the learning scenarios they design within a re-engineering context. We think that the observation of the learners' behavior can be improved by taking into account the observation needs from the designers. We originally think these observation needs can be related to and guided by the information specified into the learning scenarios. This article presents a *Model-Driven Engineering* approach for the specification of these observation needs. A specific metamodel has been elaborated to support our conceptual proposition and process. A dedicated example illustrates the use of this metamodel to specify observation needs according to a given learning scenario and Educational Modeling Language. First elements of tooling are also presented.

1 INTRODUCTION

In the research field of distant learning situation observation, most of the research deals with the analysis of the collected data during the learning session. Our works take place within a re-engineering context of these learning situations.

We want to help instructional designers to improve the learning scenarios they design. To achieve that, we assume and believe that the observation of the learners' behavior could be improved by taking into account the observation needs from the designers *a priori* of the learning session.

We also originally think that these observation needs can be related to and guided by information from the learning scenarios specifying the various facets of the learning flow. We aim at supporting and guiding designers when defining these observation needs. To this end we have already proposed a conceptual model for the observation needs, whose originality relies on the use of 'signs' and 'behavior categories' techniques (Zendagui et al., 08) as possible features for detailing observation needs on the base of learning scenario information. This paper focuses on the *Model-Driven Engineering* context and approach we follow to propose both a theoretical formalization of the links between observation needs and learning scenarios, and a practical tool for helping designers to define these needs. We follow such an approach because our previous work about *Domain-Specific Modeling* (DSM) & *Educational Modeling Languages* (EML) (Laforcade et al., 08) focuses on the use of meta-modeling techniques and Eclipse tools to support our proposition as a first formalization step.

The next section presents our research context about instructional design and observation needs. In the following section we briefly present our conceptual proposition. The MDE approach for the support of our conceptual proposition is then detailed and discussed in section 4. Then, section 5 is dedicated to our first results illustrating the use of specific MDE tools for supporting our metamodel and providing a tree-based graphical editor. Finally we conclude by discussing our research in progress and the benefits designers can expect to obtain.

2 INSTRUCTIONAL DESIGN CONTEXT

2.1 Re-engineering of Learning Scenarios

Within the instructional design context, the re-engineering of learning scenarios forms a cycle. In the first step, designers use an *Educational Modeling Language* (EML) (Koper et al., 05)(Kinshuk et al., 06) to define a learning scenario. This predictive model allows designers to explicit their pedagogical objectives regarding learning situations in terms of activities/tasks, roles, resources/services, objectives/prerequisites, etc.

In the next step, the concrete learning situation is in progress, and leads students/tutors (and other associated actors) to use the designer's pedagogical scenario. In this step, data regarding effective use of the learning situation is collected either by the *Learning Management System* (LMS) or by other means. Many experiments have shown that the effective running of a pedagogical situation does not necessarily follow the predictive scenario, leading to the need to observe the real behavior of the actors.

To be used in a learning scenario re-engineering process, this data must be analyzed and abstracted from the system format that produced it ;this facilitates its interpretation by the analysts and the instructional designers. So, the last step of this cycle consists of analyzing data collected during or after the effective running of the learning situation. This data is then converted (filtered, structured, combined, etc.) leading to enriched data, having a pedagogical meaning for the designer.

The results of this step then allow designers to compare the predictive scenario with the observed situation. Thus, they can be brought to modify their predictive scenario as a first step of a new iteration.

2.2 REDiM Project

Our research works take place within the REDiM project (Choquet, 07) whose main objective is to provide teachers with dedicated techniques and tools supportingt the re-engineering of their learning scenarios. Within this project, the UTL language has been proposed for the XML specification of observation datum / observations means and observation needs (Choquet et al., 06). However there is still a lack of learning-scenario-centered tools and practices to help designers in specifying their observation needs.

Our current research focus on this lack. To our minds, the preparation of the learning situation observation is an activity that relies on the one dealing with the design of learning scenarios (Zendagui et al., 08). We aim at helping designers in defining what is important to observe during the elaboration phase of the learning scenario. This process must deal with many potential difficulties for the expressiveness, relevance and usefulness of observation needs:

- they are linked to the learning scenario expressiveness and, by extension, to the expressiveness of the underlying EML;
- they depend on the designers' ability to specify what they want to observe and which information they need;
- they have to be specified with such details and formalized in such a machine-readable format that it will be able to automatically handle them to, for example, guide and help the track analysis.

We think that the MDE approach can formalize and help us in tackling these issues.

To assist designers in their observation needs specification task, we have studied the observation activity and its preparation within both classic face-to-face and distance learning situations (De Ketele, 87)(Wragg, 99)(Dessus, 07). The next section presents our conceptual proposition.

3 THE CONCEPTUAL PROPOSITION

3.1 The Process

To assist designers in their observation needs specification task, we propose a two-step approach (see figure 1).

3.1.1 Observable Identification

Within this process, the effective EML used by designers is not *a priori* known. It can be improved or enriched to better express designers needs (improvement of the EML expressiveness) during its use. We propose to identify the elements (concepts, relations, attributes) of the EML that can potentially be observed, tagging them as "observable". We define an observable as *any EML element whose change could be meaningful to observe*; i.e. any element whose instantiation (for a concept), value (for an attribute), or acquaintances (for a r elation)

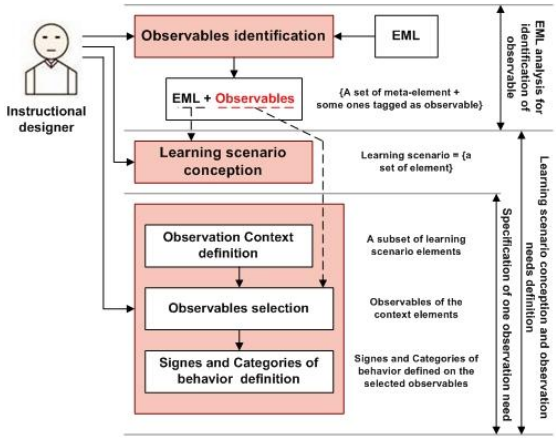

Figure 1: Teacher/designer-centred process for specifying observation needs.

can be useful to observe. For example, one might want to observe how many times an activity will be carried out (the "*Activity*" concept can thus be a possible observable), or to observe the different values of a "*duration*" property on a specific activity, or to concretely observe the order of an activity sequence (thus, identifying as observable the "*precedence*" relation defined on two activities).

This categorization of potential observables has to involve the instructional designers, or other experts of the pedagogical domain, in order to be sufficiently relevant. This identification of observables is, *a minima*, human-directed but it will be possible to eventually guide this activity thanks to a semi-automatic process based on a suggestion of observables according to a syntax-and-semantics analysis of the EML (Barré et al., 05).

3.1.2 Observation Needs Specification

The second step is the concrete specification activity of observation needs. Designers must precisely specify the observation needs they consider as relevant. Those observation needs will be intimately specified in relationship with a specific learning scenario. This activity can be done after the scenario specification or concurrently.

For each definition of an observation need, designers will follow three sub-activities: definition of the context, selection of observables, and definition of signs or categories of behavior.

The context definition aims at "contextualizing" the observation need. In addition to the observation objectives, designers have to define a subset of learning scenario elements concerned by the observation objectives. Thanks to this delimitation, only the observables concerned by elements within the context are selected and proposed to designers for the next sub-activity. The designers then have the responsibility to decide to use, or not, the proposed observables to clarify which data must be collected concerning the future learning situation. After this selection, designers can then define signs or categories of behavior (detailed in the 3.2 subsection) on these observables (Wragg E.C 99).

If the selected observables are not useful, designers can go back to the observable selection phase, as well as the context definition phase, in order to add new observables or scenario elements. They can also modify the pedagogical expressiveness of the EML, as well as modifying the observable identification at the EML level.

3.2 The BOSIC Conceptual Model

We define an observation need as composed of four parts (see figure 2): observation objectives, observation context, elements to observe or observables, and signs and behavior categories defined on one or more observables.

The observation **objectives** are useful to define the "why" of observation needs. This information allows designers to explicit what they want to do when they know the results of their observation needs from the concrete observation of learning situation runtime. This information can also be useful to facilitate the reusing of observation needs for other learning situations or other learning scenarios sharing the same objectives.

The observation **context** allows the definition of conditions under which an observation need is defined and used. Contexts allow the delimitation the learning activity to observe. It consists of selecting one or more pedagogical scenario elements. Contexts are important and must be well defined since they allow the identification of the potential observables.

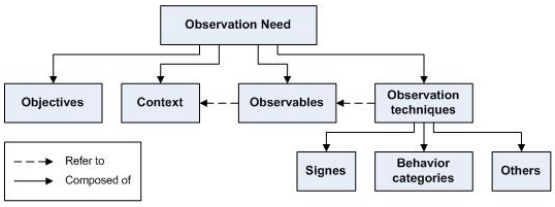

Figure 2: The BOSIC conceptual model.

The **observables** are pedagogical scenario elements for which designers want to get information after the learning situation execution. Concretely, these observables are defined at a scenario level butconform to those defined at the

EML level: they are contextualized and correspond to a kind of '*instantiation*' of the EML-level observables with respect to their context. Their specification is done by selecting observables among those than can be automatically proposed according to the context delimitation and the observables identified at the EML level. For example, “duration of activity X” is an automatically proposed observable since “activity X” is part of the observation context and since the “duration” attribute of the “activity” concept is identified as an observable at the EML level.

The **additional data** is defined on one or more selected observables at a scenario level to characterize a first representation of the observation means, in a domain-oriented language, identified by the experts. The **signs** correspond to particular events for which designers want to know apparition frequency, occurrence number or, *a minima*, to know if they occur or not, during a future observation. One or more signs can be defined on one or more scenario-level observables. For example, the “duration of at least 30 minutes” sign can be defined on the observable (“duration of activity X”). The **behavior categories** correspond to some grouping of events that will be analyzed as a block. Like the signs, one or more categories can be defined in relation to one or more observables at the scenario level. For example, the “handling events” category can be defined to indicate that we want to know all the undergone manipulations observed on the “document Y”; on the condition that the “document Y” is a selected observable, and by definition is also part of the delimited context, and that the underlying metaconcept (“Deliverable” for this case) was identified as an observable at the EML level.

The next section is about the formalization of our conceptual propositions following the MDE theories and practices.

4 THE MDE APPROACH

The formalization of the BOSIC conceptual model is necessary for two goals: firstly, to concretely support our proposition and propose a machine-readable notation for the observation needs (that will be useful, by extension, to manipulate/transform the specified needs to facilitate their reuse, etc.), and secondly, to help the building of software tools to support the observation needs specification activity by designers (user-friendly editors with helpful and guiding facilities, etc.).

4.1 MDE Projection

The *Model Driven Engineering* (MDE) is a software development methodology which focuses on creating models that describe the elements of a system (Schmidt, 06). A modeling paradigm for MDE is considered effective if its models make sense from the point of view of the user and can serve as a basis for implementing systems (productive models). The MDE principles (abstraction, modeling, meta-modeling, separation of concerns, etc.) have been applied within various educational disciplinary fields: adaptable learning materials generation, Computer Supported Cooperative Work, etc.; we have studied the application of its theories and practices for learning-scenario-centered instructional design processes in (Laforcade et al., 07)(Laforcade et al., 08).

From a MDE point-of-view, and if we do not take into account notation or concrete syntax aspects, the learning scenario is a model conformed to the metamodel specifying the terminology, or abstract syntax, of the EML used to define the scenario (see figure 3). Similarly, a set of observation needs, defined once for a given learning scenario, corresponds to a model. Because we want these observation needs defined in relation to information from the learning scenario, the models have to be linked together too. The model specifying some observation needs also has to be conformed to a specific metamodel for the definition of observation needs: the BOSIC metamodel (detailed in the next sub-section). This metamodel has to refer to the information from the EML metamodel.

Figure 3 is a four-layer OMG (OMG, 06) representation of these MDE artefacts.

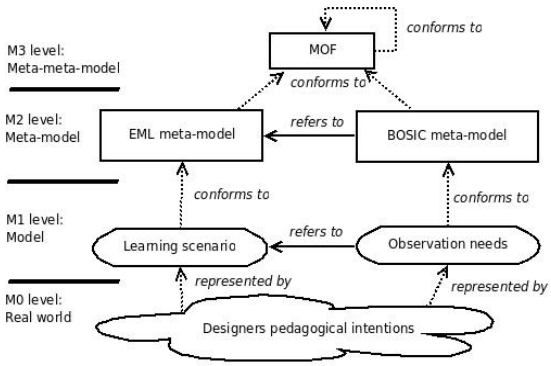

Figure 3: OMG layers view of the observation needs.

4.2 MDE Techniques Used

According to the conceptual process we outlined in the previous section, and to the MDE practices, we need concrete techniques to support both our conceptual process and BOSIC model.

The BOSIC metamodel as well as the EMLs used to define learning scenarios have to be specified using the meta-modeling technique: construction of a collection of "concepts" (things, terms, etc.) within a certain domain (Wikipedia, 08). A metamodel is a precise definition of the constructs and rules needed for creating semantic models. We illustrate an example of a metamodel for an EML in section 5, whereas the BOSIC metamodel is detailed in section 4.3.

We also need a technique to add information about the elements that designers want to tag as 'observable' to the EML metamodel . Because these potential elements can be concepts, attributes, as well as relations between concepts and because every metamodel conforms to the unique meta-meta-model MOF (OMG, 06), we need to use a MOF concept to be able to attach the 'observable' information to the class, attributes, association, etc. This meta-construction is called *annotation* (for the MOF 1.4), or *comment* (for the MOF 2.0). Section 5 shows how we use the equivalent *EAnnotation* mechanism from the *Eclipse Modeling Framework* (EMF) tooling.

Another issue from our conceptual process and model is how can the 'context' and 'observable' parts of an 'observation needs model' can refer to elements from a specific 'learning scenario'. Following the fact that the specification of an EML metamodel can use various MOF building blocks (class, attributes, relations...), it is not possible to specify a meta-relation in the BOSIC metamodel to 'anything-specified' in the EML metamodel. Also, because EMLs can differ, it is more relevant to concretely separate them. From our MDE expertise we choose to add in the BOSIC metamodel a specific concept which plays the role of a 'proxy' for the learning scenarios elements (see the next subsection).

4.3 The EMF Tooling

To concretely formalize and support the development of our proposition and dedicated editors, we chose to use a unified set of modeling frameworks, tooling, and standard implementations from the *Eclipse Modeling Projects* (Eclipse EMP, 08): EMF, GMF and ATL. In this article we only focus on the *Eclipse Modeling Framework* (EMF) because it provides the very first layer of support we need.

Indeed, the EMF is a modeling framework and code generation facility for building tools and other applications based on a structured metamodel (Steinberg et al., 2008). From a metamodel specification, EMF provides tools and runtime support to produce a set of Java classes for the metamodel, along with a set of adapter classes that enable viewing and command-based editing of the model, and a basic editor.

We illustrate the use of this very basic editor in section 5. Also, we have planned to use the *Graphical Modeling Framework* (GMF) in a second time to add a graphical layer on top of EMF, and, incidentally, to develop a graphical editor dedicated to the specification of observation needs.

Finally, the *ATLAS Transformation Language* (ATL) is the model-to-model transformation framework we will use to transform observation needs conformed to our BOSIC proposition into other machine-readable formats for the specification for observation needs (like the XML-based one proposed by UTL).

4.4 The BOSIC Metamodel

This sub-section details the BOSIC metamodel we have specified using the EMF tooling (metamodels are called ECORE models where ECORE is the MOF-like meta-meta-model in EMF). Figure 4 illustrates this metamodel in the class-diagram-oriented view proposed by the Ecore graphical internal editor of EMF.

The *ObservationNeeds* concept plays the role of the root for the specification of several observation needs in a same model, according to a same learning scenario too. In addition, the *ObservationNeed* concept is the root node for all the information in regard to one observation need. It is composed of several *Objectives* and of three other concepts representing the three layers of an observation need: *ContextLayer*, *ObservablesLayer* and *DataLayer*.

The *ContextLayer* concept is the node element under which are specified the *PSElements* (scenario elements). As previously explained, this *EClass* is a kind of 'proxy' that refers to an element from the learning scenario: it can be an instance of an *EClass* from the EML metamodel, a property (the *EAttribute* and value pair) for a specific instance of an *EClass*, as well as a link (instance of a *ERelation*) between two instances of *EClasses*. For our very first prototype, these *PSElements* will have to be specified as new inputs even if they already exist in

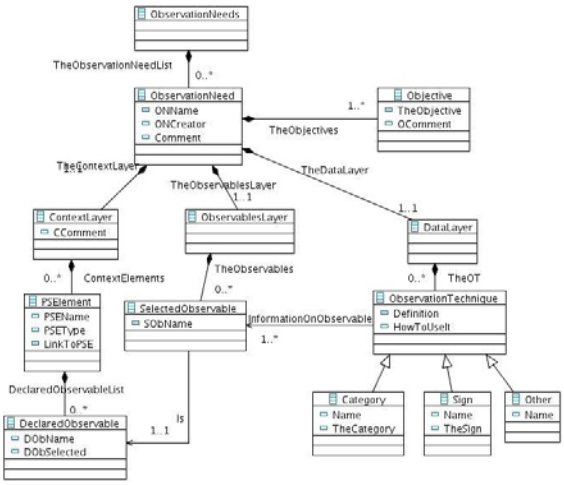

Figure 4: the BOSIC metamodel.

the learning scenario but future versions will provide designers with guiding facilities.

Similarly, the *ObservablesLayer* gathers the *SelectedObservable* which represents, according to the specification of the designers, a subset of the *DeclaredObservables*, the observables at a scenario level that can be deduced from the *PSElements* previously specified, and from the EML metamodel elements tagged as observable. We also plan to develop a specific algorithm and code routines dealing with the *DeclaredObservables* to automatically instantiate them with the deducible information.

Finally, the *ObservationTechniques* concept allows the definition of signs and categories of behavior (inheritance relation). It represents the third layer of an observation need. This information isdefined using one or more *SelectedObservable* via the *informationOnObservable* relation.

5 ILLUSTRATION

To illustrate our propositions as well as the first prototype we developed, we now present and discuss a concrete example of specification of observation needs according to a learning scenario and its underlying EML.

5.1 The EML Metamodel

Among the various case studies we have experimented on with EMF and GMF, we outline the following one for this article. Some practitioners have expressed these pedagogical expressiveness and notation needs: a UML UseCase-like diagram that shows the performing relations between roles and learning activities at a high-level of abstraction, and precedence/following relations between learning activities. We have therefore provided them with a specific graphical EML (or VIDL for *Visual Instructional Design Language*)(Botturi et al., 07) and a dedicated visual editor using EMF/GMF. A metamodel for the « *Learning Design Use Case* » (LDUC) view has been defined. It is illustrated in figure 5.

According to our conceptual process, designers have identified these potential observables from the terminology crystallized by this metamodel: some observables are EMF *EClass* (eg. *HighLevelActivity*, *Actor)*, some are EMF *EAttributes* (eg. *Duration*, *score*), others are EMF *EReferences* (eg. *nextActivities*). All these elements have been tagged as observables using the EMF *EAnnotation*

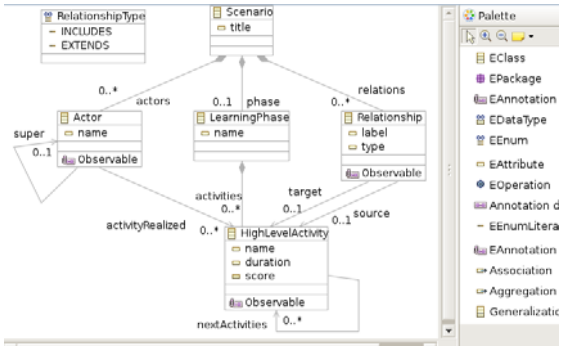

Figure 5: example of EML metamodel - the LDUC metamodel.

mechanism (only the *EAnnotations* on *EClass* are shown in figure 5).

5.2 The Learning Scenario

From the previous EML, designers have proposed the following scenario (extract on figure 6) using the graphic editor we developed thanks to the EMF/GMF frameworks. Briefly, this scenario focuses on the specific phase (“*OS introduction*”) of a learning scenario they want to play. The first learning activity *“updating”* is composed of a sequence (specified thanks to the *“next”* and *“include”* relations) of sub-activities “*QCM*”, “*Answers consultation*” and “*exchange*” (using a forum).

One must know that the graphic representation of the learning scenario does not reflect all the information specified with the LDUC editor: some have no graphic representations and can only be seen in the *properties* view of the editor (eg. the *duration* property for any activity).

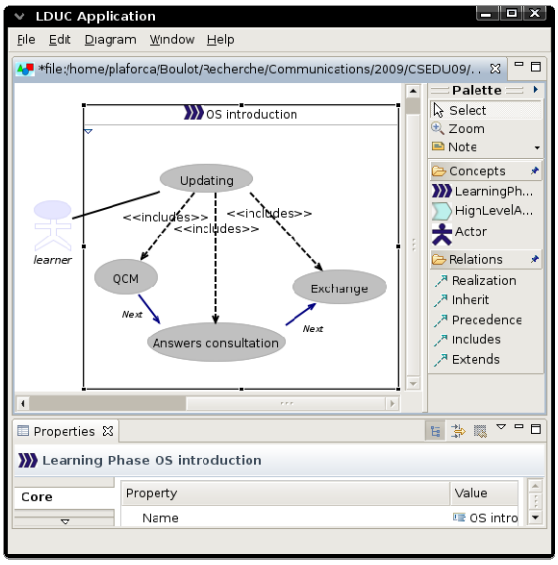

Figure 6: An example of a learning scenario.

5.3 The Observation Needs Model

Knowing both this learning scenario and the specificities of the distant platform (or LMS) that will be used to play this scenario, the instructional design team (where the instructional designers are the experts for formalizing of pedagogical intentions) want to know if the learners really take the time to consult the answers and resources available after the QCM activity, before using the forum to get explanations from their peers. For them, this question is meaningful because the LMS leaves learners independent for the order in which they perform learning activities and because the LMS does not limit the time activity to strictly follow what the designers specify using the *duration* property.

This observation need aims at gathering information about the use of the "Answers consultation" activity. The most meaningful information for this activity are that about learners who fail the *"QCM"* activity with a low score (less than 50%). It is the concrete **objective** of the teachers.

Concerning the **context** of this observation need, designers must select these elements from the learning scenario: the activity *"answers consultation*", the *"QCM"* activity and the link "*next"* between the two activities. This context filters the potential observables (*Declared-Observables*) that can be proposed to the designers: *"next"*, *"answers_consultation"*, *"answers_consultation.duration"*, *"answers consultation.score"*, *"QCM"*, *"QCM.duration"* and *"QCM.Score"*.

From this list of potential observables, designers only selected the following **observables:** *"answers_consultation.duration"*, *"QCM.Score"* and the *next"* link.

Designers then specified three observation techniques: two **signs** and one **category of behavior**. The first sign aims to give information about the number of learners who consult the resources/answers directly at the end of the *QCM* activity. The second sign focuses on the number of learners that score less than 50% for the *QCM* activity and that spend less than one minute on the "*answers consultation"* activity. A large number here will indicate that learners did not make an adequate effort to understand their mistakes. Finally, the category of behavior designers have defined aims at collecting all the durations (for each learner) for the "*answers consultation*" activity. This expected set of results will give designers with the time spent by each learner in the *"Answers consultation"* activity.

5.4 The First Prototype

The first prototype has been developed thanks to the EMF tooling. This framework generated a first version of the editor directly from our BOSIC metamodel. This editor provides designers with a tree-view of the models where each node is an instance of an *EClass* from the metamodel and child nodes are the instances of *EClass* linked by a relation of containment between the two *EClasses* in metamodels (see figure 7). Properties and links (kind of "instances" at a model-level of the *EAttributes* and *ERelation* defined at the metamodel level) appear in the property view according to the element selected in the tree-view.

In addition to the Java-code generated by EMF we have added some specific modifications to adapt the editor: personalized labels in the tree-view, interrogating routines to gather meta-information on any elements from the learning scenario, and generation routines to automatically instantiate *DeclaredObservable* according to the potential observables information that can be deduced. The screen-capture depicted in figure 7 shows how we used this editor to formally specify the observation needs we used as illustration.

6 CONCLUSIONS

This article has presented and discussed a specific *Model-Driven Engineering* approach for the support

of the definition of observation needs as models in relation to the 'learning scenario' model. We have proposed a support that is both theoretical, by providing a conceptual model and a specific process, and practical, by specifying a dedicated metamodel and by generating the first prototype of a dedicated editor, according to the use of the *Eclipse Modeling Framework.*

For now, we are working on several improvements. Some are conceptual like the use of a neutral referential for any constructivist-oriented EML to ease the definition of the context for an observation need. Other improvements are related to our MDE approach and tooling: we want to improve the editor prototype by dealing with concrete syntaxe (notation) aspects for a graphic definition of observation needs. To this aim, we have already used Eclipse's GMF (*Graphical Modeling Framework*) to provide practitioners with *Visual Instructional Design Languages* (VIDL) and dedicated editors. We plan also to use GMF to add a graphic layer on top of the EMF-generated tree-view editor for the specification of observation needs. We think that this graphical layer will give us access to facilities and services for more user-friendly editors.

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ARTIFICIAL LIFE CONTEST
A Tool for Informal Teaching of Artificial Intelligence

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Keywords: Informal teaching, Students motivation, Artificial life, Game-based learning.

Abstract: This work reports an experience in using an Artificial Life competitive game that simulates an artificial life environment for unstructured and informal Artificial Intelligence (AI) teaching to students from computer science engineering careers. The game consists of a simulated Petri dish where two colonies of microorganisms –software agents– must struggle to survive. To achieve this goal, the participants must implement surviving strategies for their agents, which include fighting strategies and basic reproduction rules to prevail over all the artificial environment. The technical bases of the contest as well as a description of the artificial life model are explained in detail. The pedagogical experience acquired in the contest development is discussed, as well as the resulting learning experience, which generated students enthusiasm and has helped them to develop mental models of possible AI algorithms.

1 INTRODUCTION

Artificial Life (AL) has a special attractive to computer science and engineering students. The promotion and foster of creativity in problem solving and the stimulation of spontaneous finding of solutions to previously unknown problems are important challenges while teaching. Given the impact of modern computer games on teenagers and young students, the time they spend on those games and the skills they develop for abstraction and generation of creative solutions, a game-like competition can encourage students to individual learning and the development of these skills by themselves. Thus, computer games may provide a great source of motivation when teaching artificial intelligence (AI) and other topics in computer science. Furthermore, an informal learning methodology gives the possibility to freely act in unknown situations and self learning without any obligations (based on the free choice of interests), which promotes the development of responsibility and self management.

The initial model, previous to the contest, was motivated by a simple and direct connection between a biological cell and a software object. After that, a model to reproduce the output of the well-known prey-predator system modeled by the Lotka-Volterra equations (Lotka, 1925)(Volterra, 1926) was developed. Some years later, based on this population model two new simulations for teaching topics related with object oriented programming, AI and biological models have been created.

The first model was a homework requiring the simulation of microorganisms having an internal artificial neural network model that sensed the neighborhood for nutrients and decided the next movement. In this simulation, a sower planted traces of nutrients and the microorganisms evolutionarily learnt the weights of the neural networks to follow these traces. After several iterations, all dead microorganisms are replaced by the offspring, obtained by crossover and mutations of the alive ones.

The second model was the Artificial Life Contest[1], where students should develop their own strategies of survival, with their own ideas about microor-

[1] http://alifecontest.sourceforge.net/

ganisms modelling. The created microorganisms must compete for survival in a common environment (with reduced nutrients availability). In this competition, they have to design and implement an artificial life form (a software agent), applying their AI and programming knowledge in a different, perhaps more attractive way than in a structured class. The simulation environment and its interactions with the agents are provided, therefore the students may only focus on defining the agent strategies for survival and how it decides what action to execute in each interaction with the environment.

For the contest development, object-oriented programming in C++ language is used (Milone et al., 2003). Students can access the environment source code (although they cannot modify it) and several examples of simple agents. Tournaments are organized periodically using the original environment (provided by the organizers) and the source code of the students agents.

The organization of this paper is the following: Section 2 presents the environment and artificial life simulation of the contest. Section 3 explains the software agents that must survive and interact in the artificial environment. Section 4 presents some details regarding winner definition and organization of the tournaments. Finally, the conclusions and future work are presented in Section 5.

2 MOTIVATION

There is a historically close relationship between Artificial Intelligence (AI) and games, such as chess, backgammon or poker, which have provided challenge problems for AI research. The use of AI in games presents an opportunity for AI educators to motivate students to learn about AI technologies through interactive learning and simulations. Playing any game well requires a player to choose a course of action taking into account the environment (the game situation) and the likely actions of other competitors or enemies (oppponents), so as to maximise opportunities for achieving goals (winning the game). Computer games as educational tools also have an intrinsic motivational factor that encourages curiosity and creates the impression that the students are in control of their own learning (Hingston et al., 2006).

There have been reported in literature several examples of AI teaching with games. In (Chiang, 2007) the traditional Pacman game has been adapted to provide student learning motivation for case-based reasoning AI technique learning. In (Kim, 2006) a virtual agent platform is presented for teaching agent systems design through a tournament game. This work aims at teaching agents in the first year of a computer science career and, differently from our unstructured learning approach, the authors use this tool as part of a formal course and for students evaluation. In fact, all of these proposals use the game for teaching inside a formal class environment.

Our approach, instead, aims at providing an informal learning methodology to senior students. This methodology has provided them an interesting opportunity to exercise the use of their imagination to solve previously unknown problems through self-learning, without a formal obligation, which also promotes self management. In general, the students that participate in the contest could organize their duties and manage their available time, exercising responsibility by themselves, without it being imposed from external pressions nor formal structures. In contrast to the classic approach to teaching AI with an objectivist approach, and similarly to (Pantic et al., 2005), we are focused in providing a simulation environment and a problem that needs to be solved through some AI technique. Like stated by this author, following a constructivist approach, an authentic real-world environment is provided in which students apply and test their knowledge and skills.

According to a recent analysis of game-based teaching and training systems (Martens Alke and Steffen, 2008) games have a high motivational character, often missing in traditional computer-based training systems. According to this analysis, this work, regarding learning theory, is an example of training with a microworld, a small world with a closed environment which functions based on its own artificial rules.

3 ARTIFICIAL LIFE CONTEST: THE ENVIRONMENT

The Artificial Life Contest is a competition of software agents that have to be designed with the objective of surviving in an artificial environment. The agents must move in order to get food, they can reproduce themselves, they can decide fighting against another species or, if they have not enough energy, to run away to avoid dying in a battle.

In the Artificial Life Contest, the environment represents a Petri dish which contains Agar (with nutrients) and two different microorganism (MOs) colonies, which must fight for survival inside this environment (see Figure 1). The competition model includes these four classes: *Petri*, *Agar*, *Colony* and *Microorganism*, shown in Figure 2. The figure also

shows the classes *MO_1* and *MO_2*, which are two different microorganisms developed by competitors, from which colonies will be built. The energy and food for the MOs are managed by the Petri and Agar classes, which will be explained in detail in the following subsections.

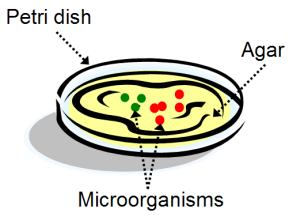

Figure 1: The "real" life environment, then simulated in the artificial life contest.

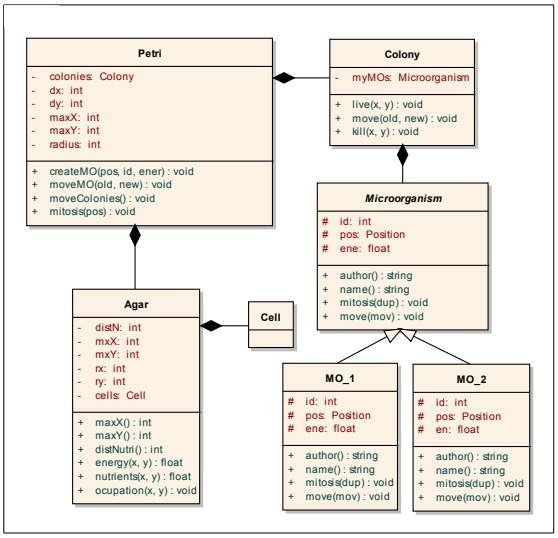

Figure 2: Artificial Life Contest model.

3.1 The Petri Class

The MOs life takes place at the container class *Petri*, where the rules of life are applied. This set of rules verify the validity of the movements required by every MO. The MOs are randomly ordered and then, from each of them, an action is requested and whether they want to reproduce themselves or not. After each agent action, the Agar is updated. The MOs can "see" during all the simulation an updated version of the environment, which is totally accessible for them.

According to the rules of the artificial life simulation, the MOs may feed, fight or procreate. The main rules are the following:

- Initially, 50 MOs of each colony are created, with 1000 energy units each.

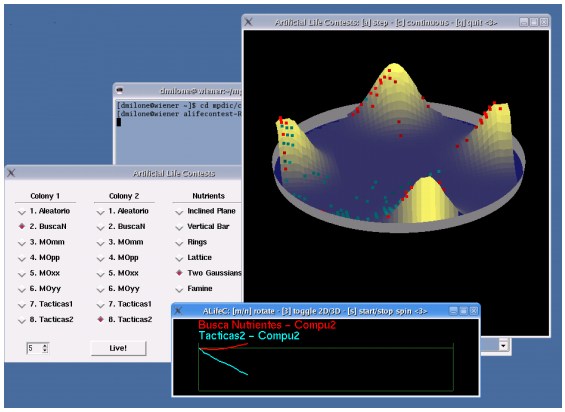

Figure 3: Artificial Life Contest: graphical user interface. The colonies are on the right window, inside the Petri dish, competing on a nutrient distribution given by two bidimensional Gaussians. The window at the bottom indicates the total energy of each colony.

- The MOs are all randomly positioned inside the Petri dish.
- Every MO looses 5 energy units per time unit due to aging, and it wastes 10 energy units for each movement.
- Every time step, all MOs increase their energy by feeding with 1% of the nutrients existing in their current position.
- The initial nutrient distribution and the way it could vary during the competition is chosen by Petri. There are actually six food distributions and there is battle for each one of them. For example, a bidimensional gaussian mixture distribution could be selected

$$G(x,y) = \sum_i N_i e^{-\left(\frac{x-x_i}{\Delta_i}\right)^2 - \left(\frac{y-y_i}{\Delta_i}\right)^2},$$

  where N_i is the maximum for each gaussian component, (x_i, y_i) are positions and Δ_i is related with each dispersion. This distribution can be seen in Figure 3 together with the graphical user interface of the competition. For this particular distribution case, a colony having a strategy to detect and remain in one of the energy peaks would certainly obtain an important vantage over the other colony.
- With respect to allowed agent actions, if a MO wants to move to a specific position, three possible situations are possible:
  1. The position is empty and it is inside the Petri dish: Petri allows it and moves the MO.
  2. The position is occupied by a MO belonging to the opposite colony: then the MOs fight and

the one whose energy level is higher survives. The winner does not simply kills the looser, but an amount of energy is taken which is equal to the difference of energy between them. If the looser remains with an energy level minor to zero, it then dies. After the fight, both MOs remain in the same previous position and the winner increments its energy in a 7.5% level regarding the looser.

3. Reproduction may be requested, by mitosis (a process of cell division, which results in the production of two children from a single parent cell). It could take place if there is a free adjacent place to put the new MO, and the father and the son remain with an energy equal to the 49% of the father energy.

3.2 The Agar Class

The *Agar* class acts like a proxy between the agents and the artificial environment, providing the MOs, when requested, the perceptions they can use for internal decision making. It models the food where the MOs may feed from and, this way, increase their energy. Agar knows the exact position and energy of every MO in the Petri dish, and this information is constantly updated.

The MOs can also ask the Agar about any information they may need, that is, the nutrient distribution, the amount of nutrients on a specific position (x,y) or the energy and species of a MO located at this point.

A very simple example of such kind of requests may be the following:

```
if (id <> agar.ocupation(myX+1,myY))
{ // to do something with a competitor
  // existing at the right of my position
}
if (ene > agar.energy(myX+1,myY))
{ // to take action according to energy
  // levels
}
```

where `id` and `ene` are the identifier and the energy of the MO, respectively.

4 ARTIFICIAL LIFE CONTEST: THE SOFTWARE AGENTS

In this artificial life model, the software agents represent microorganisms (MOs) that must live inside a Petri dish, feeding, reproducing themselves or fighting for survival. Each contestant must develop the survival algorithm of their MOs that will compete with other colonies for the exclusivity of the environment. The contest provides two basic classes that model the MOs and their colonies: the *Colony* class and the *Microorganism* class.

The *Colony* class contains a group of MOs that belong to the same species (in this case, same participant). Its main responsibility is moving the MOs when Petri requires it. The *Microorganism* class defines the MOs basic behavior. Starting from this class, the students must develop their MOs by inheritance, with their own survival tactics.

The possible actions that a MO may perform to achieve its survival goal are: eating the food, reproducing itself though mitosis and fighting against an enemy colony. Each MO must provide a virtual method that returns the position where the MO wants to move to, and consequently making a choice about feeding and attacking. In addition, MOs must provide another virtual method to communicate their decisions about mitosis.

Figure 4 shows a very simple example of a competitor MO, named *SearchN*, because its strategy consists of simply looking for the nearest position with higher food level. Through `agar.nutrients(x,y)`, a perception regarding the amount of nutrients existing in any position is requested. In the example, a mitosis as simple as: "if the MO has more than 5000 units of energy then divide" is implemented. This MO is very simple because it only considers the positions where there are more nutrients, and does not takes into account enemies positions, nor those of its own colony.

More developed algorithms may make better use of the available information to achieve more effective strategies, such as making mitosis according to the amount of available nutrients, attacking the contrary MOs, seeking and remaining in regions having more food, among others.

5 ARTIFICIAL LIFE CONTEST: DISCUSSION

The idea of converting the original artificial life model into a contest was a great motivation and a real challenge for the students. They arrive to the competition as contestants, that is to say, developers of microorganisms, as well as developers of the environment. Each year new contestants arrive and only a few of them participate more than 2 consecutive years.

About each 2 weeks we organize the "tournaments" where all the participants bring their new releases of microorganisms and "fight" in six "battles"

```
//-------------------------------------------------------
class SearchN: public Microorganism { public:
  virtual string name();
  virtual string author();
  virtual void move(Movement & mov);
  virtual void mitosis(bool & dup);
};
//-------------------------------------------------------
string SearchN::name() { return("Search for Nutrients"); }
//-------------------------------------------------------
string SearchN::author() { return("DGD"); }
//-------------------------------------------------------
void SearchN::move(Movement & mov)
{ // the MO will move to any
  // of the 8 neighborhood positions having more food

  int x_rel, y_rel;  // relative testing position
  int x_max, y_max;  // relative position having more
                     // nutrients
  x_max=0;
  y_max=0;

  for (x_rel=-1; x_rel<2; x_rel++)
    for (y_rel=-1; y_rel<2; y_rel++)
      if (agar.nutrients(pos.x+x_rel,pos.y+y_rel) >
          agar.nutrients(pos.x+x_max,pos.y+y_max))
      { x_max=x_rel;
        y_max=y_rel;
      };

  mov.dx=x_max;
  mov.dy=y_max;
}
// -----------------------------------------------------
void SearchN::mitosis(bool & dup)
{ if (ene>5000) dup=true;
  else dup=false;
}
// -----------------------------------------------------
```

Figure 4: Example of a simple MO-agent code.

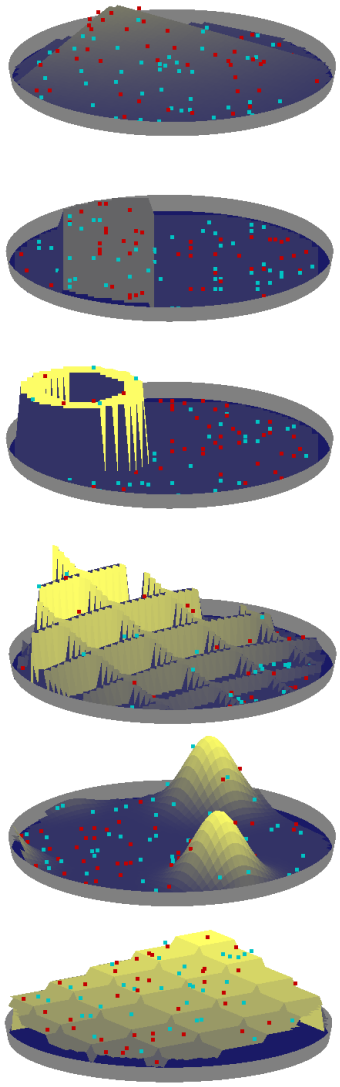

Figure 5: The six nutrient distributions used in the Artificial Life Contest battles. From top to bottom: inclinated plane, vertical bar or uniform distribution, ring, lattice, bimodal gaussian and five steps stair.

for the survival in our common environment. Students may form groups to design a MO-agent. A tournament begins and ends with only one source code per group, but it can be improved during the weeks between two tournaments.

Each battle is performed on six different food distributions (shown in Figure 5), such as: an inclinated plane, a vertical bar or uniform distribution, a ring, a lattice, a bimodal gaussian and a five steps stair distribution. The colony that dominates the other ones and accumulates the major living energy is the winner of the tournament and wins 3 points for the global ranking; the second one obtains 2 points and 1 point is for the third one.

Open source is a very important philosophical framework behind all development about computer science, both for teaching as for academic research (Sonnenburg et al., 2007). Thus, we promote these ideas not only by publishing the source code of the environment but also by uploading the source code of the winner of each tournament (with public access for all the other participants). At the end of the championship, the participant with more points is awarded with some gift from the organizing Universities and all the participants explain their strategies to the others in a common presentation.

To offer an environment as much unstructured or informal as possible, we have minimized the rules of the competition. If there is any situation outside of what would be expected, the same participants are the ones who discuss and decide, guided by the teachers, about how to solve the problem. For example, in principle it would not be allowed something like

"hacking" the Petri class. However, if the idea is original enough that the remaining participants may learn from this code and accept it, the method can become a valid strategy for future tournaments.

Another example of an unexpected situation was a winner that had encrypted all of his source code, changing identifiers by sequences of "_" characters. This way, when his code was made public and available to all other contestants, nobody could know his strategies. This situation was submitted to the opinion of all other participants and it was decided that, if the competitor wanted to continue participating, he should provide a completely documented source code.

6 CONCLUSIONS

This paper has described an Artificial Life competition based on a computer program that simulates an artificial life environment: a Petri dish where two colonies of microorganisms must survive. The contest model has been explained and exemplified, and the competition rules have been presented as well.

This didactic tool has generated great enthusiasm regarding programming and AI techniques among students. We noted important improvements along the competitions in many different aspects: abstraction, codification skills, team work, dedication, innovation, creativity when designing and implementing software agents; something that does not generally happen when teaching with traditional structured methods.

The publication of the winners source code was a big motivation for improving other competitors codes, learning by themselves from the winner strategies. Some people were more motivated to improve the artificial simulation environment while others preferred to focus on more competitive algorithms. Many of them tried to applied advanced AI techniques, such as artificial neural networks or genetic algorithms, reading and asking about these subjects to teachers, but without a formal structure.

We consider that this kind of informal learning methodology has provided an interesting opportunity to students to exercise the use of their imagination to solve previously unknown problems through self-learning, without a formal obligation, which also promoted self management. In general, the students that participate in the contest could organize their duties and manage their available time, exercising responsibility by themselves, without it being imposed from external pressions nor formal structures.

Among future work we can cite the development of a new model design, that could provide higher flexibility (through plugins) to generate different kinds of competitions, for example distinguishing between beginners and advanced students. Also, we are working to provide a new version of the contest in Java, which could simplify the multi-platform programming and would allow to also incorporate pre-compiled C++ MOs, with a more compact and integrated graphical interface.

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SHORT PAPERS

A USABILITY STUDY ON HOW NON-TECHNICAL STUDENTS INTERACT WITH A FREE-TEXT COMPUTER ASSISTED ASSESSMENT SYSTEM

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Keywords: Free-text Computer Assisted Assessment, Usability Evaluation, Blended Learning, Web-Based Formative Assessment, Open Learner Modelling, Human-Computer Interaction.

Abstract: Willow is a free-text Computer Assisted Assessment system, which can automatically assess students' short written answers in Spanish or in English. Willow is based on the combination of techniques from Natural Language Processing and User Modelling to generate students' conceptual models (i.e. a set of interconnected concepts of a certain area-of-knowledge associated with an estimated value that indicates how well each concept has been assimilated by the student) from the students' free-text answers. In the past, the system was used by a group of students of an Operating Systems course within an Informatics degree. The results of that study suggested that the system was useful for these students. Nevertheless, our hypothesis was that the procedure implemented in Willow is also suitable for non-technical domains and, that students without computer training are able to use Willow without any technical difficulty. Therefore, we asked a group of voluntary students of a Pragmatics course within an English Studies program to use the system. The results achieved support our hypothesis that Willow can successfully be applied to a non-technical domain, and it can be used by non-technical students.

1 INTRODUCTION

Computer Assisted Assessment (CAA) is the field that studies how computers can effectively be used for evaluating students' work. In early work, CAA tools were only used to score Multiple Choice Questions (MCQs) or fill-in-the-blank exercises. This can be explained because these types of items are easier to automatically evaluate with computers. However, according to the general opinion of the field, other types of assessment are necessary to cover higher cognitive skills (Sigel, 1999).

On the other hand, the automated assessment of students' free-text answers has been regarded by many as the Holy Grail of CAA. Regardless, several factors have supported the increasing interest in this field including i) advances in Natural Language Processing (NLP), ii) teachers not having sufficient time to give students appropriate feedback (despite the general assumption of its importance), and iii) the conviction that assessment should not be based only on MCQs.

Currently, there are many different free-text CAA programs, used both in academic and commercial environments, and which are able to process many European and Oriental languages. Moreover, they have been applied both to technical and non-technical domains. For instance, the Automark system (Mitchell et al., 2002) uses Information Extraction techniques to automatically score Science essays in English; the Japanese Essay Scoring System (Jess) (Ishioka and Kameda, 2004) automatically assesses Japanese students' general topic essays using LSA. Table 1 gathers a representative list of free-text CAA systems together with the technique and domain applied.

For the evaluation, the metric reported by the author is the one used: Corr, correlation; Agr, Agreement; EAgr, Exact Agreement; CAcc, Classification accuracy; f-S, f-Score; and, - for not available. When the authors have presented several values for the evaluation, the average value has been taken.

Table 1: Domains to which the current existing CAA of free text answers systems have been applied, the technique that they use and their evaluation (Pérez-Marín, 2007).

SYSTEM	DOMAIN	TECHNIQUE	EVAL.
AEA	Marketing, engineering	LSA	Corr:.75
Apex Assessor	Sociology of education	LSA	Corr:.59
ATM	Factual disciplines	Pattern matching	---
Automark	Science	Information Extraction	Corr:.95
Auto-marking	Biology	Pattern matching	EAgr:.85
BETSY	Text classification tasks	Bayesian networks	CAcc:.77
CarmelTC	Physic	Machine learning	f-S:.85
C-rater	Comprehension, algebra	NLP	Agr:.83
EGAL	Opinion and factual texts	NLP	---
E-rater	GMAT exam	NLP	Agr:.97
IEA	Psychology and military	LSA	Agr:.85
IEMS	Non-mathematical texts	Pattern matching	Corr:.80
IntelliMetric	K-12 and creative writing	NLP	Agr:.98
Jess	General topic essays	Pattern matching	Corr:.71
Larkey's system	Social and opinion	TCT	EAgr:.55
MarkIT	General topic essays	NLP	Corr:.75
MRW	Semantic networks	Logical inference	---
PEG	Non-factual disciplines	Linguistic features	Corr:.87
PS-ME	NCA or GCSE exam	NLP	---
RMT	Research on Psychology	LSA	---
SEAR	History	Pattern matching	Corr:.45

As can be seen, free-text CAA systems have been applied to many different domains, and there is no a clear trend of using certain techniques for certain domains. For instance, according to their authors, the best correlation between the automatic and the teachers' scores (95%) is achieved by Automark, which uses Information Extraction in a technical domain. On the other hand, the highest Agreement value (98% measured as the percentage of times that the automatic and the teacher scores only differed by a certain small margin) is achieved by Intellimetric, which uses full Natural Language Processing techniques in a non-technical domain.

In previous work, we implemented Willow, a free-text CAA system. Willow is based on the synergic combination of NLP and User Modelling techniques to automatically assess students' short answers written both in Spanish and English.

The core idea of the system is that the student's answer should be similar to the teachers' correct answers (reference answers).

During the 2005-2006 and 2006-2007 academic years, students of the Informatics degree at our university were given the possibility of using Willow to review their Operating Systems course (Pérez-Marín, 2007). We used this course for initial trials of the system for two reasons. Firstly, our algorithm for grading free-text answers depends on comparing student answers to the reference answers of teachers, and thus the more restricted the correct answers are, the better the system works. In technical domains, correct answers are reasonably restricted. Secondly, students of Informatics can be expected to have more ability to handle innovative software.

However, in the 2007-2008 course, we wanted to test that Willow can also successfully be used in non-technical domains (i.e. non-Informatics domains) with students without Informatics training. Therefore, we asked teachers of other faculties to collaborate with us. The English Studies Faculty took notice of our petition. In particular, the teachers

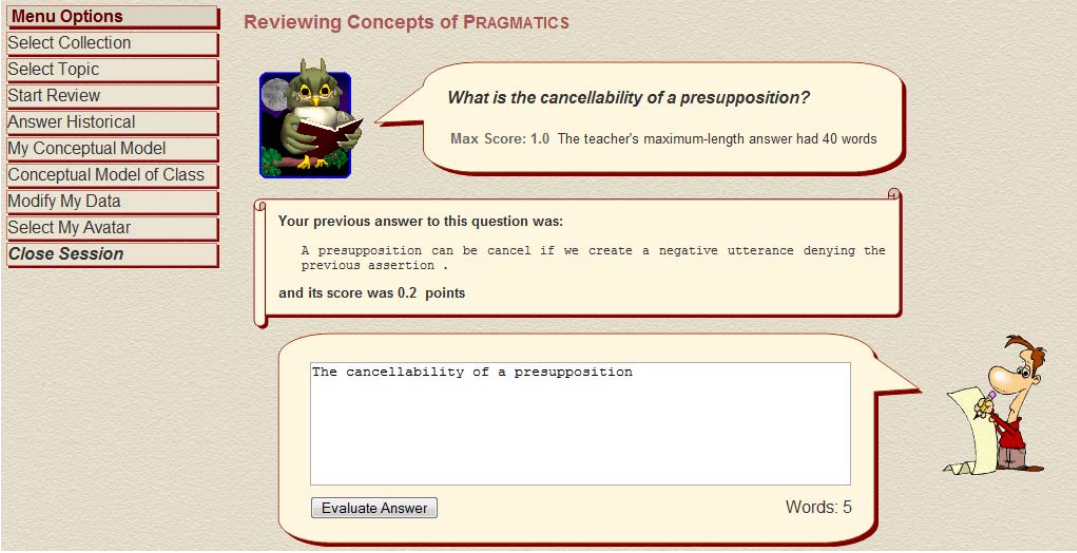

Figure 1: Sample snapshot of the interface of Willow.

of the Pragmatics subject were willing to use Willow as a complement of their lessons. 22 Pragmatics students volunteered to use Willow during one semester.

The results achieved support our hypothesis that Willow not only can be successfully applied to a non-technical domain, but also that Willow can be used by students without Informatics training with very little introduction to the system.

The paper is organized as follows: Section 2 provides a description of Willow; Section 3 describes the settings and results of the usability study conducted; and, finally, Section 4 ends with the main conclusions.

2 WILLOW

Willow is a web-based application able to assess students' short answers written both in Spanish and English in an automatic way. The goal is not to replace the teacher but to help him or her by providing students with an alternative mean of reviewing the course material. Willow scores the student's answer in terms of its similarity to a set of correct answers provided by the teacher. The more similar the answer is to the teachers' answers, the higher the score assigned is.

Figure 1 shows a snapshot of the Willow's interface. As can be seen, the interface tries to emulate a dialogue between two animated agents: an owl representing the system, and a character chosen by the student from a gallery representing the student.

The rationale to choose an owl as the animated agent to represent Willow is because in most Western cultures an owl is usually regarded as a bird of wisdom. The reason for this can be found in the Greek mythology. In fact, Athena, the Greek goddess of wisdom is often depicted holding an owl. On the other hand, the rationale to let the student choose his or her own animated agent is to increase the possibilities that the student feels that the character chosen represents him or her.

Willow is intended for formative assessment rather than summative assessment. That is, the goal of Willow is to provide more training to the students before their final exam. Thus, the system does not only provide a numerical score as feedback, but also the student's processed answer and the correct answers as provided by the teachers.

Therefore, Willow is similar to the other free-text CAA systems reviewed in the previous section as its goal and core idea is the same. The goal is to automatically assess free-text students' answers to provide the students with immediate feedback. The core idea is that the more similar the student's answer is to the correct answers provided by the teachers, the higher the score the student should achieve.

Willow has usually been applied to the Informatics domain because we are teachers of this subject. Thus, it is easier for us to do the first experiments of the system with technical students that are both more used to new software and, more approachable as they attend lessons in our faculty.

The NLP techniques used by Willow are different for Spanish and English languages. In fact, the experiments performed highlight that there is a different optimum combination of NLP techniques for each language used in Willow (Pérez-Marín, 2007).

In particular, for Spanish the optimum combination found is NLP+LSA+Genetic Algorithms reaching up to 63% Pearson correlation between the automatic and the teachers' scores (Pérez-Marín, 2007). For English, the Genetic Algorithms could not be applied as Willow has not been used by English students and thus, we do not have the information needed to run the algorithms. Hence, the optimum combination found is NLP+LSA reaching up to 56% Pearson correlation between the automatic and the teachers' scores (Pérez-Marín, 2007).

Willow has a unique feature: it is able to automatically generate students' conceptual models from the students' free-text answers. A student conceptual model can be defined as a set of concepts and their relationships for a certain area-of-knowledge. Each concept is associated an Estimate of Learner Level of Competence (ESLOC) value by the system. The ESLOC value of a concept can be between 0 and 1.

The procedure to automatically generate the student model will not be described here, as it is out the scope of this paper and, it has already been published (Pérez-Marín, 2007).

3 USABILITY STUDY

3.1 Setting Up the Experiment

After using Willow in a technical domain during two years, we wanted to test our hypothesis that the system could also be applied to non-technical domains and used by non-technical students. Therefore, we asked the rest of faculties of our home university to collaborate with us. The English Studies faculty took notice of our petition and, the Pragmatics teachers told us that they were willing to use Willow with their students.

Hence, we asked the Pragmatics teachers to provide us with the questions they usually ask their students in order to check whether it was really possible to apply Willow's core idea to Pragmatics. That is, to measure if it is possible to write a set of correct answers to the Pragmatics questions and, to automatically compare these correct answers to the students' answers.

We observed from the sample questions and correct answers provided by the Pragmatics teachers, that there is indeed more openness in what can be answered in Pragmatics than in Operating systems. On the other hand, we also realized that there were a defined set of concepts that should be reviewed. Furthermore, we decided that given that providing definitions for concepts was more difficult in Pragmatics, it was not necessary that all questions were in the form of requesting a definition.

Therefore, we asked the Pragmatics teachers to introduce non-ambiguous questions using Willow's authoring tool (Willed), or a text editor.

The two teachers of the subject agreed that they would rather use the text editor. Although they knew the application was easy to use, they already have information in text documents and they considered it would be easier for them to prepare the documentation in plain text.

After one month of non-full time work, the Pragmatics teachers came up with 49 questions, with three different correct answers per question, and covering the first four topics of the subject.

3.2 The Experiment

Once the domain has been established and the information introduced in Willow, we asked the Pragmatics teachers to allow us to go one day at their class to present Willow to the students who voluntarily wanted to use the system.

That way, we could immediately solve any problem or doubt the students may have, and at the same time, we could start observing how the students interact with the system.

Moreover, given that it was the first time that we had non-technical students using the system, we wanted to know the students' opinion before using Willow (to find out if they were somehow prejudiced against automatic free-text scoring) and thus, we asked them to fill in a questionnaire before starting the experiment.

The questionnaire consisted of three closed-answer items and two open-answer items. The closed-answer items asked the students about their degree of familiarity with computers, on-line applications and concept maps. The open-answer items asked the students whether they thought they would prefer to view just their conceptual model, or that for the class as a whole, and which representation format they would prefer: concept map, conceptual diagram, table, bar chart or textual summary.

22 students out of the 45 students enrolled in the Pragmatics course (i.e. 49%) volunteered to take part in the experiment. From them, 19 students filled in the questionnaire on a voluntary and anonymous basis. The analysis of these questionnaires revealed us that they are not prejudiced at all with on-line scoring systems.

On the other hand, these students, albeit they did not have any computer training, were quite familiar with computers: 47% of the students claimed that they were familiar with on-line applications and none of the students stated that s/he did not know how to use an on-line application.

The questionnaire also suggested that the students' knowledge of concept maps was low with 58% of the students answering that they were little familiarized with concept maps. Some students even asked what concept maps are. Nevertheless, when we explained what concept maps are, it turned out that 37% of the students prefer this form of representation to view conceptual models over the other formats available in Willow. Most of the students also stated that they would prefer just to look at their the individual conceptual model (74%), giving reasons such as that they are more interested to find out which concepts they do not yet fully understand, than in looking at the general picture for the class as a whole.

According to the results of the questionnaire, the first day the students use Willow in class with us, we could observe that none of the non-technical students had any technical difficulty in using any of the system's features. On the contrary, all of the students were able to answer several systems' questions with very little explanation (just a 5-minute Powerpoint presentation of the interface).

In fact, 123 students' answers were recorded, and as can be seen in Figure 2: 95% of the students modified which lessons they wanted to be asked, 77% students modified the animated agent used to represent them, 77% looked at the history of questions, 27% changed their personal data, 79% looked at the model and even 18% of the students try to cheat the system by copying the correct answers of the teachers as if they were their answers.

None of the students complaint about the interface of Willow and, they thought that the owl was a quite friendly animated agent.

Figure 3 shows a graph displaying the average number of questions answered by each student since November 16th 2007 (the first day the experiment started in class) till December 15th 2007 (i.e. the first month of experiment). And, again since February 5th 2008 till February 7th 2008, the next time the students started using Willow after Christmas holidays (from the end of December till the beginning of January) and the other exams in January, to review before the final exam on February 8th 2008.

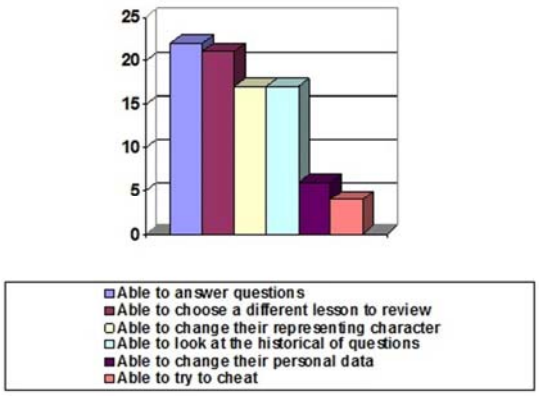

Figure 2: Number of non-technical students who have used some Willow's features.

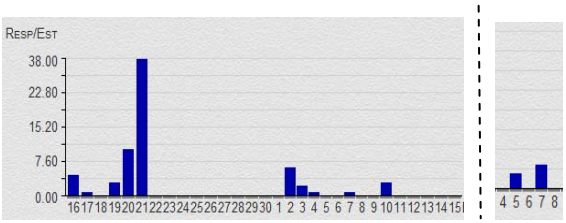

Figure 3: Average number of questions answered by the non-technical students.

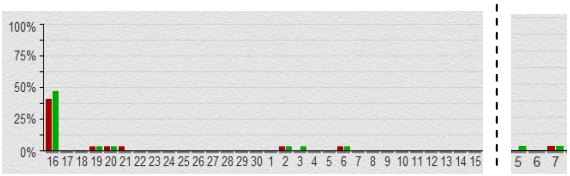

Figure 4: Percentage of students who have looked at their generated conceptual models.

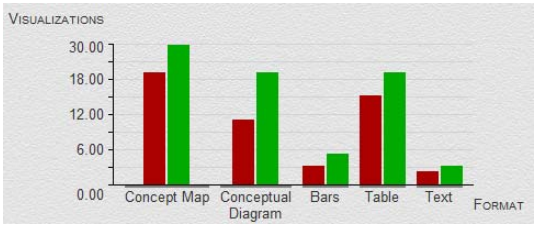

Figure 5: Number of times the students have looked at different representation formats.

As can be seen, the students have not regularly used Willow, although they have valued this

possibility by using Willow again in the days previous to the exam. Some comments that the students have emailed us about the use of Willow have been to thank us and their teachers for giving them this opportunity. Additionally, and despite students have not complaint about the interface and have regarded it as friendly, some of them (specially the ones who have used the system longer, even in 2-hour sessions, while the average assessment session was half an hour) have expressed their wish of being presented a higher variety of exercises. That is, not only open-ended questions, but also interactive games of choosing a solution or directly relating concepts.

It is also interesting to highlight that one of the student who has used more Willow has been the woman in her fifties. Contrarily to what could be thought giving the digital gap between young people and adult people, she has completed 93% of the questions of the course whereas the average percentage of completion of the course has been 17% (22% standard deviation).

Regarding the use of the generated conceptual models, 32% of the 19 students have looked again at them. Even, sometimes the students have entered the system just to look at their concept map representation and the class concept map representation without answering any questions.

Figure 4 shows the percentage of students who have entered Willow to look at their particular conceptual model (painted in green, light colour) or, to look at the class conceptual model (painted in red, dark colour). As can be seen, not only the students have valued the possibility of getting more training before the exam with Willow, but also of looking at the generated conceptual model. In fact, the logs revealed how, in the days previous to the final exam, some students have also looked again at their individual and class conceptual models.

Regarding whether they prefer the individual or the class conceptual model, according to their answers in the questionnaire, most students thought they would prefer the individual conceptual model (74%), as stated before, and the logs confirmed this preference. Finally, concerning which form of the representation formats available they prefer (concept map, conceptual diagram, bar chart, table and textual summary), it can be seen in Figure 5 how although the students have looked at all of them, the one they have inspected more is the concept map.

4 CONCLUSIONS

In this paper, the hypothesis that Willow can also be applied to non-technical domains and be used by students without Informatics training has been proved. Willow has, in the past, been used to review the Operating systems subject of an Informatics degree. However, in the 2007-2008 academic year we thought that it could also be applied to non-technical domains. Our belief was based on the fact that free-text scorers have been used both for technical and non-technical domains and, that the core idea of Willow (i.e. that the student's answer should be similar to the teachers' answers) is applicable to non-technical domains too, provided that a fairly limited and non-ambiguous set of correct answers can be written for each question.

Therefore, we carried out an experiment in the English Studies faculty, in which 22 students without English training have been able to interact with the system without problem.

In the future, we would like to do a more systematic experiment to collect more data about the differences in using free-text scoring systems such as Willow by non-technical or technical students.

ACKNOWLEDGEMENTS

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SHARK
A Web 2.0 Service Infrastructure for Knowledge Sharing

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Keywords: Web 2.0, Social Networking, Knowledge Sharing, Content Model.

Abstract: Embracing interactions in computer based learning is a good approach to empowering the effectiveness of knowledge sharing, and the popularity of Web 2.0 applications signals the readiness of applying Web 2.0 technologies to computer supported education. This paper introduces *SharK* (abbreviation of *Shar*ing *K*nowledge), a Web 2.0 service infrastructure specifically designed for knowledge sharing. *SharK* adopts a novel Unified Content Model to abstract various contents inside Web 2.0 service portals, which allows easier legacy data migration, consistent and fine-grained content security control in addition to providing an extensible platform for fast new service portal construction. Besides illustrating the key design considerations, this paper also introduces three real-life *Shark*-based knowledge sharing Web 2.0 portals, which clearly demonstrate the effectiveness and efficiency of Web 2.0 portal construction based on *SharK*.

1 INTRODUCTION

Traditional education web portals are usually deployed with many education contents put onto the web so that users are able to access those contents anytime at anywhere if internet access is available. Althought those education contents are constructed in various fancy multimedia formats (video, audio, flash animation etc.), those web portals can only provide passive learning experiences, i.e. end users only need to deal with education contents pushed to them, and there is no good way for end users to provide feedback, suggestions or share knowledges, e.g. (Kesim, 2007) and (Khalifa, 2002). As a result, people are looking for better ways of constructing education web portals that make them more interactive. Fortunately, the advancement of the web technologies make this possible.

The whole internet industry grew rapidly within the past several years. The evolution is not only reflected by the significant increase of internet user number, it is also reflected by the richer representation of the contents and how those contents are generated. Since Web 2.0 applications / services expect a lot of user-generated contents by utilizing collective intelligence and social networking, they are becoming more and more popular on internet. Famous web 2.0 services providers include *Facebook*, *YouTube*, *MySpace* etc. By adopting Web 2.0 technologies such as blogging, wiki, tagging, ranking etc., some education service providers are trending well on shaping a more interactive online learning experience, e.g. (Styles, 2007), (Williams, 2005), and (Drasil, 2006).

Different Web 2.0 applications are typically designed in respectively different data models. For example, an album application might have multiple fields in which the search engine may only index the description field. While in a blog application, the data model might be totally different and the search engine usually indexes other fields such as the blog title, blog content and corresponding comments. Because of the data model variance among Web 2.0 applications, fully integrating them into a Web 2.0 service portal and making it work well requires building new data adapters for each Web 2.0 application, which is not a trivial effort. For example, the integration of Business Suite 2.0 (blog, wiki, RSS feed) took SpikeSource several quarters.

In order to make the integration of various Web 2.0 applications (both current ones and future ones) more convenient, we define a Unified Content Model in this paper, based on which we create *SharK*, a Web 2.0 service infrastructure specifically designed for knowledge sharing. As illustrated in the right side of Figure 1, data models of all Web 2.0 applications can be respectively derived from the Unified Content Model. As a result, each Web 2.0

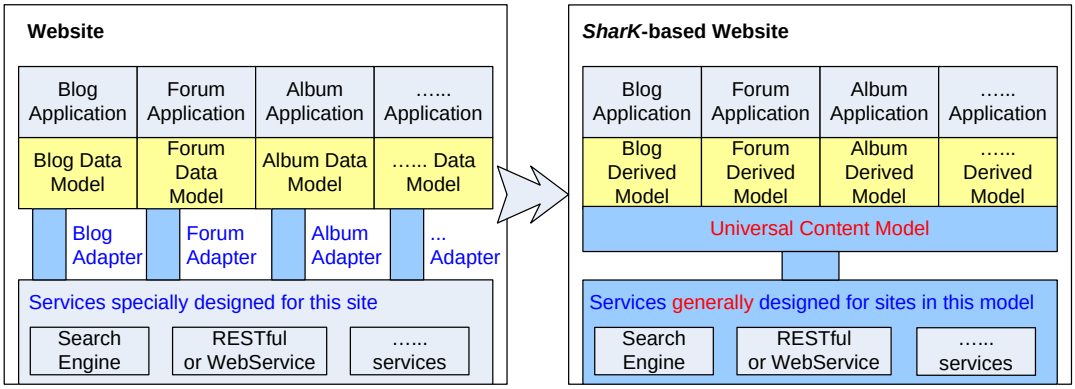

Figure 1: Comparison between traditional Web 2.0 application integration and *SharK*-based service portal construction.

application only needs to handle some application-specific data while the Unified Content Model and corresponding APIs do the rest of the work, including communicating with search engine, managing the content, processing the security settings, etc. Actually *SharK* enables fast construction of a Web 2.0 portal and the flexible integration among Web 2.0 applications developed based on the Unified Content Model. Figure 1 also gives a comparison between the integration of traditional Web 2.0 applications and *SharK*-based service portal construction.

Major contributions of this paper include the followings:

- Present a novel design of the Unified Content Model for Web 2.0 applications
- Introduce a design method to achieve UI (User Interface) separation with application logic
- Present *SharK* software architecture and how *SharK* eases the construction of Web 2.0 education/knowledge sharing portals
- Introduce three real-life *SharK*-based Web 2.0 portals that facilitate online education and knowledge sharing

The rest of this paper is organized as follows: Section 2 presents the system overview of *SharK*, followed by a detailed introduction of the design considerations in section 3. Section 4 presents three real-life *SharK*-based deployments. Section 5 introduces related work and section 6 concludes this paper.

2 SYSTEM OVERVIEW

Bearing the goal of flexible integration of Web 2.0 applications, we take modularity, extensibility and scalability into considerations when designing *SharK*. In order to reuse existing data of legacy websites, easy migration of the legacy data is also one of the design objectives.

As shown in Figure 2, the *SharK* service infrastructure can be divided into three layers:

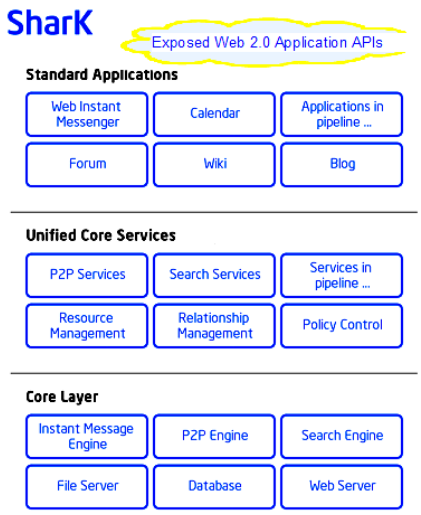

Figure 2: Software Architecture of *SharK*.

- **Core Layer**: The core layer is designed to lay out a solid foundation to support higher level layers. This layer contains major modules such as file system, database, search engine, P2P engine, web server, Instant Message engine etc. The Unified Content Model mentioned in the previous section is reflected in the data schema design of the database, which allows other modules to access the data with unified APIs. Since serving for huge volume users is one of *SharK*'s design objectives, all modules in core layers are well tuned to achieve high scalability.
- **The Layer of Unified Core Services**: This layer provides a set of APIs for conveniently building standard Web 2.0 applications. It

actually provides an abstraction of the core layer, thus minimizes the impact on the standard Web 2.0 application development when changes are made to the core layer. If more modules are added into the core layer, this layer can be easily extended by adding more core service APIs.

- **The Layer of Standard Applications:** This layer consists of typical Web 2.0 applications (Wiki, Blog, Forum, Instant Massager etc.) developed on top of unified core service APIs. *It also offers a set of standard Web 2.0 Application APIs, with which customized Web 2.0 portal can be conveniently developed.*

Clearly, the *SharK* architecture naturally fits into the knowledge sharing requirement.

- The P2P engine and corresponding P2P services make it possible to transfer/share big files such as classroom teaching video, courseware etc.
- The Instant Massager allows real-time communication among different online users, among teachers and students for example
- The efficient search engine makes it easy for users to search interested topics. Most importantly, the Unified Content Model further makes it convenient for the search engine to find results across various contents belong to different Web 2.0 applications
- Blog, Wiki and Forum bring a lot of convenience for users to express their thoughts, make comments and refine contents through tagging/ranking, which make the learning/knowledge sharing experience much more interactive

With the standard Web 2.0 application APIs offered by *SharK*, domain specific knowledge sharing portals can be easily constructed. Since those standard web applications can be freely bundled together and the UI design is well separated from the application logic (section 0), the customization effort when building a new service portal is expected to be trivial, in particular when compared with other development approaches.

3 DESIGN CONSIDERATION

Designing the whole *SharK* takes considerable efforts, and introducing the deatailed *SharK* design is out of the scope of this paper. However, this section shares several key desing considerations.

3.1 Unified Content Model

Unified Content Model is a key novelty of *SharK* design, which makes it possible to provide identical data operation interfaces for different Web 2.0 applications. The design of Unified Content Model relies on the following three basic elements:

- **Content**: Content represents a piece of information, such as text or words, a picture, a file in local file system, or an external link, etc.
- **Thread**: Several associated contents together form a thread, which is actually a session of related contents, e.g. a discussion series, a post with followed comments, etc.
- **Category**: Category is a home under which threads that have same or similar properties are put together. Category is hierarchical that can contain other categories as sub-categories

Through such abstraction, almost all data used in Web2.0 applications could be represented in this model after certain derivations (Figure 3).

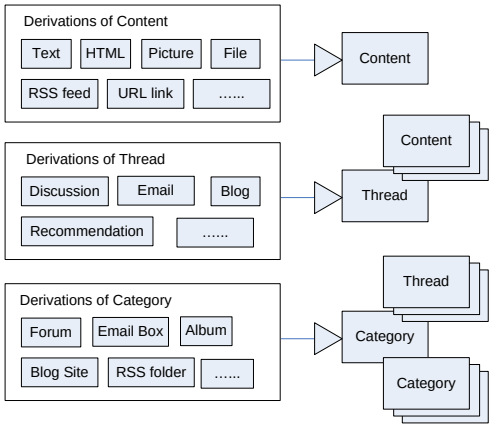

Figure 3: Content, Thread and Category.

To help better explain the Unified Content Model, Figure 4 shows the concrete design of Content, Thread and Category.

Figure 4(a) illustrates the concrete design of Content. In *Intrinsic Metadata* part, *Location* represents where the content locates, which could be a URL in internet, a path for local file system, or an ID in database. For example, we could have a specially designed format to represent the location such as *URL:http://a.com/b.html*, *PATH:D:/test.txt* or *DB:xTable/3*. This design significantly reduces the overhead brought by legacy data migration since legacy data can be either dumped as local data or use the location presentation ***points*** to it. *Visited count* is used to store how many times this content is visited.

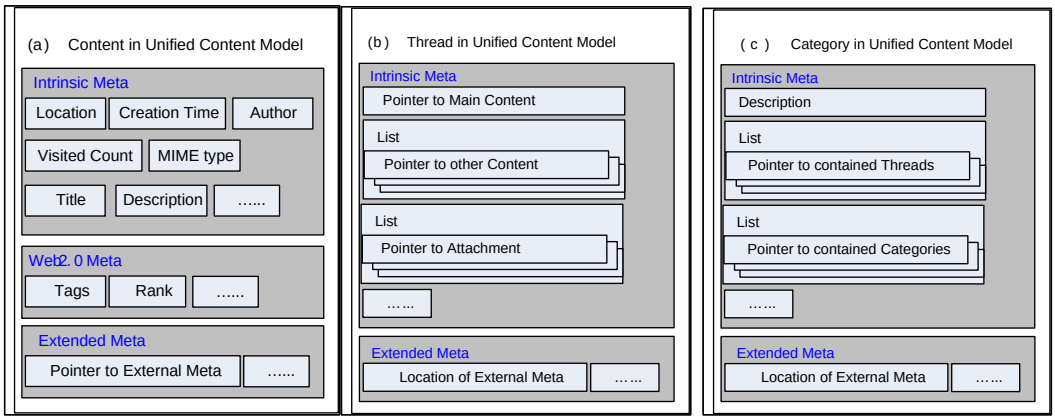

Figure 4: Concrete design of Content, Thread and Category.

Fields in *Extended Metadata* are used to represent the special properties of contents derived from the basic representation. For example, *Pointer to External Meta* contains the location of external metadata, which points to other metadata especially useful for a picture, a HTML or a file, etc. Other content fields are easy to understand. Furthermore, the hierarchical relationships among Content, Thread and Category are obvious in Figure 4.

The Unified Content Model makes it easy to define fine-grained security control over contents and bring convenience to integrate search engine into the *SharK* core layer.

- **Fine-grained Security Control**: With the Unified Content Model, security control is easy and consistent for all Web 2.0 applications. A separate security database is used to define the security settings for each piece of content, each thread and each category, no matter how these contents are used, as shown in Figure 5. Because all Standard Web 2.0 applications inside *SharK* share the same underlying infrastructure for security, Web 2.0 portal developers don't need to handle the security issue for respective Web 2.0 applications.
- **Unified Search Engine**: In the integration of traditional Web 2.0 applications (Figure 1), Web 2.0 portal developers need to spend huge effort on enabling search engine across different Web 2.0 applications. This could never be a problem in *SharK* with the adoption of the Unified Content Model. The search engine in core layer only indexes the Content and renders the search result based on the Content in the Unified Content Model. No matter which kind of Web 2.0 application is developed, its underlying data is always conformed to the Unified Data Model, thus requires no change to the search engine.

The Unified Content Model, together with other components/APIs provided by *SharK*, makes the development of a standard Web 2.0 application an easy task. Figure 6 illustrates this using the Album development as an example. As shown in the figure, developers need only take care of the design of Album-specific metadata, Album-specific application logic and UI.

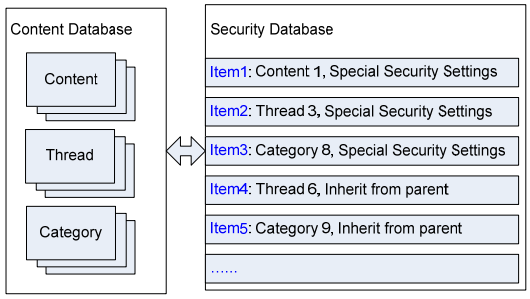

Figure 5: Unified Security Model over Contents.

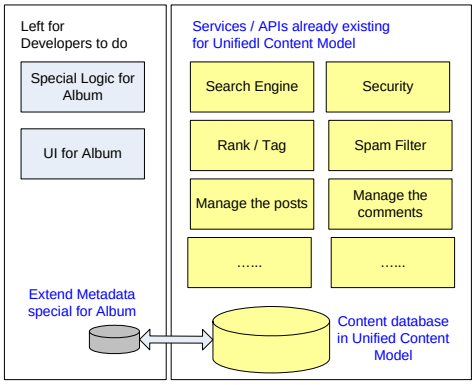

Figure 6: Album development Example.

3.2 Standardizing Content Service

Content Services APIs (Figure 7) are defined on top of the Unified Content Model, which can be used to access the contents.

In those APIs, the *criteria* could be used to retrieve a list of contents/threads/categories that match certain conditions. Each criteria is actually similar to a WHERE clause in a SQL statement, e.g. "*AuthorName = 'Tom' AND VisitedCount > 10*". Implementation of those APIs will finally turn those content operations to database operations on contents/threads/categories, and *criteria* parameter will be turned to a query condition.

```
getContent(serviceURI, contentID)
getContentMeta(serviceURI, contentID)
getContentListByCriteria(serviceURI, criteria)
getThread(serviceURI, threadID)
getThreadMeta(serviceURI, threadID)
getThreadListByCriteria(serviceURI, criteria)
getCategory(serviceURI, categoryID)
getCategoryMeta(serviceURI, categoryID)
getCategoryListByCriteria(serviceURI, criteria)
……
```

Figure 7: Content Service APIs.

3.3 UI Separation

SharK takes the advantage of a template system to separate the application logic of data access with the data representation in web page, which makes the UI design much more flexible.

As illustrated in Figure 8, the controller handles the user request, invokes services and passes all essential data to the template engine. The template engine then takes over all UI tasks from the controller, picks up the suitable page (UI template) and visualizes the supplied data with it.

Therefore, UI representation in *SharK* is completely separated from the application business logic and data objects, which brings the following benefits:

- **Parallel development of UI and business logic**: Without the dependencies on underlying layer, UI developers could independently design and implement the user interface in parallel with developers constructing the application functionalities. The integration effort of UI and business logic is also significantly reduced. In some extreme cases, UI representation of standard Web 2.0 applications could be directly applied to the newly developed Web 2.0 portal with very little further development.
- **Multiple themes**: Several sets of UI representation, a.k.a. themes, could be developed for and adopted by one Web 2.0 application. The service providers could easily customize the user interface for their customers through creating a new theme or modifying an existing one. The end users are also allowed to switch the themes in various styles based on their preferences.

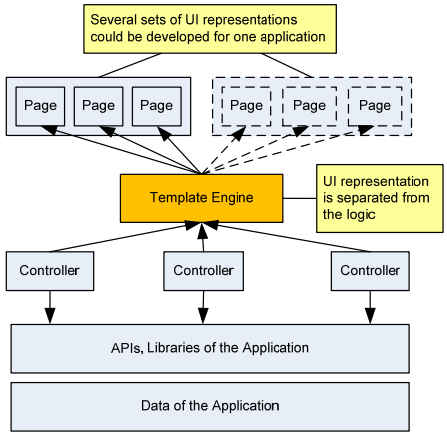

Figure 8: Separation of UI representation.

Figure 9 demonstrates a typical workflow of serving a user request with template engine involved. The template engine, based on certain pre-defined algorithms and configured policies, automatically identifies the right page to generate the UI representation. Furthermore, the rendered page is cached to improve the efficiency of the UI layer by eliminating unnecessary rendering cost for the same page fed with exactly the same data.

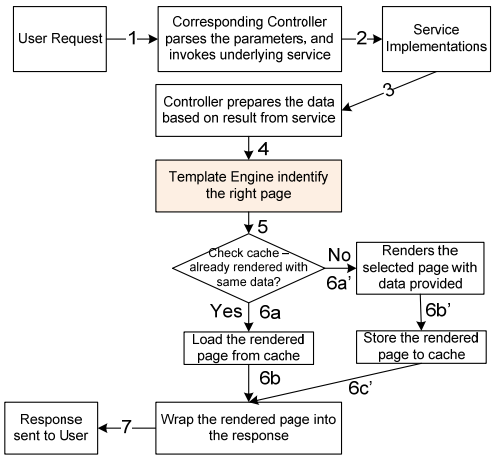

Figure 9: Flow of serving a user request.

3.4 *SharK* External APIs

SharK external APIs provide a way for developers to interface with hosted *SharK* services or conduct customizations to construct *SharK*-based Web 2.0 portals.

Each API is based on REST protocol so that it can be invoked by sending HTTP GET or POST requests to the *SharK* server. The API specification defines language-independent protocols for invoking a service, thus can be implemented in any programming language.

In general, SharK external APIs consist of a set of interfaces for *authentication*, *blog*, *forum*, *wiki* etc. Each interface defines an interface name, a set of request parameters, and the DOCTYPE definition of the response package. For example, the interface for getting a list of photos from an Album has the name of "*shark.album.photo.list*" and the request parameters of "*vendorKey*", "*sessionKey*" and "*albumId*". This interface can be invoked by sending to the *SharK* server the following HTTP GET request: *"http://SHARK_SERVER/server/handler?method=shark.album.photo.list&vendorKey=THE_VENDOR_KEY&sessionKey=THE_SESSION_KEY&albumId=THE_ALBUM_ID"*. The *url* might exceed the 255-char limitation of a HTTP GET, so it is encouraged to invoke the interface with HTTP POST. The response from an API innovation is an XML package, which is platform-independent.

4 REAL-LIFE DEPLOYMENTS

When developing *SharK*, we use many 3rd party tools to accelerate the development progress. Although different languages are used in implementing different modules, the application layer is developed in PHP using the *Symfony* framework. Actually some open source tools are modified to make them work well inside the *SharK* architecture. For example, we modified *Lucene* to make it work smoothly on top of the Unified Content Model, and added many codes to make *JXTA* fully integrated into *SharK*.

We built a reference Web 2.0 knowledge sharing portal based on *SharK* and customized it to three real-life Web 2.0 portals (Section 4.1-4.3). Although each of those three Web portals is currently deployed onto a single server, actually *SharK*-based Web 2.0 knowledge sharing portal can be flexibly deployed in multiple ways. Although deploying a *SharK*-based Web 2.0 portal to multiple machines and tuning its scalability on machine cluster belong to our future plan, actually a *SharK*-based Web 2.0 portal can scale very well even if all components are deployed onto one server. Our experimental result shows that single-machine-deployed *SharK* can scale well to serve for ~500 **concurrent** users.

Among three *SharK*-based real-life Web 2.0 portals, the 1st one is actually our reference portal, with which the construction of the 2nd one only took 2 weeks for one experienced software engineer and one experienced UI engineer. Since the 3rd portal has very different UI style, the customization took one experienced software engineer and one experienced UI engineer one month effort.

4.1 Enterprise Knowledge Sharing

In the spirit of eating our own dog food, we deployed an internal Web 2.0 portal for the purpose of knowledge sharing among employees inside an enterprise. As shown in Figure 10, communication among employees and cross organizations can be achieved through *Blog*, *Forum* and the *Web email* inside the portal. Sharing of big files is transparently supported by the underlying layer P2P services. *Mentorship* application is a new application for bridging mentorship among employees. The "*Ask Expert*" application is actually a customization based on *Forum*, which targeting for *Q/A* between technical experts and other employees. To bring better user experience, we also add the *RSS* support to allow users to subscribe forum articles and add the feature that allows employees to complete the article post to *Forum* through emails.

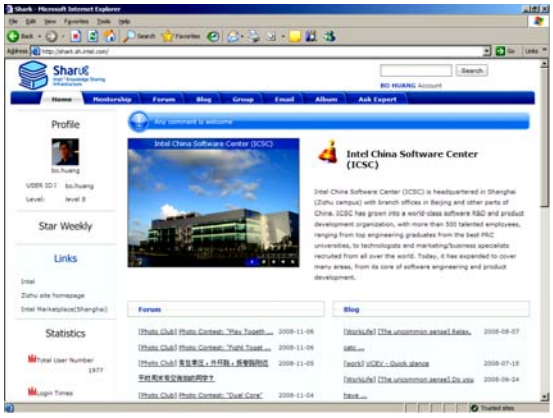

Figure 10: Enterprise internal knowledge sharing portal.

4.2 *SchoolSpace*

The *SchoolSpace* portal works as a content aggregator for education mobile SMS (Short Message Services) and a backend social networking

portal that links together parents, teachers, schools and students. When online, teachers, students and students' parents can have interaction through those Web 2.0 applications such as *Blog*, *Forum*, etc. Students' parents can even receive short messages sent to their mobile phones without logging onto this portal. Those messages include their kids' performance in school, school administration notifications, their kids' daily homework, recommended articles on this web portal etc.

4.3 Remote 1:1 Coaching

This portal serves for the purpose of bridging enterprise volunteers and students in rural areas to conduct remote 1:1 coaching. Students' profiles and enterprise volunteers' profiles are used for match-making to build 1:1 coaching relationship. The coaching is typically done through the *instant massager*, while each user can also use *Forum* or personal *Blog* for sharing mindset/knowledge/ coaching feedbacks. Internal email is used for asynchronous communication too.

Figure 11: Portal to facilitate remote 1:1 coaching.

5 RELATED WORK

SharK presents a novel design of the Web 2.0 service infrastructure by integrating different Web 2.0 applications (e.g., *Blog*, *Wiki*, *Relation*, *Tagging*, *Ranking*, *Searching*, *IM*, *P2P* etc.) that enable effective and interactive knowledge sharing.

SharK has some similarities with Business suite 2.0 (an integrated software suite with typical Web 2.0 applications), and with many Internet forum applications (such as PHPWind, Discuz! and vBulletin). On the other hand, Business suite 2.0 is heavily adapted to mass collaborations using *Blog*, *Wiki* and *RSS* feeds, and those Internet Forum applications focus more on forum-style discussions using topic threads. They all lack some applications for knowledge sharing (e.g., *IM* and *P2P*), which are important features in *SharK*. In addition, different applications in Business suite 2.0 use different data model and rely on data adapters for the integration. In contrast, *SharK* supports different applications using Unified Content Model and standard content services for better integrations and better extensibility.

Finally there is a wealth of Web 2.0 applications in the Internet, such as *Facebook* and *MySpace* for social networking, *YouTube* and *Flickr* for user geneted content sharing. Though those applications have different emphasis than *SharK*, they apparently shares some common features and goals with SharK. Unfortunately, little details of those application designs have been published to date.

6 CONCLUSIONS

This paper presents several key design considerations of *SharK*, a Web 2.0 service infrastructure specifically designed for knowledge sharing. The adoption of the Unified Content Model and UI separation methodology lay out a solid foundation for *SharK*, which makes it a unique extensible platform for fast Web 2.0 knowledge sharing portal constructions. Three real-life *Shark*-based Web 2.0 portals clearly demonstrate the effectiveness and efficiency of *SharK*-based deployments. Although we are focusing on knowledge sharing in this paper, actually SharK can be easily customized to create other categories of Web 2.0 portals.

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GROUP UP TO LEARN TOGETHER
A System for Equitable Allocation of Students to Groups

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Keywords: Working teams, Syndicate groups, Collaborative learning, Equitable allocation, Vector packing.

Abstract: Group-based learning is overwhelmingly accepted as an important feature of current education practices. The success of using a group-based teaching methodology depends, to a great extent, on the quality of the allocation of students into working teams. We have modelled this problem as a vector packing problem and constructed an algorithm that combines the advantage of local search algorithms with the branch and bound methodology. The algorithm easily finds exact solutions to real life problems with about 130-150 students. The algorithm is implemented in GroupUp – a decision support tool which has been successfully used in the University of Warwick for a number of years.

1 INTRODUCTION

Group-based learning is overwhelmingly accepted as an important feature of education methods nowadays. Researchers-educationalists claim (Hassanien, 2006; Houldsworth and Mathews, 2000) that "collaborative work in groups and group assessment have become integral components of many undergraduate and postgraduate programmes in the UK and all over the world" (see also Thorley and Gregory, 1994; Gunderson and Moore, 2008, for the theory behind this phenomenon).

As with many other similar courses, team-work plays an important role in the University of Warwick MSc and MBA programmes. For example, the students in our Management Science and Operational Research MSc, approximately 50 in number, are assigned to 'syndicates', small groups of 7 or 8 students that work together throughout their year at Warwick. The performance of a student's group will have a great impact upon their final grade not merely due to the assessed component of their team-work but also indirectly as a result of the morale lost by the students in a 'bad' group. This paper describes the process of modelling this situation from a case study perspective, the algorithm that has been created to solve it, and the decision support tool GroupUp which has the algorithm embedded within it. Our work differentiates itself from previous work on a number of counts. Firstly, to the best of our knowledge, the algorithm is the first to find exact optimal solutions to this problem and is capable of finding solutions quickly for problems much larger than those described in the existing literature (Bacon, Stewart, and Anderson, 2001; Baker and Benn, 2001; Baker and Powell, 2002; Dahl and Flatberg, 2004; Desrosiers, Mladenovich, and Villeneuve, 2005; Weitz and Jelassi, 1992). Secondly, the algorithm is implemented in a decision support system with a well developed interface simplifying related data manipulations, again, a feature unlike previous methods.

Given the nature of Operational Research courses and the nature of Operational Researchers it is hardly surprising that a sizeable body of literature has built up relating to the issues surrounding student group formation. Broadly speaking approaches break down into two categories, or schools. The Diversity School holds that groups should be formed to enhance the learning experience and this can be achieved by giving students the opportunity to work together with others very different from themselves. By contrast the Equality approach aims at giving each student an equal chance of success by making groups as identical as possible. Baker and Powell (2002) look in depth at solutions to this problem that use, as we will, binary data structures to represent the characteristics of each student. They point out that the heuristic objective functions used to resolve the problem, whether they stem from a Diversity or Equality

rationale, mathematically aim at the same goal. Insofar as this goes we agree, however we would argue that the data you feed into your algorithm and in particular the method used to encode it into a binary structure will differ based on whether you are grouping with a Diversity or Equality objective. Furthermore our research is not heuristic in nature since we search for exact solutions. Consequently we will state that at Warwick we approach the problem from an Equality perspective and rephrase the problem thus

The Equitable Partitioning Problem

Taking a pool of N items with attributes $A_{1..N,1..S}$ (of any data type) partition them into K groups such that one cannot say that any two groups differ for any non-trivial reason.

As attributes taking into account while allocating students to groups, we usually consider gender, nationality, educational backgrounds (first degree), age. In fact there is no restrictions on the number and nature of the attributes that can be taken into account. One may think of adding learning styles, based e.g. on the well known Honey and Munford questionnaire (Honey and Munford, 1986) or personality types such as the Myers Briggs Personality Type Indicator (Myers and McCaulley, 1985), etc. It is also possible to solve a problem of "dispersing" previously formed groups (Dahl and Flatberg, 2004) by adding as an attribute the "old" group number.

2 DECISION SUPPORT SYSTEM FOR ALLOCATING STUDENTS TO EQUITABLE GROUPS

The application GroupUp is an Excel Add-in for Microsoft Office with a simple interface in Excel. The engine (the main algorithm for finding an optimal allocation) is implemented as a DLL module written in C.

In step one of the allocation process a user is asked to identify the data set (see Figure 1) and then to choose the data columns that should be taken into account.

In the next step of the allocation process the user is prompted to identify the sets of undistinguishable items within each attribute. For example, in the example shown in Figure 2, a set named "UK" is created to group items with undistinguishable values. For this step, all attributes with more than two different values need to be looked through in order to classify items into undistinguishable sets.

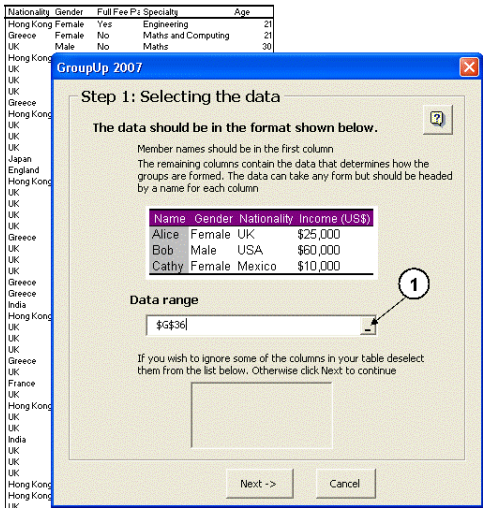

Figure 1: First step in an allocation process: (1) the user is asked to identify the data set.

For the attributes with numeric values there is an option of identifying undistinguishable groups automatically or by defining boundaries for the intervals (see Figure 3).

In the last step 3 (see Figure 4), the user decides on the number of groups to be created. With a push of the button, the job is done!

The results are available in different formats (tables and charts) and are saved in a new worksheet.

To simplify the allocation process for subsequent occasions, an option is provided to save the auxiliary files enabling the customer decisions at each stage (undistinguishable attributes, intervals for numeric data, etc.) to be remembered.

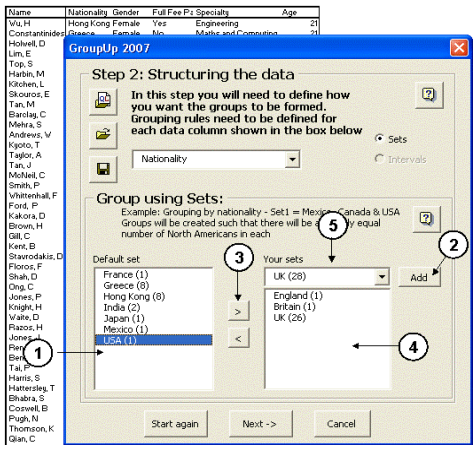

Figure 2: Second step in an allocation process: (1) all values of an attribute ("nationality" for this picture) are in the left window; (2) new set – UK – is added; (3) items with the chosen values of the attribute are moved into the new set (to be undistinguishable) – (4) and (5).

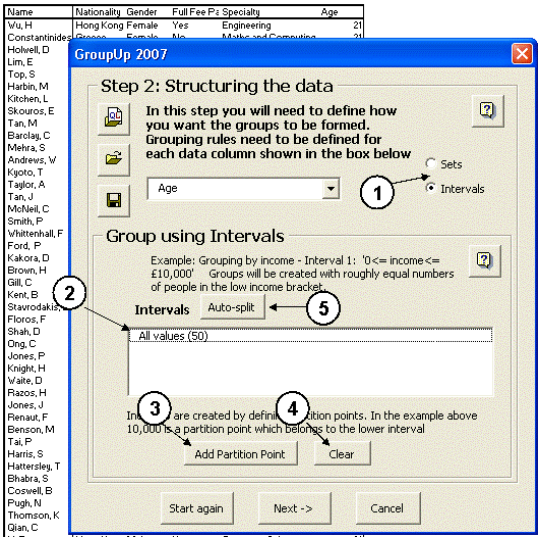

Figure 3: For the attributes with numeric values there is an option of defining intervals (1); based on the total number of values (2), it is possible to decide on introducing partitioning points (3) (button (4) to undo the decision) or use an automatic split (5).

3 INITIAL MODELLING

Our model was created in two stages. The initial model is very similar to previous approaches to this problem as tackled by O'Brien and Mingers, (Mingers and O'Brien, 1995; O'Brien and Mingers, 1997), and Baker and Benn (2001), in that it is a simple conversion of student attributes to a binary form.

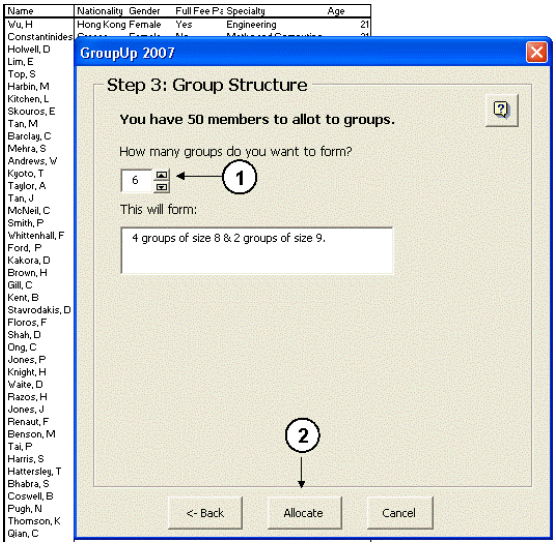

Figure 4: Decide on the number of groups (1) and push the button (2). That's it!

We then constructed the algorithm (and software) that we shall speak of in Section 5. During this early developmental stage, a number of weaknesses were identified in the original model and the algorithm. By addressing these we eventually developed a product satisfying us both as researchers and as customers of a software product.

3.1 The Basic Model

We begin by converting our data into a binary attribute matrix A where A_{ij} = 1 if student i possesses attribute j. In the case of Gender and other naturally binary attributes this is a simple case of Female=1, Male=0. More complicated attributes, such as Nationality get broken down into multiple columns i.e. UK=[1,0,0] , Hong Kong=[0,1,0], Other=[0,0,1]. Our objective is now to get an equal sum for each binary attribute in each group.

It is reasonable to question whether this mathematical definition squares with the loose definition of our objective with respect to numeric attributes. One of our attributes, Age, takes numeric values and the natural impulse might be to say that the most important factor from an equality perspective is that the mean age should be equal in each group. Leaving aside the added complexity this would add to the model we would argue that, though you can no doubt contrive counter-examples, the implicit intention of including any attribute, nominal or numeric, is to create an equal distribution of this attribute in each group and that a series of binary categories achieves this in a more satisfactory manner than means or totals. As example consider partitioning a set of people with the following ages [21, 21, 21, 21, 23, 23, 23, 23, 27, 35] in two groups. Using the mean you would inevitably get [21,21,21,21,35], [23,23,23,23,27]. Using three binary columns (Fresh from University, Limited Experience & Experienced) you would get [21,21,23,23,27], [21,21,23,23,35]. Though you may disagree we consider the differences between the binary groups a lot more trivial than those that use the mean.

3.2 Objective Function

As Baker and Powell (2002) note there are many different metrics that can be used as heuristic objective functions with the aim of equalising groups however when one is aiming for an exact solution they all (or rather nearly all, a point which we will return to in the next section) amount to the same thing with little to differentiate between them

except for speed of calculation. The method we use is to minimise the integer sum of squared deviations across groups and attributes. To speed this we employ the concept of the perfect group with summed binary attributes $t_{1..J}$. For K groups and N items the sum of values of attribute j can be represented as

$$\sum_{i=1}^{N} A_{ij} = (K - r_j)t_j + r_j \quad (r_j<K)$$

Put another way if we are going to split 25 men into 7 groups we will ideally have 3 groups ($K-r_j$) with 3 men (t_j) in and 4 groups (r_j) with 4 men (t_j+1) in. For convenience sake we take the lower bound, 3, as the ideal number of men in a group. Now for x_{ik} = 1 if item i is in group k, the objective function is

$$Z = \sum_{j=1}^{J}\sum_{k=1}^{K}\left(\left(\sum_{i=1}^{N} x_{ik}A_{ij}\right) - t_j\right)^2$$

Conspicuous by its absence is any scheme for weighting the columns such that, for example, it could be made equally important to split up the single Gender column and the 3 combined columns of Nationality. We come to this in the next section.

3.3 A Perfect World

A natural extension of the concept of the perfect group is the concept of a perfect grouping where each group has either t_j or t_j+1 members for each binary attribute. It may be the case that such a solution is mathematically impossible for a given problem and this is the reason we talk of 'perfect' solutions rather than 'optimal' ones. That said the 'perfect' grouping provides us with a convenient value for the lower bound of our solution

$$Z_{\min} = \sum_{j=1}^{J}(r_j((t_j+1)-t_j)^2 + (K-r_j)(t_j-t_j)^2 = \sum_{j=1}^{J} r_j$$

One of the more astonishing discoveries of this research is that practical instances of this problem are, universally in our experience, capable of perfect solution. It is possible to contrive data sets that are 'imperfect' i.e. mathematically incapable of perfect solution. In fact for any number of students and groups as few as three binary columns of data are all that is required. Nevertheless we have found it is safe to assume that a perfect solution will arise for all practical data sets. This insight opens up new possibilities for two reasons. Firstly weighting the columns becomes completely unnecessary since you will get a perfect solution for all columns no matter what the weights are. Secondly, as long as one doesn't go wild, it is possible to add new binary columns without compromising the integrity of an initial solution. Whilst you may do this by including more attributes for each student we use this ability to address the deficiencies in and enhance our basic model.

4 FURTHER MODELLING

4.1 Natural Binary Attributes

During experimentation a set of results were produced for a group of 13 students, 6 of whom were male and 7 female; the students needed to be divided into three 'equal' groups. The Gender column for this allocation is shown in Figure 5. The computer claimed that the solution was perfect and yet Male clearly takes three different values, something that should not occur in a perfect result. After searching our code for errors it was discovered that the solution actually is perfect. Female was given the binary value 1 and is consequently distributed evenly with either 2 or 3 women in each group but because total group size can be either 4 or 5 this meant that the total number of men in each group could take any of three values. Such a problem can be resolved by converting Gender into two binary columns, just as one would with a multiple value attribute, thus men will be standardised as well as women. Complicating the model like this is not always necessary. If each group was going to be exactly the same size or the number of women in each group was going to be the same, the problems of integer division would not arise. In this instance by making Male = 1 Gender would require only one binary column as men split evenly amongst the groups.

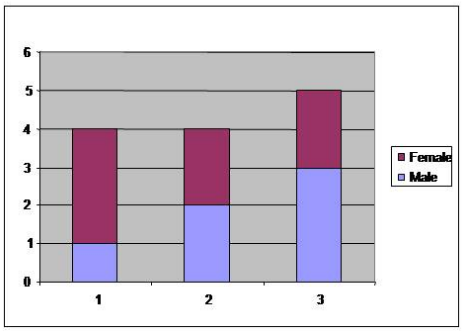

Figure 5: The natural binary problem.

4.2 Group Splitting

A similar problem to that on the MSOR programme exists on the Warwick MBA. In addition to the basic equitable partitioning requirement the MBA requires three iterations of the allocation process to be conducted, one for each term of study. This requires that groupings be constructed with the condition that no students should be in the same group twice. Initially we attempted to build this into our algorithm using a technique based on Latin squares but found that, while the updated algorithm could handle creating one additional grouping, any further brought it grinding to a halt. Consequently we returned to an earlier idea, creating the groupings one by one and splitting the groups by including previous group numbers as attributes. "Was in Group 1" becomes a binary attribute and with luck people who were previously in Group 1 will all be separated. We had initially shied away from this idea on the basis that, since the MBA requires 14 groups an additional 28 attribute columns (when two previous groupings are taken into account) would mean we would end up with a non-optimal answer. The MBA group-splitting requirement is hard so this would not be acceptable. We now use a hybrid of the two methods with one previous grouping split up algorithmically and all subsequent ones split up using attributes.

4.3 Sparsity

Another aspect of the MBA problem caused us to add bonus columns to our data structure. The fact that it is a much larger problem, coupled with a requirement for a much finer partitioning of attributes leads to a situation where the basic model detailed above can result in groups with significant non-trivial differences. Mingers and O'Brien (1995) worked on the same MBA problem and took the view that, when it comes to attributes such as Nationality it is more important to have an equal number of nationalities represented in each group than equal numbers of students of each nationality. In figure 6 you can see two extreme examples which illustrate the fallacies of both our methods. Mingers and O'Brien's (1995) model could, in theory, lead to an optimal grouping with six UK students in one group and only one in another whilst our basic model, on the other hand, could lead to seven nationalities being represented in one group and only three in another.

The problem for our model arises due to integer division and what we term 'sparse' attributes, minorities such as Spain above where there are not enough people to have one in each group. To see how the problem arises take 3 UK students and one Canadian and put them into two groups. You will naturally get 2 UK in one group, one UK and the sparse Canadian in another. Add in three Chinese students and a sparse Spaniard and you could get one group with 2 UK students and 2 Chinese with the other group being composed of 4 different nationalities.

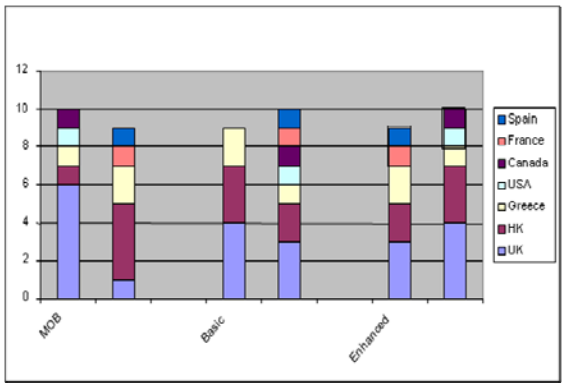

Figure 6: The problem of sparsity.

Of course the position might be reversed so that the new groups have three nationalities each but since there is no control mechanism in the basic model to ensure this, sparse columns do present a problem.

We have resolved the sparse problem by taking into account that in a perfect grouping the number of nationalities represented in a group is equal to the number of standard categories, for there must be at least person from each of these categories in each group, plus the number of people from sparse categories in that group, each of which must come from a different nationality. Where appropriate a new binary attribute is added to our model for each column with more than one sparse category. The new attribute, IsSparse, takes the value 1 for all items that are in a sparse category. In a new perfect grouping the number of people from sparse groups will be evenly distributed, as far as integer division will permit, and hence the problem is resolved. It is true that this method does not by necessity provide an optimal solution in terms of Mingers and O'Brien's (1995, 1997) model however the difference is negligible and in terms of achieving our overall goal, namely groups with no significant differences, it is difficult to see how this composite model could be improved upon.

5 CONCLUSIONS

The problem of allocating students to equitable working teams is a well known practical problem – many Higher Education institutions throughout the world face this problem when trying to improve the learning process for their students. GroupUp is a simple tool to resolve this problem in practice (a trial version of the software is available on request from v.deineko@warwick.ac.uk). We are now planning to undertake some extensive collaborative research with both practitioners and researchers in the field of education. This collaboration will explore how different rules for constructing the groups influence both the group dynamics and the efficiency and effectiveness of group performance.

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THE LAW&ICT SHARED VIRTUAL CAMPUS

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Abstract: An European Shared Virtual Campus on LAW&ICT (Law and Information and Communication Technologies) has been created to provide an educational technology platform to offer European-wide graduate and postgraduate level courses and for lifelong learning. In this learning framework, an international Degree, Bachelor in LAW&ICT, an international Degree, Masters in LAW&ICT, and an international Lifelong Learning Programme in LAW&ICT are been development, with the participation of ten European Universities. Also, an Europe-wide network of experts in LAW&ICT has been created to share the knowledge and disseminate the results and experiences. The LAW&ICT Shared Virtual Campus encourages the mobility of teachers, students and professionals among countries, sharing knowledge about similar and divergent aspects in LAW&ICT.

1 INTRODUCTION

e-Commerce, e-Government, digital signatures and intellectual property of ICT products are a vital reality in our society, where the importance is developing at a faster rate in commerce than in public administration. This situation is creating differences between countries, causing problems for citizens and consumers, especially in the cross border operations. Public administrations, on the other hand, are organized along pre-digital rules of governance with the new public management appended as an extra requirement.

In the European Union there exist a number of directives and common practices knowledge of which should be shared between the countries using a common platform, and the knowledge of each country and the diversity of cultures should be incorporated in the development of this dissemination platform, where it will be possible to include contributions from the different stakeholders and the personnel involved in the definition and use of the Law referring to the technologies.

To satisfy these needs, unlike many other areas of formal education, in the LAW&ICT field there exist previous attempts at harmonization at European level, Council of Europe. The most significant rules in this respect are Resolution (73) 23 (Resolution, 1973), Recommendation (80) 3 (Recommendation, 1980), Recommendation (92) 15 (Recommendation, 1992) and Recommendation (95) 13 (1995).

Since 1999 a number of Universities, belonging to ten European member states, has been attempting to implement these Resolutions through working together in teaching and researching in Law & ICT. The results are today the content of the Legal Framework for the Information Society (LEFIS) studies (www.lefis.org). The resultant outputs have been study programs and courses in the field. Most of these courses are currently offered to graduate and postgraduate students and continuing education in different subjects. The studies are systematized also from professional competences according to the TUNING methodology.

The LAW&ICT Shared Virtual Campus Project takes this initial development work and extends it further, including to Lifelong Learning. The project uses the resources that the mixture of old and new methodologies and technologies offers, and the possibilities that development in the European reform process of the Higher Education Area has brought to University structure and interaction.

Figure 1: The LAW&ICT Shared Virtual Campus logo.

2 OBJECTIVES OF THE PROJECT

The transition to the information society promises new services, solutions, and products but at the same time brings with it challenges, issues and problems in many areas. One of these areas is the joint activity between Law, Management and Technical knowledge subjects ("knowledge areas"). These joint activities comprise an important interdisciplinary field, especially the intersection of ICT and law. ICT offers solutions to the legal system for new and better services to the citizens and to improve the legal system itself. Law offers balanced solutions to the use of ICT in areas such as Intellectual Property Rights, privacy, and security. New technological solutions offer services such electronic signature, e-Commerce, e-Governance and e-Democracy, and at the same time introduce new legal issues. These are also studied in the use of ICT in the legal system and law in ICT.

ICT and Law is thus a vital discipline. There is need for training and education and the sharing of expertise, experience, teaching and learning, and best practice. This need is to be found across Europe. But training and education available in this area are limited, and the sharing of best practices and experience and expertise is not widely practiced. One reason for this is the scarcity of experts in the field. Another reason is that the field itself is not yet mature and needs to be defined.

The LAW&ICT Shared Virtual Campus objectives are: 1) to teach the topics in a broad perspective (at all university levels of teaching), using the possibilities offered by the virtual campus, 2) to create an interdisciplinary team of both technological and law specialists, and 3) to train a number of students to research and to develop the knowledge about these matters in their own country and share that information with other students of other countries, developing a common framework and using that knowledge to create courses to be followed using on site and e-Learning for citizens interested in this matter. This will help to the community to achieve one of the goals focused upon in Lisbon: making the EU the most competitive knowledge-based economy.

Also, an initiative like this will reinforce the role of universities in facilitating access to "knowledge for all" by creating and disseminating knowledge and innovation to follow up the discussion by the European Heads of State at Hampton Court in October 2005. In this case this will be reinforced with a close collaboration between public and private institutions and universities and firms.

The specific aims of the project are:

1. Creation of an European Shared Virtual Campus on LAW&ICT to become:
- A developer publishing new studies and initiatives.
- A promoter of investigation, research, innovation and dissemination of results.
- An Information exchanger between experts as well as policy makers and students.
- A Campus Administrator.
- A promoter of new online courses and seminars to help decision makers to know about LAW&ICT.
- A virtual location for debate and European policy making.
- A home for editions of Newsletters to exchange knowledge and good practice.
- Support of an International LAW&ICT Library and an on-line LAW&ICT Encyclopaedia.

2. Development of:
- An international Bachelor Degree in ICT and Law (LAW&ICT Degree): 180-240 ECTS
- An international Masters Degree in ICT and Law (LAW&ICT Master): 60-120 ECTS
- An international Lifelong Learning Program in ICT and Law: 2 to 4 ECTS Modules

3. Identification of good practices:
- in the teaching of the legal framework for ICT issues in Europe through the exchange of national and particular experiences;
- in the teaching of the application of ICT to juridical aspects of society.

4. Creation of a network of experts in LAW&ICT all over Europe to share the knowledge and disseminate the results and experiences. The network is envisaged to become bigger and to be periodically updated and improved. It is devised to

be a meeting place and a resource centre for experts. This network will be the motor of the LEFIS Network.

Figure 2: The LAW&ICT Shared Virtual Campus main Webpage.

3 THE VIRTUAL CAMPUS SCHEMA

The LAW&ICT Shared Virtual Campus has the following schema:

- Education system: Blended learning with e-learning and on site courses and seminars.
- Learning materials: Multilingual International LAW&ICT Library and on-line LAW&ICT Encyclopaedia.
- Quality: The objective will be excellence in all the project outputs.

3.1 Education System

The design and development of LAW&ICT modules is guided by the social constructionist pedagogy. This pedagogy consists in the contrasts of the contents of the teaching with other prior knowledge and culture. It accepts that there is more interpretation going on than a transfer of information from one brain to another.

The today basic content of the educational system that constitutes the LAW&ICT Shared Virtual Campus is integrated for:

1.- The learning that the participant Universities impart in their ordinary teaching with the help of the learning technical resources that they use, in general the Moodle system, and

2.- The foreseen learning to teach jointly as an initial content of the LAW&ICT Shared Virtual Campus

The imparted learning at the present time is constituted by 39 modules/courses on the target matters of the Virtual Campus: LAW&ICT.

The 39 modules/courses can be studied in blended format, in the characteristic languages of the participant Universities or in English.

The list of courses is collected in: http://www.lefis.org/app/vcampus/Management/progress_report/courses.pdf

We present in the next paragraphs the current distribution of the offered modules attending to the language, the number of courses and the name of the responsible University of their learning:

−Finnish: three, two are responsibility of the University of Vaasa and one of the University of Lapland, Rovaniemi (both located in Finland).

−English: eighteen,

- Two are responsibility of the Polytechnic Institute of Beja (Portugal),
- Three are responsibility of the Queen's University of Belfast (United Kingdom),
- Two are responsibility of the Bahcesehir University located in Istambul(Turkey),
- One is responsibility of the University of La Laguna (Spain),
- One is responsibility of the University of Münster (Germany),
- One is responsibility of the University of Lapland, Rovaniemi (Finland),
- Two are responsibility of the University of Torun (Poland),
- Three are responsibility of the University of Vaasa (Finland),
- Two are responsibility of the University Mykolas Romeris, Vilnius (Lithuania) and
- One is responsibility of the University of Zaragoza (Spain)

−German: two, responsibility of the University of Münster (Germany).

−Lithuanian: two, responsibility of the University Mykolas Romeris of Vilnius (Lithuania).

−Polish: one, responsibility of the University of Torun (Poland).

−Portuguese: three, responsibility of the Polytechnic Institute of Beja (Portugal).

−Spanish: eight, five responsibility of the University of Zaragoza, two responsibility of the University of La Laguna (both in Spain) and one of the Polytechnic Institute of Beja (Portugal).

−Swedish: two, responsibility of the University of Vaasa (Finland).

The courses are imparted preferably at graduate level, other courses are proposed for the foreseen studies of postgraduate and graduate degree that the Universities plan to impart jointly as soon as possible. There are several initiatives that propose the joint use by the students of the different Universities the offer of the network partners.

The initial foreseen joint offer of postgraduate level in e learning modality is constituted by the LEFIS Master, title recognized by the University of Zaragoza and the LEFIS Diplomas (six in total) and Courses of Specialization.

The educational load of the Master is constituted by 60 ECTS, 30 ECTS is the load of the Diplomas and 5-6 ECTS the load of the Courses. The registration for this offer is open.

3.2 Learning Materials

The learning materials are constituted by the own contents of each module and those that form part of the LAW&ICT digital Library and the LAW&ICT Encyclopedia.

All the materials are integrated by several kind or resources (handbooks, presentations, papers, exercises, links...) developed by the responsible teachers. Another part has been elaborated by the LEFIS network along their activities period, (from 2003) thanks to the realization of seminars and conferences and the elaboration of books: especially the volumes that integrate the LEFIS Series (six until this moment: http://puz.unizar.es/catalogo/colecciones_libros.php?coleccion=40).

3.3 Quality

A Committee of Approval of the courses and Insurance of the Quality, integrated by five representatives of the participant Universities and two external auditors, veil for: the new courses proposal and elaboration process, the approval of the courses, and the permanent guarantee of quality of the imparted courses.

Members of government organizations and companies are invited to participate in the activities of the Committee.

4 THE INFORMATION TOOLS

The LAW&ICT Shared Virtual Campus relies on a set of information tools to ensure a highly relevant and precise transfer of knowledge among their actors.

In order to ensure maximum customization and interoperability and also to provide the best transfer potential of the project to both developed and developing countries, only free open source software has been used (Figure 3).

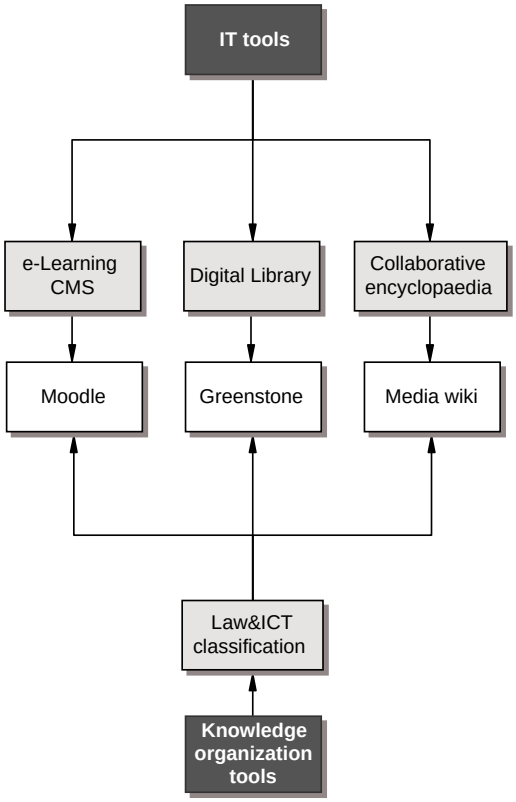

Figure 3: A sketch of the system architecture.

The information system is composed of three different functional and technological environments.

The first environment is an e-learning content management system to provide basic and advanced electronic learning features, which is built on Moodle, well-known open software for digital learning environments. One of the reasons to choose Moodle was that most of the partner Universities uses this Learning Management System.

The second environment is the digital library, whose aim is storing all the media that is or can be useful for the e-learning community and can be stored or pointed to. The digital library is built on the popular digital libraries software Greenstone.

Finally, the third component is a collaborative environment with version control —that is to say, a Wiki— to provide for the development of a shared conceptual and terminological network, available in all the languages of the virtual campus participants.

The three system components share a common knowledge organization tool —the LEFIS Law & ICT Classification—, whose aim is to provided a common classification and systematic retrieval tool for the LEFIS community.

4.1 The Content Management System

The Moodle platform is used to manage the creation, management and use of all the digital campus courses. The pedagogical and learning material design approaches are described in section 3.

4.2. The LAW&ICT Digital Library

Though from their very beginning very different views and models of digital libraries have existed (Borgman, 1999; Dabello, Saracevic et al., 2004); nowadays, they are the unavoidable platform to provide just-in-time high-quality user-focused, precise and exhaustive multimedia materials.

The LAW&ICT Digital Library aim is publishing and making available multimedia documents on LAW&ICT, ensuring all the bibliographic control features available in a library and also the immediate online availability of the materials.

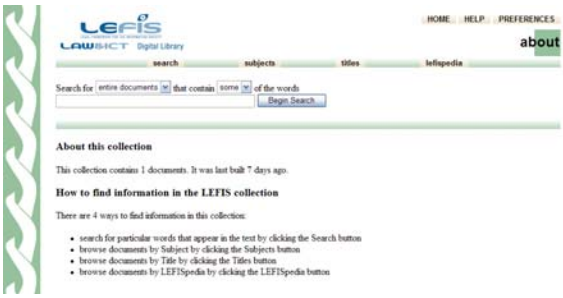

Figure 4: The LAW&ICT Digital Library main Webpage.

The LAW&ICT Digital Library is implemented on Greenstone, a suite of software for building and distributing digital library collections produced by the New Zealand Digital Library Project at the University of Waikato, and developed and distributed in cooperation with UNESCO and the Human Info NGO. Greenstone allows for Dublin Core metadata cataloguing and standardized storing formats.

The library is including all kind of relevant multimedia material —printed, audio, still images, video, multimedia—. It is accepting relevant published works —academic, professional, legislation, jurisprudence— and also related grey literature, publishing free materials with author permission or redirecting to copyrighted materials.

One of the main subprojects is the online republishing of out-of-print materials with copyright recovered by authors in the LEFIS digital series.

4.3 The Collaborative Environment: LEFISpedia

Another column of the LEFIS virtual campus is the online encyclopaedia. Online collaborative encyclopaedias follow the remarkable success of Wikipedia, and is being more a more envisioned and used in specialized contexts (v. g. Giustini, 2006) and, of course, legal education (Noveck, 2007).

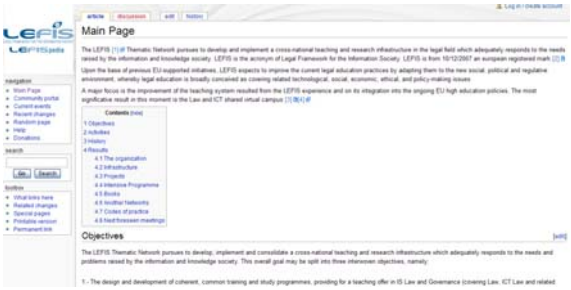

Figure 5: The LAW&ICT Encyclopaedia (LEFISpedia) main Webpage.

Advancing in this direction, the LAW&ICT Encyclopaedia (LEFISpedia) is a moderated and supervised scientific multilingual collaborative dictionary on LAW&ICT with a strong concept tree and hypertext functionalities.

LEFISpedia is implemented on Mediawiki, the engine supporting Wikipedia, the famous and popular Internet encyclopaedia.

The LAW&ICT Encyclopaedia will have ISSN to encourage and recognize participation. Regarding motivation, it is considered to be important for senior scientists to participate in any successful online encyclopaedia, as it has a serious chance to become one of the best and most consulted reference tools in the area. On the other side, junior and postgraduate researchers can quickly gain visibility and recognition by participating in such a project.

The editorial organization is formed by a scientific editor, a technical director, a panel of subject editors -forming together the scientific council- and reviewers, which in the future will be differentiated in an editors' panel and a reviewing one.

It is being considered to hire assistant editors to include previous definitions by important and relevant authors, from works with free copyright or gaining permission from authors or editors (with proper recognition). Assistant editors would be responsible for interlinking entries among them and

with other external documents. Copyright recognition is, of course, considered a key quality topic.

All the authors must be identified. They can be either self-appointed candidates, nominated by any person or body, or invited by any member of the scientific council. Their participation is subjected to approval by the scientific council.

The LAW&ICT Encyclopaedia will be open to public participation using forums and comments with standard netiquette.

4.4 The LAW&ICT LEFIS Classification: A Common Architecture for IR

The LAW&ICT LEFIS classification is aimed at providing a shared systematic conceptual mainframe for the virtual campus. Therefore, it is being used both at the courses, the digital library and the Wikipedia.

It is a faceted (Ranganathan, 1967) and expandable classification that has currently 75 classes. The classification is based on a methodology of faceting concepts for applied social science domains that has been developed in previous projects (García, Galindo, Lasala y Yubero, 2005; García, in press).

It has six trees addressing domains (society, rights and duties, commerce, and government), procedures and tools (politic, legal, managerial, educational, technological and research-oriented), agents (generic and individuals), perspective (discipline, ideology), frame (space and time), and form and media (language, form, media and type of document).

Each document is indexed for eleven facets and subfacets: domain, procedures, actors, perspective, time, place, multinational, national, spatial scope, language, form, media, and type of document. The order of the facets produces the citation index or ordering string for the document. It is possible to assign more than one term in each facet, though one has to function as main one for classificatory purposes.

5 THE IDENTIFICATION SYSTEM

One of the problems risen when designing the technical solution for the LAW&ICT Shared Virtual Campus Website was the way that users with privileges to access to some of the information and functionalities (mainly teachers and students) would be identified, remaining a part of the contents for public access.

Because of the previous works, the research group already had developed an identification module based on digital certificates to substitute the identification mechanism of Moodle based on the pair user-password, as well as a Public Key Infrastructure (LEFIS-PKI), based on open standards (X.509, SSL, S/MIME), to manage the provision and maintenance of digital certificates.

For this project, authentication module is been updated, using webservices instead of the POST/curl method, as the way to access the AuthMgr PKI system of the LAW&ICT Shared Virtual Campus Website.

Also, we want to extend the identification by means of digital certificate to limit the access to a private part of the LAW&ICT Digital Library. To this end, a wrapper for redirecting certified user to the resources in the digital library is been developed, this is to say, an authentication module to integrate LEFIS-PKI and Greenstone, in the same way as LEFIS-PKI and Moodle are.

The third tool, LEFISpedia, remains free access for everybody searching information about Law and ICT.

6 CONCLUSIONS

Development and innovation is being carried out in the integration of e-learning, wiki, digital libraries and PKI software to provide an integrated environment for knowledge representation, organization and sharing in the field of Law and Information and Communication Technologies.

ACKNOWLEDGEMENTS

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DISTANCE LEARNING WITH HIGH-DEFINITION LOW LATENCY VIDEO AND MULTI-MEDIA INFRASTRUCTURE

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Keywords: Optical Networks, High definition, Distance learning, High performance computing.

Abstract: Although distance learning has a history that spans many decades, the full opportunity that is implicit in its exploitation has not been fully realized due to combination of factors including disparate experience between it and its classroom counterpart. However current and emerging technologies are helping overcome this barrier by providing significantly better interaction among the individual participants, thereby opening new avenues for knowledge dissemination. LSU in collaboration with five other institutions has developed effective methods that greatly extend the educational opportunities through combination of advanced technologies and educational methodologies. LSU and its partners have tested these technologies in real-time over the last two years. While further improvements are needed, this activity represents the current state of the art in technologies utilized and the quality of content and experience delivered. The distance learning initiative undertaken by LSU and its partners is driven by a vision for education, which aims to deliver expert & top-quality educational content to locations irrespective of their economic or technological limitations.

1 INTRODUCTION

Distance learning is as effective as the means to emulate the local classroom experience is successful. The motivation to realize the potential of distance learning is to address critical challenges being imposed by the realities of economics, demographics, cultural diversity, and the rapidly increasing wealth of possible topics and specialties. Of particular importance to the work undertaken by the authors represented in this paper is the opportunity to dramatically increase the choice of educational pursuit by students independent of geography, financial circumstances, and stature of the educational facility. Only by aggressively addressing this challenge of choice can the full potential of every student be realized for the benefit of themselves and society as a whole.

Although distance learning has a history that spans many decades through continuing education programs and more than two decades through low grade video, the full opportunity that is implicit in its exploitation has not been fully realized because of disparate experience between it and its classroom counterpart. Recent advances in high definition digital video over Internet have opened new vistas in the quality of the distance learning experience with advances in both visual quality and narrowing of round trip latency for realistic dialog. As will be discussed in the next section of this paper, a transformative change in the future of higher education may be achieved through the effective use of a combination of these and other technologies for a synthesis of the distributed teaching and learning experience.

Louisiana State University in collaboration with five other institutions has undertaken an important experimental program in distance learning to develop effective methods greatly extending educational opportunity through the combination of

advanced technologies and educational methodologies. Specifically, LSU has employed a range of real time video qualities including the use of uncompressed high definition for low latency over long distances in real time. It has combined this with an active web site for a multitude of material dissemination techniques including on-demand video download to provide a viable and effective educational experience that rivals that of local classroom teaching. To exercise these technologies and methods in a real world distance learning setting, LSU has developed a new first-year graduate course: "*High Performance Computing: Models, Methods, and Means*" which is intended as an introductory treatment of the multi-subdisciplinary area of high performance computing for the largest diversity of student interests. This course was also opened to advanced undergraduates as the prerequisites were minimized for maximum participation. This course was received in real time by four other campuses for each of two cycles in the Spring of 2007 and 2008.

The purpose of this paper is to present the methods employed, the resulting experiences, and the advances still required to fully achieve the dream of the promise of distance learning as a mainstream strategy. The next section of this paper discusses the details of this promise that provides the long-term motivation of our work and its importance to the future of college education in the US. Section 3 provides an overview of CSC-7600, the computer science course developed in part to develop the methods used in conjunction with the advanced distance learning technologies. Section 4 provides a comprehensive description of the array of technologies and their synthesis used for this experiment. Section 5 then describes the strengths and weaknesses experiences from the perspective of the educational process. Finally, Section 6 briefly discusses additional extensions to the techniques employed that are being pursued to improve the overall educational experience in response to our initial results. This work has been funded in part by the National Science Foundation (NSF) and by the LSU Center for Computation and Technology (LSU-CCT).

2 VISION FOR DISTANCE LEARNING

The role of distance learning combined with the advanced technologies and methodologies that enable it will have a transformative impact on how higher education is accomplished in the 21st Century. In the US diversity in demographics, geographical economics, and the effects of world competition is challenging effective delivery of quality education, especially in rapidly changing Science, Technology, Engineering, & Mathematics disciplines, including computer science and engineering. Such fields demand expertise and experience in a diversity of sub disciplines for effective education at the college level. These areas are in constant change and require faculty who are actively participating in related research to remain current. Unfortunately, these specialties are under-represented or entirely absent at many or even a majority of US universities and smaller colleges. As a consequence, students at these otherwise fine institutions are deprived the opportunity to benefit intellectually in these areas. While many such students may not ultimately undertake such studies in any case, they are deprived the fundamental opportunity of choice. At a time when many young students are still in a stage of personal development, being deprived of such choice predetermines that outcome of their potential evolution and overly constrains the promise of their professional potential.

A second critical factor is the cost of education. This cost includes the development of new courses as well as those advanced courses which must be constantly updated. In recent years, the cost of a student-seat-hour has skyrocketed in the US only partially offset by increased student tuition raises. Even these increased tuitions can prove a severe inhibitor to economically challenged students in their choice of college or even whether or not they undertake higher education at all. While many factors contributed to these escalating costs, one major factor is the significant increase in the salaries of faculty in fields for which there is a strong industrial competition. High technology and applied science fields are among these.

The application of advanced digital multimedia, communication, and computer technologies may alleviate and even transform higher education through distance learning. When combined with innovative methodologies of teaching, these emerging technologies may deliver:

- Higher quality education by making courses available from national experts in specialized fields, and investing more resources in to the development of each such course,

- Lower cost by amortizing the course development across a wider range of institutions and students,
- Greater choice for students in pursuit of the professional and personal growth through access of the widest possible number of excellent courses being delivered at their local institution, and
- Increase the number of highly specialized courses by amortizing such courses over an aggregate student body distributed across a large number of institutions.

This last opportunity is a subtle but important one. Often a course, which could be taught, is not because enrolment is too few. Although the material may important, the desire of the professor to teach it is high, and the interest of the few students who sign up also high the economics simply cannot permit the realization of such a course. The exploitation of distance learning may create a distributed student body of sufficient capacity to justify teaching a course and bringing new diversity and quality to education. Ultimately all of these factors provide unprecedented choice for students of the widest variation in circumstances. This may be true internationally as well with technologies spanning national boundaries and language barriers reduced through a worldwide community.

To achieve the promise of this vision for freedom of choice and opportunity in higher education, advanced technologies and pedagogical methodologies have to satisfy key requirements:

- Point to point high bandwidth digital communication that is real-time, reliable, stable, and bounded in cost for practical application,
- Broadcast capability n-way to n-way,
- High definition video streaming,
- Low latency video and audio for real-time dynamic interaction,
- Active web site for access to all course information and materials including but not limited to course slides, schedules, problem sets, reference materials, tutorial notes, homework solutions, and wikis for frequently asked questions,
- On-demand downloadable videos of lectures and recitation sections,
- Self-tests and quizzes for frequent evaluation of progress,
- Back channel communication for set up and management of networked sites, as well as continuation of lectures with degraded resources, and
- High quality course material crafted with the recognition of the strengths and limitations of the media being used.

The remainder of this paper describes the methods and experience of one consortium of universities to address these challenges for a new graduate course in high performance computing provided in high definition video among multiple campuses in the US and one in Europe.

3 HIGH PERFORMANCE COMPUTING COURSE MATERIAL

LSU has developed a new course with the express purpose of teaching it via distance learning using the advanced technologies described in the next section. CSC-7600 – High Performance Computing: *Models Methods and Means* – has been offered as a first year graduate course and advanced undergraduate course. It has been so structured to serve four key professional goals including:

1. Computational sciences – for students who wish to focus on other fields that require the use of high performance computing as a tool to achieve the goals of the science or engineering discipline being pursued,
2. Research in Computer Systems – for doctoral students in electrical engineering and computer science who wish to conduct research in this and related fields of study,
3. Hardware & Software Developers – for future engineers pursuing positions in industry involved in the design of hardware or software systems associated with HPC, and
4. Systems Operations – for future managers and administrators of supercomputers and their centers.

Because of the diversity of professional goals and disciplines from which participating students may come, this course required a minimum of

prerequisites including: user familiarity with a Unix-like environment (e.g., Linux) and programming experience with the C programming language. Wavers were provided in most cases for those without C background but with experience with other comparable languages such as Fortran. No text book was used but reference material from a number of sources (Sterling, 2003; Gropp, 1994; Chandra, 2001; Hennessy & Patterson, 2003; Galvin, Gagne & Silberschatz, 2005) was made available through the course web site, some of which was developed expressly for the course. All lectures were taught using slides in electronic form. These were developed using Microsoft PowerPoint and disseminated via the web site in .ppt and .pdf formats. The availability of slides downloaded to remote sites early was a risk mitigation factor that allowed the lecture to proceed even if the video link was disrupted by using the back channel conference call channel. It also allowed a higher quality remote presentation of slides that was achieved through live video capture and distribution of the same visual material. Live demonstrations were done this way, however that was not always sufficient for the purpose.

The one-semester curriculum was taught over a fifteen week period including exams and holidays and comprised six major parts:

A. Introduction and Throughput Computing
B. Clusters and Message Passing
C. Shared Memory Processing
D. Parallel Algorithms and programming techniques
E. Operating Systems
F. Visualization and Advanced Tools

The course partitions the concept space for HPC into three classes of parallel processing, two of which are commonly referred to and a third essential to a correct representation as it relates to scalability, programming models, and system architectures. The cross cutting theme is performance and throughout the course performance implications are examined as well as skills are developed using tools for evaluating performance. The first part explores the simple but important form of capacity or throughput computing that exploits concurrent work stream of independent and unrelated user jobs. The class of architecture employed for this is a workstation farm and loosely couple clusters. Condor is taught as a framework for controlling this ultra coarse grain parallelism and simple means of measuring performance are introduced. Weak scalability is employed to increase performance by increasing the number of jobs as the system size is increased.

The second part provides in-depth coverage of the very important message-passing execution model used with commodity clusters and MPPs and programmed with MPI. Collaborative computing is offered the domain of weak scaling that applies multiple processing elements to a single parallel task. As the system scale is increased, so is the size of the application problem yielding more work to do and maintaining a constant level of granularity. The third part covers the most difficult form of HPC, capability computing in which a single problem of fixed size is able to reduce its time to execution through increased system scale. OpenMP is used on a shared memory system to represent capability computing and provide a programming model.

The fourth part is dedicated to reinforcing the lessons of the previous three by investing substantial time in additional programming experiences for different classes of problem algorithms. The use of instrumentation tools such as Tau and PAPI are developed to measure performance improvements and evaluate effective scalability. The course considers four sources of performance degradation including overhead, latency, contention, and starvation and shows how they may be addressed through different techniques.

The fifth and sixth parts focus on system software and methods for using supercomputers to practical advantage. This includes the important domain of scientific visualization for conveying the meaning of the resulting data to the end user. The course included hands-on experience through examples, exercises, and projects using a cluster of SMP nodes dedicated to the course.

4 ENABLING TECHNOLOGIES FOR DISTANCE LEARNING

Technology is the key component to enable teaching and distribution of course materials without any geographical barriers. The HPC course was distributed to different sites using different technology methods for each site. The technology method used were uncompressed HD streaming, compressed HD streaming using a Polycom HD device, Access Grid and SD streaming using Ncast stream engine. The type of technology used at each site was determined based on the available resources at that site.

Table 1: Distance learning technologies used by different participating sites.

Media Format	Sites
Uncompressed HD Video (Ultragrid)	Masaryk University, Brno, Czech Republic
Compressed HD Video (Polycom)	University of Arkansas – Fayetteville, Arkansas
Access Grid	Louisiana Tech University – Ruston University of Arkansas – Little Rock, Arkansas
Web streaming (NCast)	Back up option and also used for recording of lectures to enable post reviewing for students

- **Uncompressed HD video streaming:** This technology was used to stream uncompressed HD video of the HPC course to Masaryk University, Brno, Czech Republic over a private 10Gb optical network using a open source application called Ultra-grid. Each HD stream is 1.5Gbps. Multiple optical networks had to bridge connections and make allocations to make the communication happen between LSU and Masaryk University over 10Gb optical network. The network partners were Louisiana Optical Network Initiative (LONI), National Lamda Rail (NLR), StarLIght and CESNET.
  Two high-end workstations one to send and the other to receive video were deployed at both sites. The sender workstation consists of video capture components and a 10Gb network interface. The receiver workstation consists of an Nvidia graphics card with a DVI out that is capable of displaying HD resolution (1920x1080) and a 10Gb network interface. A HD camera and a HD display device (LCD or Plasma screen) were deployed at both locations to capture and display video respectively.
  The HD camera was used to capture the video at each location and fed the capture device on the sender workstation. Ultra-grid application then sent the captured video over 10Gb network to the recipient site. The receiver workstation at each site received network stream and Ultra-grid displayed the far site video on the HD display at each site. A different application called Robust Audio Tool (RAT) was used to send audio over the same network.

  Pros: The video quality was extremely sharp with almost no latency. The output resolution was 1080i. The interaction was very good in this technique.

  Cons: Deployment of this technique was very expensive, bandwidth intensive and involves lot of manual intervention throughout the session. The equipment costs a lot and the charges for the network bandwidth usage are extremely high. Not all sites have 10Gb network access to participate using such a technique and even then the site has to purchase the workstations, capture cards, etc, which are expensive. Even after making such an investment, they can only collaborate with another site that had all these and a 10Gb network, which is very uncommon.

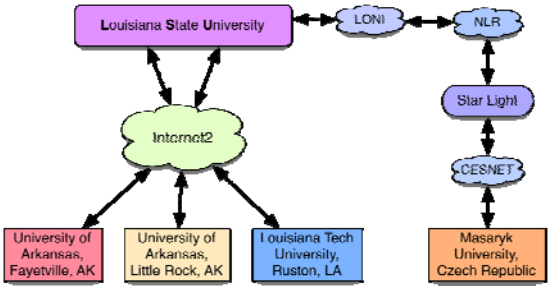

Figure 1: The different interconnection technologies used in the distance learning experience.

- **Compressed HD streaming:** This technique was used to stream compressed HD audio/video to University of Arkansas at Fayetteville. A Polycom HDX 9000 unit was deployed at both the locations. This is boxed product that works well and the stream is sent on commercial Internet. At LSU, the same video captured on the HD camera (used for the uncompressed technique) was fed in to the Polycom unit and the audio was picked from the room mixer/echo canceller. University of Arkansas has a HD video camera that fed the video to the Polycom unit and the audio from the room mixer. Both sites had HD LCD screens to display the far sites.

  Pros: Video quality was good with a little latency. The output resolution is 720p. Very low bandwidth utilization of less than 1Mbps, that is affordable at all sites. The device can talk to non-HD Polycom or any H323 unit.

  Cons: The unit is expensive as it is a commercial solution.

- **Access Grid:** Access Grid is an open source application developed to enable collaboration of research universities. This application is

available at many universities and simply uses low cost capture cards, cameras and PCs to capture send and receive video to/from far sites. This technology was used to stream to University of Arkansas at Little Rock, Arkansas and Louisiana Tech University at Ruston, Louisiana.

Pros: Very easy to setup and the application is free. Anyone can install the AG on a PC and participate in the class

Cons: Video quality was not very good as the resolution is very low. There is a little latency. Students cannot feel the interaction as opposed to other techniques above. Application is very unreliable.

- **Webstreaming:** A boxed product called NCast was used to send the video stream live over the internet. Users can access it via a browser or quicktime video. Also the same video is recorded to enable on demand access to the lectures. This feature was very popular as students accessed the videos numerous times. This technique also served as backup plan if AG does not work

  Pros: On demand access and very basic requirements to access the video

  Cons: Huge latency. Not suitable for interactive sessions mainly due to latency factors.

5 EDUCATIONAL EXPERIENCE AND DISTANCE LEARNING

In its first offering, this course involved more students than any other computer science graduate course presented that semester. In its second offering, it received the highest student evaluations of any graduate course of the computer science depart in its semester. For this accomplishment, the professor was awarded the Graduate Teaching Award for his College in 2007.

Student and Faculty Perceptions. Technical application is only one facet explored in the presentation of the course. A study was conducted through the first iteration in order to ascertain student response to the various technical aspects that were used during the class. This study was designed to demonstrate both the strengths of using multiple technologies to foster interaction as well as the weaknesses proctored by trying to combine these technologies as well as human factors and have them mesh together seamlessly.

The study itself consisted of a combination of anonymous surveys, journal entries and discussions with the instructors as well as proctors from the various remote sites. In order to maintain continuity, only sites that made use of all of the various technical applications participated in the study. This included two remote sites: the University of Arkansas and a satellite location on the campus of Louisiana State University, as well as the local site at LSU. The overall population comprised 38 participants: 16 (42.10%) attending the class from a remote site and 22 (57.89%) attending from the local site.

Students who participated in the anonymous survey revealed correlations between three distinct areas of interaction and the technological aspects of the course. Dependent on the strength of the technology at the various sites, students demonstrated a greater sense of interaction between themselves and the other sites as well as with the host site. These correlations offer keys to the technical areas that need the most work to best engage every student.

Video Quality and Interaction. The technology that had the most positive impact on student interaction was the uncompressed video. Every student participating in the course either agreed or strongly agreed that they were able to clearly see the professor. Considering that current research suggests that video clarity is paramount in maintaining student attention as well as retention in a distance-based course the use of the uncompressed high definition video offered students the ability to engage the professor as well as the other sites visually (Coventry, 1998; Fillion, Limayem, & Bouchard, 1999; Pitcher, Davidson, & Napier, 2000).

According to journals kept by the proctors at the individual sites, while video quality offered a numerous amount of tweaks and readjusts throughout the course, it more often than not remained running and smooth once initiated. As a result, any problems that may have been encountered in regards to networking, camera issues, and the like were often not experienced by the student considering the amount of setup time allotted to the course before it was presented each class day.

Table 2: Remote Site Students Opinion of Interactivity Key: 1 – Strongly Disagree | 2 – Somewhat Disagree | 3 – Not sure | 4 – Somewhat Agree | 5- Strongly Agree.

	N	Min	Max	Mean	Std. Dev.
I could hear the professor clearly.	19	1	5	3.63	1.342
I could see the professor clearly.	19	4	5	4.63	.496
The audio/video quality did not distract me from the course material.	19	1	5	3.47	1.124
I made use of the video archives outside of class.	19	1	5	3.26	1.661
I felt comfortable asking questions during class.	19	1	5	2.47	1.389
I felt like I could interact with people from other institutions.	19	1	4	2.11	1.100

Audio Quality and Interaction. Where video problems were not perceived within the course, audio problems abounded and offered a significant deterrent to student interaction. According to Frater, Arnold, & Vahedian, (2001) as well as Tan & Tan (2006), audio quality stands out as the most important technology within a synchronous distance-learning environment to maintaining the ability of students to interact with the professor and remote sites (Frater, Arnold, & Vahedian, 2001; Tan & Tan, 2006). According to follow up comments offered by students the audio often distracted them from the material and was the technology that needed to improve the most. The survey also demonstrated a positive correlation between audio quality and the students' perception of their ability to interact with both the host site as well as the remote sites.

According to proctor journals, much of the audio problems stemmed from the varying types of equipment being used. While every site made use of the Robust Audio Tool to send and receive audio, each site used their own mixers, microphones, speakers, echo-cancelling equipment, etc. to process the audio being sent and received. In synchronous distance-learning situations, if one site is sending bad audio then it often propagates to all the sites. For example, there was often a problem when one site's echo cancelling was faulty. All other sites would then have to either mute the offending site or continue while hearing their own voices sent back to them often to the point of complete distraction.

Asyncronous Technologies. Asynchronous technologies were often called upon to provide a firm brace to class. Whenever there were issues in the live class offerings, online videos were provided to allow for the continuity of learning. One of the more interesting developments demonstrated from the student surveys was the fact that more local students regularly viewed the archived videos than the remote students. Those who did view the videos both locally as well as remotely commented that they used the videos for study guides and to assist in the assimilation of the entirety of knowledge given throughout class. More important to the idea of interactivity, there was a positive correlation demonstrated between students who viewed the videos and the perceived ability to interact and ask questions during class.

6 CONCLUSIONS

Table 3: Local Site Students Opinion of Interactivity Key: 1 – Strongly Disagree | 2 – Somewhat Disagree | 3 – Not sure | 4 – Somewhat Agree | 5- Strongly Agree.

	N	Min	Max	Mean	Std. Dev.
I could hear the professor clearly.	19	4	5	4.74	.452
I could see the professor clearly.	19	4	5	4.95	.229
The audio/video quality did not distract me from the course material.	19	2	5	3.89	1.05
I made use of the video archives outside of class.	19	4	5	4.68	.478
I felt comfortable asking questions during class.	19	1	5	3.16	1.39
I felt like I could interact with people from other institutions.	19	1	5	2.79	1.13

Distance Learning is fundamentally important in furthering knowledge across man-made limitations. Based on our experience, using the latest technologies it is possible to enable distance learning across wide range of partners irrespective of the local technological constraints. The tried and tested methodologies developed by LSU and its partners, verify the fact that using the technologies such as optical networking, compressed HD via polycom, live streaming via web, can be effectively utilized (measured by student experience surveys) to deliver

highly involved – technical content across geographical boundaries. Furthermore through offline (non-live) mediums such as podcasts and on-demand web streaming (of recorded material), the educational content can be disseminated to a wider audience; more importantly reaching the end users who do not have access the state-of-the-art technologies. While a lot more needs and can be done, this work demonstrates the critical strides taken by LSU and its partners in developing the essential elements and methodologies to deliver expert content to remote sites irrespective of capability limitations.

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XML-BASED COURSE SYLLABI
An Electronic Implementation of the CDIO Syllabus

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Keywords: XML, Syllabus, CDIO, Open courseware, LMS, Learning objectives.

Abstract: A syllabus forms the structure of a course (or program) offering and is used to assemble its constituents. Course websites and LMS's, also contain similar information, and in some sense, are quite similar to course outlines or syllabi, and replicate some of the information that can also be found in administrative websites of universities. From a system perspective, this duplication and dispersion of information can be a source of confusion and hinder the set-up of an integrated workflow approach to manage all the course information for visualisation or reporting purposes.

Course outlines or syllabi, whatever the support used for distribution, are essentially "paper" documents that are most often created using word processors or limited web forms in course management systems. Currently, there is no accepted standard format for representing syllabi that could facilitate automatic production or processing of their contents.

In this paper, we present a model for a specialized tool to create, edit and publish course syllabi that can be used alongside LMS's and other administrative environments. The proposed prototype is based on XML to semantically tag the set of detailed elements of the CDIO Syllabus towards a complete and consistent implementation of an electronic syllabus. The objective is to cast the programs and course outlines into a schema, including both contents and learning outcomes, that allows the incorporation of the formulation and mechanisms for verification that the goals are fulfilled.

1 INTRODUCTION

Syllabi are a key element of university teaching. In most cases, syllabi take the form of a paper or electronic document where the key aspects of the course are described: instructor information, course material, assessment and grading, course calendar, etc. In other cases, syllabi are embedded in a course web site and can include numerous electronic resources. For students, syllabi are the most important source of course information. For university faculty and administrators, syllabi are at the center of pedagological course design and program offering.

Although universities usually provide course descriptions in online catalogs, detailed syllabi are usually not available in a centralized location (MIT OpenCourseWare is a nice exception): depending on the university, they can be found in departmental or faculty personal web pages or inside protected Learning Management Systems (LMS). When syllabi are posted in different locations, nothing guarantees that the content will be the same everywhere. When course syllabi are embedded in a course web site, the same information is often available in the HTML pages as well as in a PDF file, leading to unnecessary work for the instructor or the administrative staff. Furthermore, updates are often not synchronized and can mislead the students.

Within a department or a faculty, the course web site interfaces can be very different, adding unnecessary browsing difficulties for users in search of a very specific piece of information. The course web sites are most often designed and maintained using different software tools, adding difficulties when staff or instructors are assigned to different courses or departments. Finally, in many cases, no procedure insures

that all the course web sites are properly archived.

Either in plain web pages or embedded in a CMS, course syllabi of a faculty or a department are structured quite differently, which unnecessarily complicates the reading tasks of students. Although universities provide templates for paper course syllabi, these guidelines are not applied for the design of web based syllabi which are quite different and probably need specific interfaces more appropriate for electronic browsing. As a result, users are exposed to quite different web interfaces and some key elements like assignments due dates are displayed in different locations, not necessarily optimal from a usability perspective.

Finally, the information contained in a LMS or in a course website is often duplicated in parallel administrative systems. For reporting or administrative purposes, many universities seek specific course information like the objectives of the course, the evaluation method (assignments, exams, etc) and broad descriptions of topics covered. This is particularly the case for professional accreditation purposes, which require the formulation of learning outcomes and specification of mechanisms for verification that these goals are fulfilled. As these parallel administrative systems, when they exist, are not generally linked to course syllabi, special reports seeking precise elements of teaching and learning are not possible.

In this paper, we present a framework designed to provide a solution to these important questions, combining Open Syllabus (Gerbé and Raynauld, 2005) and the CDIO Syllabus (Crawley E.F., 2007). Open Syllabus is an electronic environment using a XML model-based approach, which aims to replace both simple traditional syllabi and more elaborate web syllabi by providing a structured approach using templates, reserved vocabulary, unified web user interface, centralized location and integration with administrative systems. The CDIO Syllabus is a comprehensive codification of knowledge, skills and attitudes which constitutes a requirements document for contemporary engineering education.

Building on the work carried out at HEC Montréal on `Zone Cours` (http://zonecours.hec.ca) and at École Polytchnique on the CDIO implementation, a methodology to structure and assemble the various elements required in an electronic syllabus or course web site is investigated.

2 THE SYLLABUS

2.1 Organization of a Course Outline

Due to their importance as the cornerstone of teaching and learning, universities provide guidelines, suggestions and even templates on the proper use of course syllabi. Numerous researchers have confirmed the central role played by syllabi. For (Parkes and Harris, 2002), syllabi serve three major roles: the syllabus as a contract, the syllabus as a permanent record and the syllabus as a learning tool, and provide a very detailed example of a course syllabus with 12 specific elements or sections. In a recent paper, (Marcis and Carr, 2004) report on a student survey about the relative importance of 23 distinct elements usually present in a course outline. Table 1 illustrates a simple mapping of the purposes of a syllabus and its associated elements.

Table 1: Mapping of the various syllabus elements into its purposes.

1. **The syllabus as a learning tool**
   - 1.1. Title and authors of textbooks and readings
   - 1.2. Course goals and objectives
   - 1.3. Course format (for example, lecture, discussion, videos, classroom activities)
   - 1.4. Attendance policy
   - 1.5. Late assignment policy
   - 1.6. Academic dishonesty policy
   - 1.7. Class participation requirements
   - 1.8. Examination and quiz dates
   - 1.9. Schedule of topics to be covered
   - 1.10. Holidays observed
   - 1.11. Amount of work (for example, amount of reading, number and length of other assignments)
2. **The syllabus as a contract**
   - 2.1. Grading procedure and policies
   - 2.2. Number of examinations and quizzes
   - 2.3. Kind of assignments (for example, readings, papers, presentations, projects)
   - 2.4. Reading material covered by each examination or quiz
   - 2.5. Type of examinations and quizzes (for example, multiple choice, essay)
3. **The syllabus as an administrative record**
   - 3.1. Instructor information (for example, name, title, office, location, phone number, e-mail address)
   - 3.2. Instructors office hours
   - 3.3. Course information (for example, course number and title, section number, credit hours)
   - 3.4. Course description
   - 3.5. Days, hours, and location of class meetings
   - 3.6. Required prerequisite coursework necessary to enroll in the course

These papers as well as the analysis of numerous course outlines (including those of the MIT Open-

CourseWare initiative) show that it is quite feasible to propose a model or a template that would incorporate most if not all the basic constituents of a course syllabus. The wording of the different elements could change across universities but, as the tables make it clear, the meaning of the different elements can be made quite precise. One can imagine the construction of a set of automatic rules that could help to translate syllabi of different universities.

3 THE CDIO INITIATIVE

3.1 The Syllabus

Four leading engineering universities[1] have proposed a new engineering education model, named CDIO (D. R. Brodeur and Ostlund, 2002). The CDIO Initiative seeks to re-emphasized the role of actual engineering practice in balance with the current engineering science model. This aims at training expert engineers who master the technical fundamentals of their field while acquiring the skills required to function in industrial enterprises, developing complex value-added engineering systems in modern team-based, multidisciplinary environments.

The learning activities are tightly integrated with the engineering process of product development around four phases: Conceiving-Designing-Implementing-Operating.

In previous papers, Ed Crawley and his colleages have developed and codified a comprehensive understanding of abilities needed by the contemporary engineer (Crawley, 2001). Known as the CDIO Syllabus, this codification is the set of knowledge, skills and attitudes expected from a graduating engineer. Initially designed as a requirements document for designing and implementing undergraduate engineering programs, it turned out to closely correlate with the criteria for accrediting engineering programs (ABET, 2000). It is consists in four high level requirements, which can be further detailled into second, third etc... levels objectives. This hierarchical breakdown makes the transition from the high level goals, to the level of course units or lectures. The depth or degree of granularity is the matter of specific curriculum for each field.

For conciseness and to maintain a generic presentation, a condensed form of the CDIO Syllabus with the 1st and 2nd levels is shown in Table 2. (Bankel J., 2005)

[1]Chalmers University of Technology, Linköping University, and the Royal Institute of Technology, in Sweden, and the Massachusetts Institute of Technology in the USA, and which have been joined by several other engineering schools throughout the world.

Figure 1: Structure of the CDIO Syllabus.

Table 2: Condensed Presentation of First Two Levels of the CDIO Syllabus.

1. TECHNICAL KNOWLEDGE AND REASONING
   - 1.1. KNOWLEDGE OF UNDERLYING SCIENCES
   - 1.2. CORE ENGINEERING FUNDAMENTAL KNOWLEDGE
   - 1.3. ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE
2. PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
   - 2.1. ENGINEERING REASONING AND PROBLEM SOLVING
   - 2.2. EXPERIMENTATION AND KNOWLEDGE DISCOVERY
   - 2.3. SYSTEM THINKING
   - 2.4. PERSONAL SKILLS AND ATTRIBUTES
   - 2.5. PROFESSIONAL SKILLS AND ATTITUDES
3. INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
   - 3.1. TEAMWORK
   - 3.2. COMMUNICATIONS
   - 3.3. COMMUNICATION IN FOREIGN LANGUAGES
4. CONCEIVING, DESIGNING, IMPLEMENTING, AND OPERATING SYSTEMS IN THE ENTERPRISE AND SOCIETAL CONTEXT
   - 4.1. EXTERNAL AND SOCIETAL CONTEXT
   - 4.2. ENTERPRISE AND BUSINESS CONTEXT
   - 4.3. CONCEIVING AND ENGINEERING SYSTEMS
   - 4.4. DESIGNING
   - 4.5. IMPLEMENTING
   - 4.6. OPERATING

3.2 Specification of Learning Outcomes

In addition to the Syllabus, where the contents are outlined, the CDIO initiative introduces the goals or learning outcomes for knowledge and skills in a systematic way. To deal with these aspects, (Bankel J., 2005) have proposed the Introduce-Teach-Utilize (ITU) concept.

Introduce(I) : topics that are introduced in the course, but not subject to examination.

Teach(T) : knowledge and skills that are taught in the course and also subject to examination.

Utilize(U) : knowledge and skills that have been acquired in previous courses and are considered to be prerequisites.

Table 3 illustrates a generic application of this concept for a course. A more thorough presentation is given

Table 3: Example of a Course Level ITU-matrix.

	SYLLABUS LEVELS										
COURSE CONTENT	**1** *1.x.x*			**2** *2.x.x*			**3** *3.x.x*			**4** *4.x.x*	
Topic 1	T			I						U	
Topic 2						T				U	
Topic 3		I									
Topic			T			U					

in (Gunnarsson S., 2007) including courses as well as entire curriculum applications.

4 THE OPEN SYLLABUS MODEL

In the spirit of (Tungare and al, 2006), who advocate the use of standardized representations, (Gerbé and Raynauld, 2009) have proposed a model, illustrated in Figure 2, that could accommodate numerous types of syllabi. The nodes are defined as follows:

- CourseOutline corresponds to the syllabus or the course outline.
- CourseStructure organizes CourseUnits.
- CourseUnit is a section of a course outline. Instructor information, Lectures calendar and General course information are examples of CourseUnit elements.
- CourseUnitStructure is a sub-section of a section. CourseUnitStructure organizes the information of a CourseUnit. For example, the lecture could be devided in two parts.
- CourseUnitContent is the key pedagogical container of all the learning resources. CourseUnitContent includes the readings, the files and the assignments typically found in a lecture.
- CourseProxyResource is a proxy that serves to qualify the use of a particular resource in a CourseUnitContent. For example, a reading could be mandatory in a course but optional in another.
- Ressource is a very low level element that corresponds to some specific learning material; for example PowerPoint files, citations, urls, text files, assignment guidelines.....

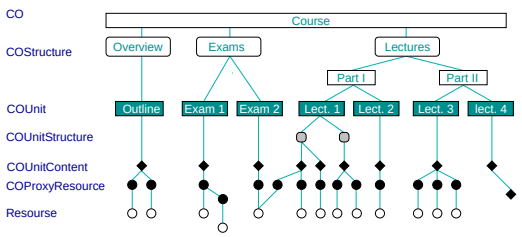

Figure 2: Structure of the Proposed Course Outline Model, adapted from (Gerbé and Raynauld, 2009).

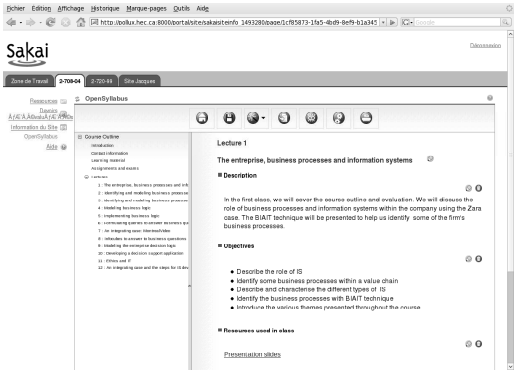

Figure 3: Page for Lecture 1.

Figure 3 illustrates the model in the context of a simple course outline created with OpenSyllabus Sakai 2.5 tool based on GoogleWebToolKit(GWT). The tree on the left displays the CoStructure elements (Introduction, Contact information, Learning material, Assignment and Exams and Lectures). There are CourseUnit elements represented by 12 different lectures. The resources in the Lecture 1 page on the right hand side panel are part of a CoUnitContent. The description is a text resource with the rubric Description put on the CoproxyResource. The objectives are also a text resource with the rubric Objectives put on the CoproxyResource. The last resource is a Power Point file with the title Presentation slides and the rubric Resources used in class put in the CoproxyResource.

The XML file corresponding to the course outline of Figure 3 is given in Figure 4. As explained before, the CoUnitContent contains a text Resource with associated CoProxyResource set to CoContentRubric Rubric=Description and some other useful properties like the security which is set to public. CDATA contains the text. This XML description is the building block for the OpenSyllabus GWT editor and can lead to very sophisticated operations for reused or display.

5 COURSE INFORMATION MANAGEMENT

5.1 LMS-XML Integration

To our knowledge, most Learning management Systems such as Moodle, do not currently offer tools or plug-ins to create and edit XML-based course outlines. Although, it quite easy to construct and display a course website that will mimic the vocabulary, the presentation and the content of Figure 3, the underlying structure cannot be manipulated since it is not

```
<COUnitContent type='lecture' scrty='public'>
<COResourceProxy type='text' scrty='public'>
<COContentRubric type='description'/>
<properties>
<visible>true</visible>

</properties>
<COResource type='text' scrty='public'>
<properties>
<text>
<![CDATA[ <P>In the first class, we will cover the
course outline and evaluation. We will discuss the
role of business processes and information systems
within the company using the Zara case. The BIAIT
technique will be presented to help us identify
some of the firm's business processes.
</P>]]>

</text>
</properties>
</COResource>
</COResourceProxy>
...
</COUnitContent>
```

Figure 4: XML code fragment for the production of the Page of Figure 3.

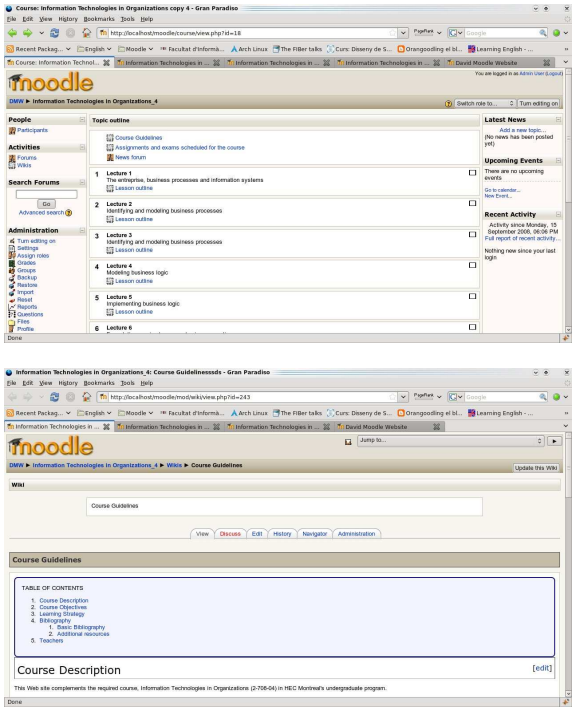

Figure 5: Moodle screen capture resulting from the import of a Open Syllabus XML file.

model-based. LMS's cannot recognize that the content underneath the title:`Objective` in that figure are indeed the learning objectives of Lecture 1.

In some preliminary work, we have explored the possibility of linking XML-based syllabi to Moodle. Figure 5 illustrates the results of a plug-in that can read an OpenSyllabus XML file similar to the one presented here. The XML file imported for that example included the description and the objectives of the course as well as the title of the different lectures and their content.

With the current prototype, the instructor can edit the resulting content but the changes will not be added to the underlying XML file. Further work is necessary to enable both import and edit/export XML capabilities in Moodle. However, the prototype opens interesting avenues concerning the integration of standardized course related content in LMS's. For example, one can imagine that official description of courses, learning objectives and university policies can be pushed to course websites in a similar fashion. It is also possible to develop and use simple XML editors (for example the GWT OpenSyllabus editor) to generate the XML file to be imported in th LMS for final use by the instructor and the students.

5.2 Reporting: Accreditation

For professional accreditation purposes, an essential fonction is to measure the program outcomes which is based on the capability to compare and assess the quality of the training given at different universities. Besides gathering specific and precise information such as the number of hours given to some particular subject matter, the ability to extract the formulation of learning objectives and outcomes of individual courses as well as of entire education programs is now becoming increasingly important. In addition, this would assist instructors in mapping course design to measurable outcomes, thus helping the process of institutional program offering. This requires to complete work on reporting standards currently in progress (Course Description Metada).

5.3 A Course Information System

A syllabus can be viewed as a collection of metadata for a course, which leads to an integrated workflow approach to manage all the course information. The development of Open Syllabus as a specialized Syllabus Editor to help create and edit syllabi will encourage adoption of such schema as the CDIO or similar codifications adapted to other fields.

Of strategic importance is the integration of a syllabus editor into course management systems so that the use of such specialized tools will be seamless from the instructor's point of view. Furthermore, linking these parallel administrative systems to course syllabi as shown in Figure 6, could aleviate repetitive work

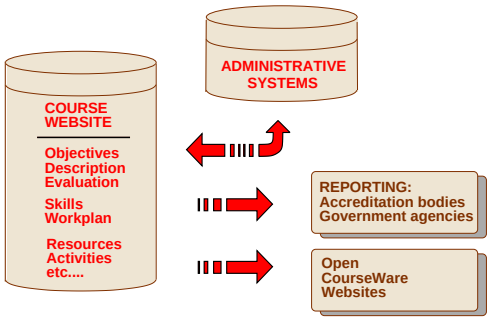

Figure 6: Overall System Architecture.

for both faculty and administrative staff, as well as avoiding many sources of errors resulting from the lack of synchronization of updates.

This integration of administrative and pedagogical systems will result in:

- faster and more accurate content search;
- enhanced sharing of syllabi and learning resources by providing export/import possibilities;
- provide a completely open gateway to the public content of all course syllabi in the spirit of the MIT OpenCourseWare project.

6 DEVELOPMENT OBJECTIVES

The lack of standardization of a semantic description of syllabi has resulted in a wide variety of formats with serious drawbacks. This paper has sketched the development of an electronic syllabus based on a XML model which semantically tags the set of detailed elements of the CDIO Syllabus. This approach is quite flexible and each university could easily parametrize the various elements of the model as well as the vocabulary used, while keeping a semantic suitable for sharing.

The authors believe that, for OpenSyllabus to have its intended impact, it needs to be integrated into the current pedagogical practices of educators and administrators. In particular, the adoption of a model-based course outline approach requires some integration with the course management systems used in different universities. In some cases, a generic GWT OpenSyllabus tool or some kind of advanced XML editor can be used directly by instructors and support staff to create, edit and publish structured syllabi. In other cases, taking advantage of its light or minimal web services architecture, the GWT OpenSyllabus client can be linked much more closely to a course management system as it is the case for an alpha prototype version of OpenSyllabus/Sakai. In other cases, the course management system itself could provide XML editing capabilities or could be modified to handle XML tagging. Whichever path chosen, an XML based approach to course outline like Open Syllabus could foster a much better integration of pedagogical information with administrative systems, providing a cost effective solution to the increasing reporting requirements from international agreements or accreditation agencies.

It can be envisionned that the availability of electronic syllabi, using an XML-based approach will make the content of a course much more reusable and open up possibilities for publication in a wide range of formats.

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AN INTELLIGENT ASSISTANT TO SUPPORT STUDENTS AND TO PREVENT THEM FROM DROPOUT

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Keywords: Non pedagogical agent, Intelligent Personal Assistant, Educational Agent, Tutor, Coach, Student support, School help, Dropout prevention.

Abstract: The research and development of an educational agent are commonly focused on the pedagogical aspect; the main objective is to automate the teaching activity, to replace the teacher in virtual learning environment. Our goal is different: it is to create a non pedagogical intelligent assistant that follows students during their learning to prevent dropout. This assistant can be compared to a coach, a motivator, or a mentor that motivates, encourages, and helps students to overcome their difficulties.

1 INTRODUCTION

Nowadays the use of Information Technology (IT) is essential in education. The development of IT in learning is one of the most important preoccupations for the future.

Our aim is to use Artificial Intelligent mechanisms as machine learning, fuzzy logic, and intelligent agents to build a personalized and autonomous virtual assistant that helps students during their learning experience. Currently the intelligent agent technology is broadly used in e-learning with a pedagogical purpose; it helps students to learn and intends to replace teachers. The aim of our approach is not to build another virtual teacher; the services of our assistant will be focused on the non pedagogical aspects of learning such as the management of motivation, stress, school orientation and task organisation. The actions of our assistant will be oriented at complementing the teacher's work.

In this article we present our concept of an assistant supporting student learning in three sections. The first section will explain the concept of educational agents, in proposing a taxonomy of educational agents. In the second section we will study the different types for student support: tutor, coach, and mentor. And the last section will focus on the architecture of our intelligent assistant.

2 A TAXONOMY OF EDUCATIONAL AGENTS

2.1 Characteristics of Educational Agent

The analysis of the taxonomy of educational agent indicates the positioning and the functionalities of our assistant. Educational agents can be considered as "Software agents" (Franklin&Graesser, 1996) and more precisely "User agents". This kind of agent is based on the concept of delegation and indirect management tasks (Sanchez, 1997); agents offer to end-users a new approach to interact with computer systems.

The Sanchez's taxonomy (Sanchez, 1997) can be extended in adding a new type of agent. The Intelligent Personal Assistant (IPA) is a sub-type of User Agents. We consider that an IPA differs from Information Agents, Task Agents or Synthetic Agents because it is more personalized and its relationships with its user are closer and durable. It can be considered as virtual companion.

The role of an IPA is to reduce the complexity and the rigidity of human-machine interactions, and to anticipate the needs of the user with some personalization capacities (Briot&Demazeau, 2001). The Foundation for Intelligent Physical Agents

(FIPA) states that *a personal assistant is like a secretary, it accomplishes routine support tasks to allow the user to concentrate on the real job, it is unobtrusive but ready when needed, rich in knowledge about user and work* (FIPA, 2000). The personal assistant will work in collaboration with the user in the same environment; the most important part of a personal assistant is the management of the user profile (Maes, 1994).

IPA can have the appearance of a simple software interface with button, textfield, list, radiobutton… Or it can be personalized with a human representation, a multimodal user interface as an Embodied Conversation Agent (ECA) that can carry a conversation with the user through the common communication modalities like speech, gestures, body stance, and facial movements.

The virtual companion, IPA represented through an ECA can be refined in various kinds depending on its purposes. It can be used for educational assistance, professional helps for complex task or entertainment. Educational agent is a specific kind of Embodied Conversation Agent (ECA) with a representation in 2D or 3D and a natural language communication capacity.

In our approach, an educational agent is a software agent, user agent, Embodied Conversation Agent and Personal Intelligent Assistant (see Fig. 1).

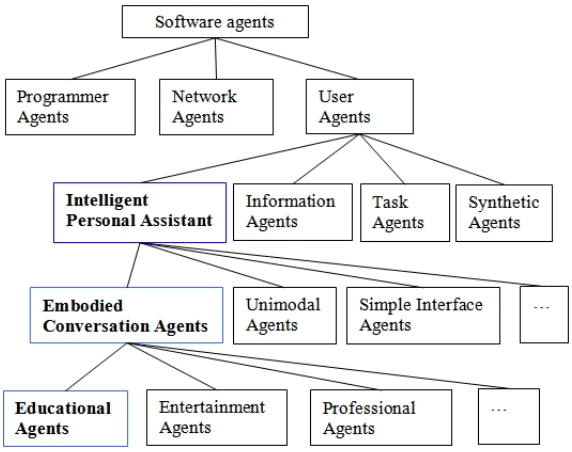

Figure 1: An extended software agents' taxonomy.

From the extended taxonomy (see Fig. 1), we can determine the common and essential capabilities of educational agents as it inherits the properties and capabilities of Intelligent Personal Assistant and Embodied Conversation Agents.

Capacities of Intelligent Personal Assistant (Maes, 2003), (Sanchez, 1997):

- To assist a user to perform task so it can hide the complexity
- To have a certain degree of reasoning and autonomy; user can delegate some tasks to the agent.
- To manage the user model and the domain model
- To learn the user's interests, goals and preferences from the interaction of the user with the IT system or with the intelligent assistant. This capacity is the most important and it is essential for personalization.

Capacities of Embodied Conversation Agent (Cassel et al., 2000):

- To recognize and respond to verbal and nonverbal input
- To generate verbal and nonverbal output
- To deal with conversational functions such as turn taking, feedback and repair mechanisms
- To give signals that indicate the state of the conversation and contribute new propositions to the discourse

The design of an educational agent has to include at least all of the previous capacities. In the next part we will explore the capacities of different kinds of educational agents.

2.2 Different Types of Educational Agents

In the education field, the use of intelligent agents can increase the attention of the student and make the learning more attractive. An Intelligent Personal Assistant should be a key success factor for online learning tools. Experiments conducted in California's university (Baylor, 2003) showed that the use of pedagogical agents motivate students and facilitate the learning. Usually, the educational agents have a pedagogical goal, their presence is supposed to replace the teacher in an e-learning environment.

(Chou et al., 2003) highlight two types of educational agents and place them into two categories:

- pedagogical agents involved in learning activities, they simulate a teacher. ITS (Intelligent Tutoring System) is an example of this type of agent.
- personal assistants providing help and information that pertains to learning activities, like collecting content to perform an activity or reminding tasks.

The exploration of the taxonomy of educational agents permits to define, identify and explain the general role of our assistant. We can see that there is a lack in the development of non pedagogical agents; a lot of the educational agents on the e-education market are principally designed to improve the transfer of knowledge without an intervention of human teacher.

The taxonomy of educational agents determined by Chou et al. (2003) only focuses on pedagogical agents, and how to improve the content learning transfer. But in the learning activities or processes there are other aspects. For example, motivation is essential in cognitive learning processes (Barnier, 2003) (Pintrich, 2000). Students need to be motivated and encouraged when they are in a failure situation. The non-pedagogical aspects of learning can include:

- the management of stress,
- the management of emotion : fear, anxiety, reduce the attention and cognitive abilities,
- a time management, task planning, scheduler,
- a vocational orientation,
- the identification of strengths and weaknesses,
- a development of self-confidence,
- a development of responsibility,
- a development of autonomous.

We can add four types (see Fig. 2) of student's agents to the description of pedagogical agents from (Baylor, 2003) and (Ali, 2002):

- the digital tutor
- the digital secretary
- the motivator agent
- the mentor agent

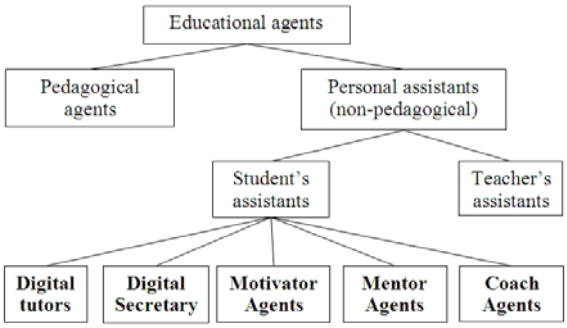

Figure 2: Different types of student's assistant in educational agents' (Chou and al., 2003) taxonomy refined.

Mentor agents and motivator agents can also be considered as pedagogical agents but here we will only retain the non-pedagogical aspects of these agents.

Our assistant is a personal assistant and is in the sub-type student's assistant. In the next chapter, we will explore the concept of a tutor, a coach and a mentor and precise the role of our non pedagogical assistant.

3 DIFFERENTS TYPES OF STUDENT'S SUPPORT

With the massification of education, school dropout is one of the most important challenges for the education system. The best solution to help students to prevent dropout is the personalization of the learning to fit the student's abilities. A personalized support relation will allow improving their results.

3.1 Dropout: The Main Issue in 21st Century's Education System

In OCDE (Organisation for Economic Co-Operation and Development) countries, between 5% and 40% of students drop out of school and 30% of adults have only primary or lower secondary school (Field et al., 2007).

The consequences of failures at school are multiple:

- It generates stress, anxiety, and decrease self-confidence for students. These can have serious consequences for the teenagers like depression, behavioural disorders (runaway, flight, fight …).
- It increases the costs of education system; the financial costs of educational failure are high.

The causes of dropout can be differentiated into three categories of factors (Roiné, 2007):

- Individual factors: tardiness, suspension, absenteeism, lack of motivation, low social network, poor or trouble relationship with adults, disciplinary infractions, low self-esteem, substance abuse
- Familial factors: family organization, parental responsibility, socioeconomics status, poor education of parents
- School factors: relationship between teacher and student, equity in education, negative school climate.

Our assistant will focus on individual factor to help students. In the next section, we present

different types of support or help to prevent school failure. The different kinds of help can be classified by the relation with the learning content (Shea, 2004), the master just transmits a learning content while the mentor transmits the life experience and assists in the decision making.

3.2 Tutor

The concept of tutor is mainly encountered in e-learning environments; his mission is to maintain the motivation of learners. The tutor is the link between the e-learning system and the learner. His three main competencies are (Denis, 2003):

- pedagogical and relational: evaluates student works, analyse the progression, help and guide students
- technical: gives advise for technical problems
- disciplinary: gives academic subjects instructions and resources

3.3 Student Coaching

The role of a coach is to help student to identify and exploit his potentials. The study of French's school coaching shows that the helps are focused on vocational orientation on management of motivation, stress and self confident.

3.4 Mentor

It's the most personalized and closed relationship in learning. This type of relationship is commonly used in enterprise for the career path and the turnover management. A mentor is model, a motivator and advisor for students (Houde, 2004).

3.5 The Supporting Services

The analysis of non-pedagogical agents and supporting methods has permitted to identify four types of services for our non pedagogical assistant: student coaching, vocational guidance, virtual secretary and technical help (see Table 1).

The student coaching, vocational guidance modules are designed in using psychology concepts, affective computing and cognitive learning.

The technical part can be considered as an Intelligent Help System (Winkels, 1992) which assists the user with a current problem and to teach the user about the information system.

Table 1: Our four types of services.

Services	Functions
Student coaching	Diagnoses difficulties Motivates when student has bad results Gives a concrete meaning to the learning Increases the self confidence Reduces stress and anxiety
Vocational guidance	Gives a feedback on the potential of the student Identifies the potential vocation appropriate to the student's strengths and weaknesses
Virtual Secretary	Reduces cognitive overload Reminds tasks Organizes and plans work Manages files and contents
Technical help	Helps to use new tools Guides in the Virtual Learning Environment

4 THE ARCHITECTURE OF OUR ASSISTANT

In the previous sections we have identified the issues and the roles of an intelligent assistant to support students and to help them to overcome difficulties during learning.

4.1 Architecture of Our Assistant

The architecture of our assistant has four main modules. It can be considered as an instantiation of the ITS's architecture (Wenger, 1997) without the dimension of pedagogical expertise (see Fig. 3).

1) User Profile. This module manages all the information about the user, his environment and the Information Technology platform (virtual learning environment, e-learning tool). Technologies of semantic information representation can be used as ontology and the norm OWL to design user's data representation.

2) Embodied Conversation Agent. This module is the human-computer interface; the interaction with the user is in natural language.

3) Reasoning. This is the core of our assistant; fuzzy-logic based inference mechanisms are used, and machine learning tools are added to detect when a student encounters difficulties. The early identification of the failure is the key success factor

of our system. The reasoning module contains the student's diagnosis and the non pedagogical helps modelling.

4) Interoperability Technology. This is an interface that manages the exchange of information with a Virtual Learning Environment or e-learning portal and the integration of our assistant. This is the IT interoperability layer of our system.

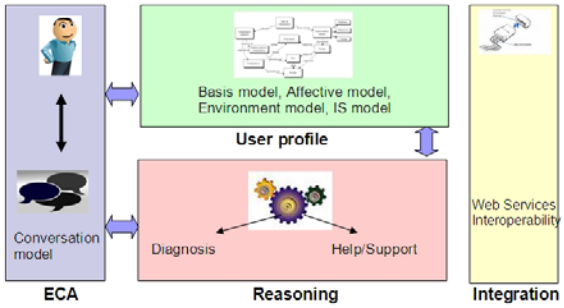

Figure 3: Architecture of our intelligent supporting assistant.

4.1.1 User Profile Module

The goal of the user's profile is to store student's characteristics. The management of user description is essential to an adaptive and personalized system.

Its objectives are:

1) To construct a model of student characteristics
2) To capture and maintain the coherence and consistency of the student profile
3) To give the pertinent indications to the HMI (Human Machine Interaction) and Reasoning modules.

The tracking of interaction with the Embodied Conversation Agent, and the use of the keyboard and mouse will allow the construction of the student profile. The user model is composed of four sub modules. The Basis, Environment, and Domain models are based on the works of (Brusilovsky, 2001), and (Kobsa, 2001).

- The **Basis model** maintains personal information as interests, preferences; cognitive profile, learning style and schooling's data: identification, personal data, interest, preferences learning results.
- The **Affective model** manages the student's emotion through the tracking of keyboard and mouse interactions. It will detect the stress, the sadness (depression) and the anger. This model is based on the theory of affective modelling by (Picard, 1997).
- The **Environment model** keeps information about the student's work context: type of device, place, and time.
- The **Information System (IS) model** handles the information about the technical environment in which the assistant is integrated, for example a Virtual Learning Environment. And the information about the student's learning, for example the school's organisation.

4.1.2 Embodied Conversational Agent Module

The interaction between student and assistant is carried out by an animated agent. First the communication will be in text mode like chatting on instant messenger and later we can add speech capacity.

The assistant can have the appearance of a talking head or a full-body character (see Fig. 4) and is considered as a multimodal system.

Figure 4: Different types of animated agent: full-body character and talking head agents.

Its objectives are:

1) To manage the dialog model to communicate with the student, it may include the facial or body corporal expression,
2) To interact with the user profile to learn new knowledge about student.

4.1.3 Reasoning Module

This module has two objectives, the first one is the detection of the weaknesses and the difficulties of the student and the second is to offer an appropriate help. On ITS the student's diagnosis aims to detect a specific lack of knowledge, in our case the global difficulties on school subjects are diagnosed.

The detection of the student's difficulties is based on the values of grades from learning evaluations, tardiness, suspension, absenteeism

(excused or unexcused, frequency), disciplinary infraction, teacher's remark. The evaluation of theses values individually and jointly will determine the degree of failure and activate the helping pattern.

5 CONCLUSIONS

In this paper we have studied the functionalities of a non pedagogical intelligent assistant to support students during their school learning though the taxonomy of educational agents and different types of the student support. This assistant can be considered as a coach or a companion that gives psychological helps and advices when student encounters difficulties. Our aim is to reduce the dropout through the use of Artificial Intelligent methods.

The limitations of our system reside in:

- The monitoring of the current student's state: school performance, physiological and psychological state. The performance level of our system depends on the quality of the analysis of these states.
- The construction of expert knowledge to support student.
- The relation between the assistant and the student: relevant and acceptance of advices from the intelligent assistant.

To solve these difficulties we need to combine Artificial Intelligence techniques with psychology, cognitive and learning theories.

Until now we have conceived the architecture and lead some experimental development of each module separately:

- The conversation module is build with a pattern-design model based on xml,
- The diagnosis of dropout is based on fuzzy rule,
- The user's profile is designed with web semantic standard; OWL is used to maintain user's characteristics.

Our next step is to make these modules work together to build a prototype of our non pedagogical agent, test and validate it in real-world applications.

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THE USE OF AN INNOVATION CLASSROOM
A Perspective in the Introduction of ICT in Elementary Schools

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Keywords: Collaboration, Knowledge, Aula de Innovación, Innovation, Classroom, Concept Maps, CmapTools, Panamá.

Abstract: In Panama, ICT's (Information and Communication Technologies) are implemented in elementary schools through the Conéctate al Conocimiento project (Tarté, 2006). This project has reached up to more than 700 schools across the country, providing them with the tools to create a national knowledge network. All this effort is towards the promotion on knowledge construction and collaboration in such construction. The aforementioned requires constant practice and feedback if what one pretends to achieve is that the individual can express through the tool without being limited by it, that the tool becomes a springboard to build, express and share his/her knowledge. This paper will show an approach to the introduction of ICT's in schools through a new model called *Aula de Innovación* (Innovation Classroom). We also show examples that support the validity of the model, it is not a recipe book that can be applied in any context, but a concrete experience that allows us to guide and point out some key issues in school activities regarding the use of ICT's. The objective of this paper is to share an approach in the use ICT as a tool to collaborate in the building, sharing and publishing knowledge.

1 INTRODUCTION

The introduction of ICT in education, to be more precise, in educational tasks, has always been a topic for debate. Nowadays, no one rejects the importance that the presence of ITC's has in the integral education of our students, regardless of the educational level; however, the topic takes relevance when we think in which is the best manner to carry out such a task. The traditional instructional models are starting to yield terrain to learning environments that are better self-regulated, in which the spatial and temporal symmetries are starting to be modified by the people and the educational institutions are becoming organizations that learn in community. This last item is not a generality, much less in Latin America, where much of the educational models lack on ICT integration, sometimes for budgetary deficiencies and in other cases because of pedagogical model driven and centered solely on ICT's.

Conéctate al Conocimiento project is introducing progressively ICT's in elementary schools in the Republic of Panama, this is done in an environment which allows the students and teachers to construct, publish and share knowledge, which is *Conéctate al Conocimiento* main objective, in order to have a future society with individuals that had the opportunity and developed the abilities that allow them to be competitive. It is then, when we see technology performing a role of mean and support for a network of people (students, teachers, community in general), so the ICT's potentiate the capacity to perform meaningful educational transformations. The bet for the incorporation of ICT's has been the model of the *Aula de Innovación* (AI, its English literal translation is Innovation Classroom) which is the place where all the computational equipment is placed. The physical design of the as well as the functional design were conceived to avoid "techno centrism" and made the AI a place for the construction of knowledge, leaving aside the traditional "computer lab" where the students go to learn about software and computers and where the machine has a leading role. The pedagogical model behind the AI implies the use of computers with the final goal of learning sciences, mathematics, language, etc. and to allow the student to develop the higher thinking abilities during the learning process. In order for the

aforementioned isn't just already spoken and heard poetry, *Conéctate al Conocimiento* is trying to abruptly land all the epistemological ideas about ICT's and education, in a model that possesses four important components: a) Equipment, b) Permanent training, support and follow-up c) Empowering the schools by giving them an active role in the process and d) Creating support networks among the peers to make it a self-sustainable process.

Encompassing all of the above, the AI becomes a space that affords that processes such as collaboration, knowledge construction and meaningful learning can take place. This article describes what is an AI? Which pedagogical model it implements? The role of the AI coordinator (CAI) and which are *Conéctate al Conocimiento* projections to include other models according to the necessity and always looking for educational equity.

2 WHAT IS AN INNOVATION CLASSROOM?

An Innovation Classroom AI is physical space designed specifically for knowledge building and meaningful learning. This space is equipped with technological tools that promote communication and knowledge sharing and publishing among the schools. The main objective for an Innovation Classroom is to serve as a platform to a great national school network promoted by the Conéctate al Conocimiento Project (Tarté, 2006). This network is propeled by students, teachers, parents and the community in general.

The whole concept of an Innovation Classroom is oriented towards promoting the use of technology as an excellent tool to obtain better results in the learning process. But the role that technology plays is secondary because it is just a tool and not the final goal, which sets us apart from the common techno-centered approach. Conéctate al Conocimiento Project is formed with the goal of developing a Panamanian society which is able to take advantage, with equity, of connectivity, and at the same times enhances innovation

The AI concept is being implemented in government elementary schools across all the country. There are around eight hundred AI's built and equiped which are distributed in all the country's provinces and reservations. Each AI is equiqued by the project with computers, printers, digital cameras, projectors, scanners, a server with a public IP and Internet access. Through the IC the community gain access to the Internet, the schools can network and access services such as e-mail, a meeting space called "Punto de Encuentro" (meeting point), discussion thread, chat service, content publishing and distance learning system. The project provides every service needed in the AI, such as equipment, structural fittingouts, furniture, services and support.

3 WHAT DOES AN AI HAVE?

The AI includes tables, chairs and computer equipment. The computer equipment will be organized accordingly to the description in the Diagram No. 1 (See figure 1).

The equipment is assigned to the AI in accordance to the number of students of the classroom with the most population, divided into two which will yield the number of computers, the computers are assigned one for every two students in order to promote sharing and collaboration, and teamwork. To these computers it is added a printer, a scanner, a server, a digital camera and a projection screen. Besides all this, the AI has Internet access. The server is prepared in the project with the corresponding information for the school; the technician in charge of the installation should verify its configuration.

The computers in the AI are connected to a Local Area Network with Internet access, the LAN could be via structured wire lying or wireless access. The AI counts with one computer which is assigned to the CAI teacher.

The computers that the students, the teachers and the CAI use were originally programmed with a group of software that will allow them to carry out their learning activities. These computers come with the following configuration: Windows XP Profesional Operating System, Microsoft Office, CmapTools (A knowledge modeling kit to build concept maps), Scanner management software, Printer management software.

Recently, the program Spark has been added in the newer installations and maintenance roll-outs due to the necessity of intercommunication and collaboration.

The server that contains the students work: Linux Operating System, CmapServer Program (software for the concept map application), Printer Management Software.

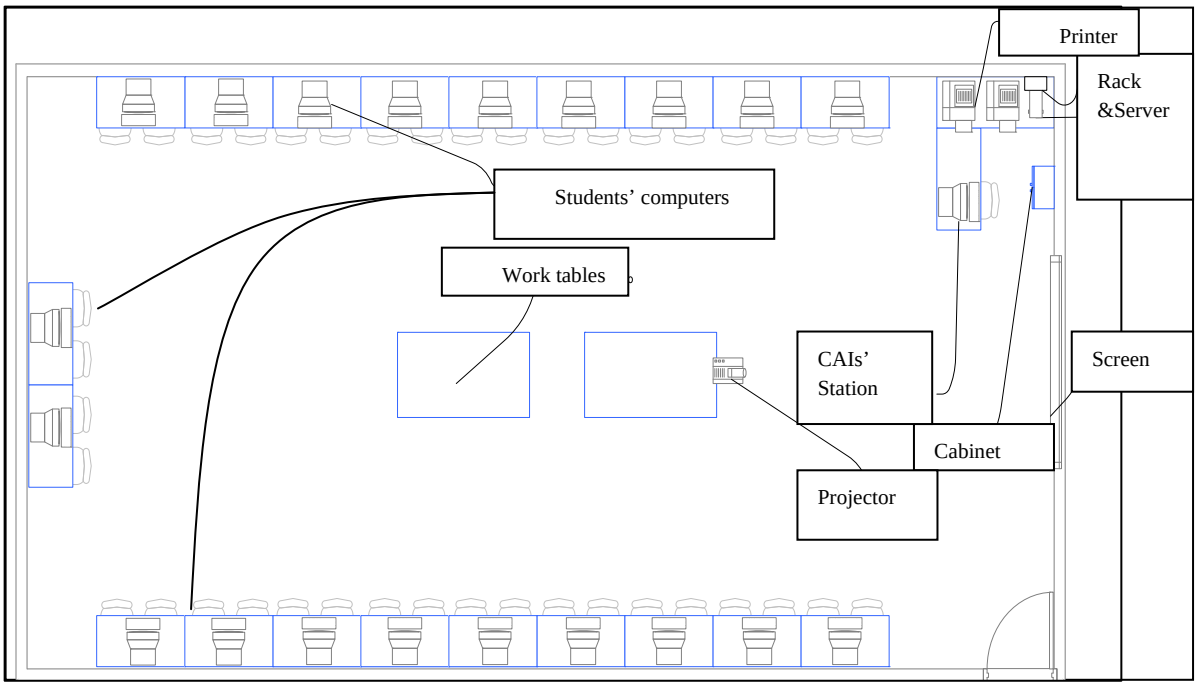

Figure 1: Diagram of the AI.

4 WHAT'S NEW IN THE AI MODEL?

The AI was thought of as a different conception from the traditional computer lab. The differences between these two approaches include physical and spatial distribution, its purpose and the manner in which the users interact within.

4.1 How is a Traditional Computer Lab?

Figure 2(top) shows a spatial distribution for a typical "computer lab" of and educational institution in Panamá. This model presents some limitations such as that the teachers can move in the lines to help students, but, once they are in a row, they are no able to observe the following rows and quickly grasp what the students are doing in order to offer help. The teacher's role consists of "explaining" how the applications and equipment operate so the students start learning about the machine itself and not about the topics covered in the educational curriculum or develop abilities with the help of the computers.

Computers are spatially distributed in exactly the same manner of rows and columns that the chairs in a traditional classroom (Figure 2 bottom). The interaction among the individuals is limited by the presence of the computers that block any exchange of ideas or opinions among the students that are not physically close.

Figure 2: Comparison between a computer lab (Top) and Innovation Classroom (Bottom).

4.2 What is the Approach of ICT in the AI?

Accordingly to the constructivist model of Conéctate al Conocimiento (Tarte, 2006), it is necessary to have a twist in the approach of the use of technology in education. Traditionally the incursion of computers into schools, by itself, does not solve the educational problem, because introducing technologies without a pedagogical model behind will make us stay in the first wave (Scardamalia & Bereiter, 1994). In this wave the introduction of the tool becomes the objective itself. To move on to the second wave, technology has an objective, which is the use of technology regardless of the pedagogical objective, as Papert said it is a techno-centered model (Papert, 1993).

For instance, offimatics courses and seminars where the teacher learns how to use different tools (word processor, spreadsheets, etc.) without taking into consideration its pedagogical applications within the classroom, in other words, how does the teacher use it to promote learning among the students? In the third wave, technology becomes an affordance, it is used as means to achieve a goal, in the educational case, the goal is the developing of skills that allows the people to learn how to learn (Novak and Gowin, 1984). Conéctate al Conocimiento aims to surf the third wave, this aim is materialized through different complementary ways, such as: Teachers' training, Support and Follow-up visits to the schools, and the supply of all the necessary technological tools needed for such a task. The teachers' training is based in theoretical fundaments from the Meaningful Learning Theory of Ausubel and the Constructivism Approach from Vigotsky theory, using tools like concept maps (Novak, 1984) powered by CmapTools (Cañas et al., 2006) as a tool for sharing and collaboration. All the tools are the means for the students could develop different collaborative projects, that are a learning strategy that integrates the approaches of collaborative learning and projects based learning, in which the students develop the necessary skills to learn how to learn.

4.3 Who is a CAI?

A CAI (Spanish acronym for Innovation Classroom Coordinator) is a teacher in charge of the physical space of the AI. The CAI has different roles, among them pedagogical and technological advise. The CAI does not substitute the grade teacher during the time in the AI, because the CAI works co-ordinately with the grade teacher, in this model the grade teacher provides the topics to be addressed within the AI and the CAI provides the technical know-how to better take advantage of the tools offered by the AI in order to promote meaningful learning. The CAI also complements the teachers' role as a coach for the students. The ideal CAI should fulfil a profile defined by the following aspects:

- CAI takes part in the design and implementation of Collaborative Projects within his/her school and with other schools, nationally and internationally.
- Promotes the use of all the technologies provided by the AI and search for additional technologies to make them available to teachers and students.
- Plans and takes part in the activities of the AI jointly with the grade teacher. Empowers the teacher to the point where he/she can perform with confidence in the AI without needing the CAI's support.
- The CAI's effort towards training and formation for his/her peers are extended beyond the teachers of his/her own schools (for instance: educational community, other schools, institutions, etc.)
- The CAI implements a flexible system for the use of the AI which allows for its the optimal usage (for instance: through reservations made via e-mail, electronic agenda or other means). The use of the AI is extended beyond the normal school schedule, to include users that do not belong to the school itself.
- The CAI makes records regularly and draw conclusions from them. Besides, he/she shares the conclusion with the school teachers (for instance: the CAI organizes disclosure meetings that help in the training of the school teachers).

5 PROMOTING THE CREATION OF A COLLABORATION NETWORK

As we have already mentioned, each school that joins Conéctate al Conocimiento Project has its own server, where the CmapServer (Cañas et al., 2004) software is installed, this is the complementary software of the CmapTools client software and it allows the school to have a place in the Directory of Places (list of concept map servers and Internet resources) (Cañas et al., 2004) de CmapServer. Currently when the CmapTools client software is started and the user goes to "Shared Cmap in Places", selecting "All Places" it can be observed the

large quantity of places that starts the name "Conéctate Escuela… (Panamá)" (figure 4), which are all the places that belongs to Panamanian elementary schools where the students and teachers are saving their contents (concept maps, images, presentations, videos, etc.) with the huge possibility of sharing them with others (Figure 3). Besides all these, every resource that is stored in a CmapServer can be accessed through any Internet browser and Google indexes all the contents in the school server thus one simple search in Google of any topic from common to the elementary school curriculum (for instance: Hidroelectricas de Panamá [Hidroelectrics fo Panama]) could yield results that point to concept maps or resources from students in Panamanian elementary schools.

Currently, the IHMC team is implementing and improving an Internet concept map search engine: http://www.cmappers.net which makes it easier to look for concept maps related to a specific topic and also offers the opportunity to share them.

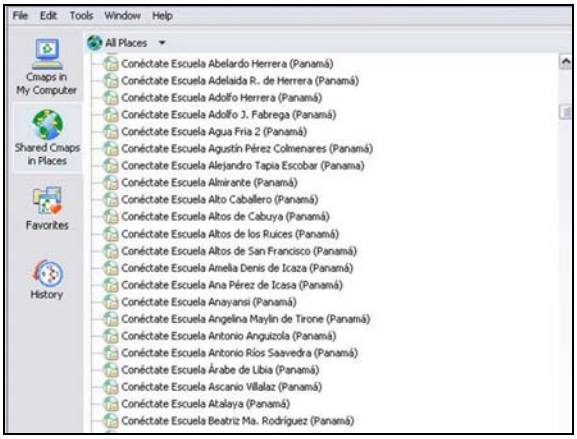

Figure 3: View of the CmapTools software that shows a little part of all the places (servers) that belong to elementary Panamanian schools.

6 SOME SUCCESSFUL CASES

6.1 School Network Creation (Case de Bocas del Toro Province)

Students and teachers from the Bocas del Toro province are part of a mutual support network that is growing up as we speak. Blogs, Knowledge Models (Cañas et al., 2003) digital magazines are some of the contents resulting form the interaction of the network members. Project facilitators initially promoted and favored the birth of the network, however, step by step, the network took on a life of its own having students and teacher thinking and finding new manners to collaborate. Thus the network became an item to be described rather than be driven. Here are some of the spaces that teachers have created to collaborate and publish (http://reddecolaboracionbt.blogspot.com/, this is a blog that contains the links to the others schools' blogs of the network).

6.2 Collaborate to Learn

The Republica de Nicaragua school, located in Colón Island, Bocas del Toro province, have carried out several collaborative activities with other educational centers in the country through the use of the tools in the AI. This has allowed the students to live experiences through collaborative projects. Among these projects there is "La Estadistica" (Statistics) (2007) where teachers and children from the Finca 41 school in Changuinola. Most recently, they participated in the "Solo Buenas Noticias" (Just Good News) (2008) with students from the El Perú elementary school in the Coclé province. Besides, the school is part of the "Bocas del Toro School Collaboration Network." Additionally, this school participates a research, jointly with other Panamanian school that takes part in Conéctate al Conocimiento project. The idea is to compare the learning that takes place when students collaborate versus those where there was no collaboration, using concept maps to watch and record the changes in the students' learning. Being collaboration one of the main strategies of Conéctate al Conocimiento, it is important that teachers and students learn to collaborate in order to take advantage of the variety of topics, contents and information that can be built and share through collaboration.

Figure 4: Sixth grade students from the República de Nicaragua school using MSOffice to create graphics in the statistics project.

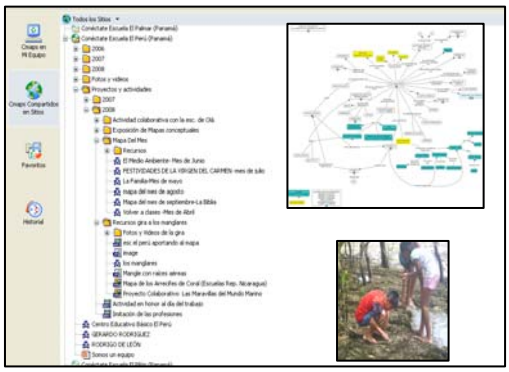

Figure 5: A screenshot of the El Peru server where all the resources made by the students are located (http://elperu.conectate.gob.pa).

6.3 The Students are the Protagonists

Students from the El Perú elementary school in the Coclé Province, Panamá, have developed a series of experiences through the Collaborative Projects. One of these experiences is titled “Solo Buenas Noticias” (Just Good News). This project was designed and implemented by teachers and students, with the support from Conéctate al Conocimiento facilitators. The students learned to teamwork, how to take advantage of the Internet as a space not just to look for more information regarding the topic of interests but also as a place where they can make public their knowledge about the social topic of interest in their “Map of the Month” using CmapTools. They have created videos where the students wrote the scripts (using word processing tools) as well as editing them using video editing software. The videos allowed the students to present their opinions and to contribute to the publications of topics related to the community where the school is located. The teacher Yessenia Fuentes, the school CAI, assures that the students have become more independent, the make better judgments when exchanging opinions about the topics they are addressing, the on-line interaction with students that are not physically close-by using communication tools (such as Skype or Windows Messenger) has had a positive impact, because the students worry about such things as their orthography, diction and idea coherence, additionally it helps the introvert students to be more communicative and open. All the students’ productions are available in the school server via CmapTools or via web browser at http://elperu.conectate.gob.pa.

6.4 Jaqué “A Conected Community” Technology Access in Remote Areas

Jaqué is a remote community in the South Pacific of Panamá, bordering with the republic of Colombia, it has an approximate population of 2,600 which 1,200 of them are Colombian displaced people, the rest are national Panamanians from several different ethnic groups such as Emberas, Wounaan and African American. Because of the remote location of this community, it lacks efficient communication means, just to public telephone that rely on satellite antenna (most of the time they are out of order and when they are in working conditions the settlers has to stand in long lines waiting to use them); one local radio station which belong to the church and the telegraph are the only means the inhabitants count with to communicate with family in the rest of the Panamanian republic, there are no signal from television channels, radio stations and of course there’s no Internet access. National or international news arrive weeks later in form of newspaper clippings stapled to a bulletin board next to public telephone (Figure 6).

Figure 6: (Top)Bulletin board where the member of the community received the news. (Bottom)Teachers, students and members of the community taking advantage of the AI resources.

Wishing to fulfill with the goal of equity and quality in Education, Conéctate al Conocimiento, is

reaching out to many remote and "disconnected " communities such as Jaqué, transforming the life of its inhabitants. The Marcos Medina Ambulo elementary school in Jaqué was furbished with an AI, the Conéctate al Conocimiento facilitators lived and shared with the community for three consecutive week, with the community and help the inhabitants including teachers, students, and representatives from several community sectors to use e-mail to communicate with their family in other parts of the country. This has improved the communication opportunities through the use of Internet as a mean to be informed and communicated. The teachers learned to successfully use concept map in their classes with and without the use of CmapTools. Using concept maps, teachers and community members are carrying out knowledge capture some of the processes of the activities that native group within the community carry out. For instance the Red de Mujeres de Jaqué (Jaqué's Women Network) a group of women that manufacture papers using manual processes and organic elements.

6.5 Use of the Forums during the Encuentro de Niños Innovadores (Innovating Children Summit)

The Encuentro de Niños Innovadores (ENI) was a great event, organized by children for children organized conceived to provide the students, it was conceived as an opportunity for the students to share their learning. The schools that organized the event were 22, and they presented 11 different projects, that is two schools worked collaboratively in one project. Comparing these numbers to the large scale in which Conéctate al Conocimiento operates they are not a significant sample of the students covered by the project. Because of the above, an on-line version of ENI was organized by Conéctate al Conocimiento, called "ENI Virtual". The objective of this version was to allow the children that could not be present physically, to access the event on-line in schools that have an AI with Internet access. The web site that was created for such task (eni.conectate.edu.pa) consisted of a Web page that described the event, a live broadcast room for each project and the Forums room. A forum room was enable for each one of the topics presented during the event, both had the same name for a easy recognition. The users could access any of the forum rooms and write their comments, there was no limit to the number of comments a user could make, or the times he/she could access a given room. Every school received a generic user to grant the students access. The students' comments are being processed and analyzed to grasp in which manner they interacted in these forums.

7 CONCLUSION AND THE NEXT STEPS

The implementation of ICT in Panamanian elementary schools through the use of the AI is being carried out in a fashion that has no precedent in the country. The approach that is maintained is one of taking advantage of the ICT's to build, share and publish knowledge, integrating knowledge tools such as concept maps and technological tools such as CmapTools. It can be appreciated the growth of a network of schools that increasingly need support and follow-up, at this point where connectivity in the AI takes an additional relevance because of projects that are taking shape and could be considered as our next steps:

The creation of a distance-learning platform that would allow the training of teachers, students and community members in a national scale, with an autodidact character, using a non-lineal structure and free access to the constructivism-based resources.

At this moment, Conéctate al Conocimiento is developing the website Punto de Encuentro is conceived as an on-line space in which an member of the Conéctate's community can share and create new Experiences and participates in collaborative projects. It is understood as an experience everything that is within the context of CaC (learning experiences, educational activities, educational events, news…). Sharing these experiences implies that the user can report his/her experiences and know other users' experiences; this is to interact with other users (There is an integration of tools to communicate the users each other like chat, e-mail.)

The user should meet, literally, with other users in the moment that he/she accesses the PE. That is why the initial interface is fundamentally a global panoramic that allows to see who is connected at that moment. The manner in which the users can be seen is through a geopolitical distribution of the educational regions. Using a map of the regions, it could be seen, in real time who is connected and where he/she is. The idea of this background is to create the visual sensation of a human network.

The experiences are reported using resources. The resources can be text, concept maps, videos, images, url addresses, file attachment, and others.

The experiences as well as the resources should allow annotations (comments) from other users, in a manner that "discussions" are generated around the experiences (in resemblance to forums.) besides establishing a experience and resource ranking (What do you think about my experience? To be graded with stars, from 1 to 4 stars. An experience can be an isolated event, or it could be part of some project activity or a course that is being taken by the user.

This platform intends to become the online extension of *Conéctate al Conocimiento*, creating innovation by becoming the first platform for the integration and communication among different schools, teachers and students (lately), overcoming geographical, cultural and social barriers and allowing them to share in a common space where they can exchange experiences, contributions and knowledge.

The massive installation and use of the *Nicho* environment. *Nicho* is a software environment that provides teachers and students in a school, or group of schools, with their own unique user id, an email address, chat, and a personal space for storing documents; this same environment configures CmapTools and a CmapServer for storage of knowledge models. In *Nicho*, students and teachers are able to access their "space" and their communication tools from any computer in the school, and from outside the school, e.g. at home or an Internet café. *Nicho* was designed for Conéctate al Conocimiento, and is being deployed and used to provide a collaborative environment to public schools throughout the whole country." (Lott et al, 2008).

The implementation of a model 2 in the school (taking the AI as model 1), it is based on portable computers (laptops) instead of desktops computers. This model has already been put to practice in several schools (especially in schools that are hard to reach), however, it is still in the development stage. It will be implemented in a larger scale across the country later.

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PRACTISING WEB DESIGN ESSENTIALS BY ITERATIVE BLOG DEVELOPMENT WITHIN A COMMUNITY PORTAL

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Keywords: Education supporting platform, Community portal, Blog-supported learning, Learning communities, Lifelong learning, Teaching web design, Teaching XSLT.

Abstract: Following constructionism and the learning by doing approach of Papert in our university web design course students are given the task of building a personal blogs. Students thus practice selected Web technologies. The task is supported by a dedicated web-based integrated development environment. Their blogs are interconnected and communication is available. Students are also encouraged to publish relevant articles on their blogs. We have observed competitiveness boosting, experience exchange, and overall increase of involvement with the course. Our experience suggests improved quality of learning to the benefit of our students.

1 INTRODUCTION

Blogging, online communities formation and social networking have recently become important socio-economic phenomena that increasingly influence lives of all, no matter the age, background, or professional affiliation. Within the field of online publishing, the impact of blogging is especially influential. The blogosphere has proven to serve as an unforeseen media space easily accessible to everyone. Blogs have been used on an incredible variety of purposes, such as personal publication, independent journalism, online marketing and corporate public relations. The omnipresence of blogs and blog articles does in turn shape the habits of Internet users and it has impact on user's needs. Thus blogging has become unignorable in particular for web designers and web application developers. Therefore we advocate coverage of blogging by web design and web development curricula at any level. We will demonstrate later on that such inclusion may in fact contribute to the quality of such curricula increasing the fun factor and students' involvement with such courses.

The benefit of information technologies in learning has been justified (Papert and Caperton, 1999; Mosel, 2005) by such theoretical frameworks of knowledge and learning as radical constructivism (von Glasersfeld, 1995) and constructionism (Papert and Harel, 1991). These frameworks conjecture that knowledge is constructed from perception and interaction with the world. Moreover, perception, interpretation and representation of communication and knowledge are subjective among different learners. Constructionists suggest learning by doing – by personal experience and by practical exploration, by doing things in real world. Benefits of blogging and the newly emerging social Internet in education have been analyzed by Mosel (Mosel, 2005). According to Mosel, blogging contributes to effective construction and organization of knowledge. Through communication and discussion, that is easily triggered by the possibility of leaving a comment, one compares her subjective perceptions with the others and a socially shared view may evolve. Mosel views blogging and the associated social Internet technology as an emergent phenomenon and suggests its application in curricula and didactic applications as an open issue of particular interest.

In this paper we describe our university course on web design which makes use of blog development and blogging as practical assignments. In our course students learn web technologies through iterative development of their own blogs, directly experiencing the power of the technologies and experimenting with them freely. This is in accordance with Papert's learning by doing approach. We encourage stu-

dents to communicate with others, we focus on building a learning community, and thus facilitate learning of serious skills in a way which is appealing and entertaining.

In order to achieve all these goals we provide a web-based integrated development environment for our students which they use to build up their blogs. Blogs of all students are integrated into a portal, and accessible to all the other students. Communication and discussion is immediately available via comments under the blog articles, and so students get feedback and advise from their colleagues and from course lecturers as well. During our three year experience with this practical assignment and our platform we have observed on our students effects such as unpredicted creative realization, competitiveness boosting, mutual exchange of experience, etc. We conclude that thanks to our application students' interest and involvement with the course increases, students find working on the assignment amusing and quality of learning is increased. Our experience shows that choosing blogs and blogging for practical assignments was a particularly rewarding step and we agree with observations of Mosel (Mosel, 2005).

Full version of this paper is available online as technical report (Homola and Kubincová, 2009).

2 EDUCATIONAL BACKGROUND

Newest trends in the learning theories try to map and reflect the real impact of information and communication technology on the society. In this respect educational knowledge and learning theories such as constructivism and constructionism have become more and more significant. Constructivism, as an epistemology theory given by Piaget (Gruber and Voneche, 1995) refers to the process of knowledge construction from human experience. In radical constructivism of von Glasersfeld, the relation between the objective world and the individual's constructed representation of reality is characterized by the notion of *viability* (von Glasersfeld, 1995; Mosel, 2005). According to this theory, the important aspect of the subjective representations that individuals construct during the process of learning is the extent to which these are in conflict with the reality they face. These subjective representations are the more viable, the less the learner encounters conflicts when comparing them with new perceptions and acting upon them. Low viability of constructed knowledge purportedly leads to revision of constructed knowledge in the process of repetitive exploration of reality from different angles and viewpoints. Radical constructivism results in the conclusion that human beings do not only actively construct perception and consciousness, but also knowledge and learning (Mosel, 2005). In accordance, constructivists regard humans to be inventively active subjects which create their knowledge from perception and interaction with the world.

Didactic approaches based on constructivism put stress on learning by discovering. Constructionism – a learning theory by Papert (Papert and Harel, 1991), states that the most effective way of learning is the learner's active knowledge construction. The use of these theories is promoted by the educational approach called *learning by doing*, in which learners obtain new knowledge from their own experience gained through the practical application of the subject matter.

Impact of new technologies on the learning process is an important research issue that has enjoyed attention (Papert and Caperton, 1999). A valuable insight on benefits of blogging and newly emerging technologies of the so called social Internet in education is offered by Mosel (Mosel, 2005). Mosel builds on notions of *microcontent*[1] and *micropublishing* as introduced by Spivack (Spivack, 2003). Loosely speaking, microcontent refers to URI-referable units of information accessible via Internet, each typically encapsulating no more then a small number of central ideas. Microconent typically occurs in collections of common themes and topics. The act of publishing microcontent is then called micropublishing by Spivack and Mosel. Undoubtedly, blogging is the most popular and most typical type of micropublishing. Blog postings are mostly rather short and consist of one or few topics. Hence they usually are more focused than longer elaborate articles which tend to have many interrelated arguments and are often highly complex.

According to Mosel, micropublishing and specifically blogging contributes to effective social construction and organization of knowledge of elevated quality with respect to the theory of radical constructivism. Blogs are often thematically focused and learner-centered. They represent also author's subjective views and statements as well as relations to other resources. The possibility of leaving a comment right under the blog article contributes to interaction and collaboration with other users. As small units of knowledge are much easier to discuss and deconstruct, they are also more helpful with respect to new knowledge construction. In addition, through collaboration, by identifying, formulating and discussing problems and interests, a socially shared view can evolve. Mosel views blogging and associated social

[1] Spivack's notion of microcontent (Spivack, 2003) is not to be confused with the notion of microcontent used in typography and usability (Nielsen, 1998).

Internet technology as a rather unexplored emergent phenomenon and suggests its application in curricula and didactic applications as an open issue of particular interest.

3 OUR WEB DESIGN COURSE

The course "Modern Approaches in Web Design" is part of the Master-level curriculum in applied informatics at our university. The course provides a unifying view of the rich palette of web technologies currently used, that are to some extent covered within various other courses and concentrates in greater detail on selected technologies. The course has four main objectives. First, to give an overview of main technologies employed in web design and web development. Second, to cover selected technologies such as XML, XSLT[2] and CSS in great detail. Third, to make students acquainted with standards, methodologies and production issues that are relevant to industrial-level web development such as accessibility, usability, search engine optimizing, web application security, etc. Finally, to rise awareness of emerging phenomena that nowadays more than ever shape the Web and influence web design such as Web 2.0, blogs, community portals, social networking, etc.

Secondary although still very important goal of our course is to develop students' lifelong learning and personal development skills and competencies related to effective operation with professional knowledge that they acquire during their training but also during praxis. Such competencies include: ability to gather knowledge from various information sources, to analyze, synthesize, process and critically evaluate information, to effectively communicate one's professional stances and opinions, etc. We address these secondary goals by practical assignments that involve such activities (e.g., collecting information and publishing digest on-topic blog articles).

Students work on several practical assignments of which only one – the main project assignment – is mandatory, the rest are extra assignments which are awarded by extra evaluation points. For the main project assignment each student needs to implement a personal blog, especially the visual layout. The most notable extra assignment is the task of publishing blog articles on any topic that is related to the course. With this assignment students are encouraged to make their own research on Web technology, methodologies, tools, etc., a skill that they will frequently employ in their future praxis. Another interesting extra assignment is to implement original and unusual features on their blogs.

In the course learning contract students agree with their name and evaluation being exposed their colleagues which as we believe boosts competitiveness (see Sect. 5). At the end of the semester projects are evaluated. Half of the score for the project is for submitting a feature-rich blog, the other half is for meeting the web design quality standards such as code validity, accessibility and usability. The extra assignments add up some score and possibly improve student's grading. The extra score is not at all limited, and students may publish as many blog articles as they wish. However, they need to do some research or to spend extra working hours on their project and experiment with original features, and hence this assignment is practically limited only by the amount of working time they are willing to invest.

The nature of our course, its content and aims have inspired us in development of a supporting application that provides blog space for our students and it also serves as integrated development environment with help of which students are able to implement the visual layout of their blogs while sharing the same back-end. The main goals for the application are the following: to provide each student with a unified basic development environment for her blog, where especially all the blogs share the same back-end, and students can fully concentrate on the task of developing the visual layout for their blogs; to enable to use the very same blog space for submission of the blog articles for the extra assignments; to have such a blog portal back-end for this purpose, that would enable and boost students' communication; to support the teachers in the evaluation process.

4 OUR BLOG PORTAL

Our platform is part of the blog.matfyz.sk community portal. This portal is accessible to general public and is purported to become a dedicated unofficial community portal for the students but as well for the staff of our faculty. It serves to three main goals:

Community goal. To create an alternative and unofficial communication channel for the people connected to the faculty.

[2] XSLT, the XML Style sheet Transformation language, is a recursive declarative template language that specifies how one XML format is translated into another one. Thanks to its nature, programming in XSLT is significantly different from common imperative languages such as C++ of Java. As XML has become widely adopted, XSLT programming is an important skill to train for computer science and applied informatics students.

Figure 1: Typical blog within our portal in default layout.

Figure 2: Article editing within the student's interface.

Educational goal. To provide a supportive environment for various courses taught at the faculty, most notably our course.

Research goal. The portal has been mostly developed by Bachelor and Master students as part of their Bachelor/Master projects. Design of the portal focuses on various research issues related to community building, internet publishing and social networking, various Web related technologies and real-world deployment of native XML databases.

Once a student has registered to the portal, the portal interfaces change for her and also the way her blog is processed is changed, and – from the student's point of view – the portal effectively turns into an integrated blog development environment. The portal makes heavy use of XML technologies. All data is stored in native XML database, the XML Query Language (XQL) is used for querying, and XSLT is then used to transform the XML data into browser readable XHTML documents. This fact has enabled us to develop with little effort special interfaces for students of the course, which are different from the interfaces used by ordinary users, and are heavily XML-oriented. Students post their articles using a designated data-driven XML format. Students' blogs are processed differently by the portal. At the beginning no layout is applied on their blogs and the students must develop the visual layout of their blogs by themselves, in XSLT and CSS. As their blogs are being developed, students are encouraged to post course related information on their blogs. Thus the portal supports two of the practical assignments of the course: development of visual layout of one's personal blog, and also publishing on topic articles on one's blog. And, thanks to the design of interfaces, students practise XML, XSLT and CSS on the way.

As the portal serves for variety of goals, there are also trade-offs that had to be undertaken. For most of the semester, most of the students' blogs are underdeveloped, some even broken for certain periods of time. However, for the community building purpose, students' articles are visible to all portal visitors, including random internet users. When such a visitor encounters an article written by one of our students, the article is formatted using the standard portal layout. Students' own layouts are only visible to other students of the course. Each visitor, whether a class mate or not, is able to post comments on student's article. Thus students collect feedback from their colleagues, but possibly also from wider public.

We will now describe how students use the portal within the course and what they learn by using it. In order to demonstrate the functionality and features of her blog, the student is required to publish at least several articles throughout the semester. In addition students are encouraged to publish on topic on their blogs as they are rewarded extra evaluation points for that. By editing articles via the XML-oriented interface provided for them, they train all the basic XML notions and skills such as well-formed XML syntax, DTDs, validation, element and attribute types, etc. Another thing students extensively practise is programming in XSLT, as the portal only allows this language to be used in order to process the data and create the layout of one's blog. This is a useful skill since XSLT is nowadays more and more frequently applied in various contexts as XML data formats have become widely adopted. XSLT itself uses XML syntax, hence students contact time with XML is further increased.

To complete the project assignment students must implement a blog layout that includes basic and commonly expected blog features. Students are also encouraged to go beyond this basic requirements and to implement advanced features such as interactively folding tree views of comments, their own article management, access statistics, polls, etc. They are

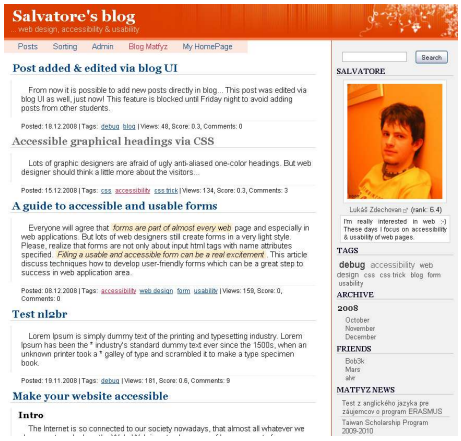

Figure 3: Custom blog layout by a student of the course.

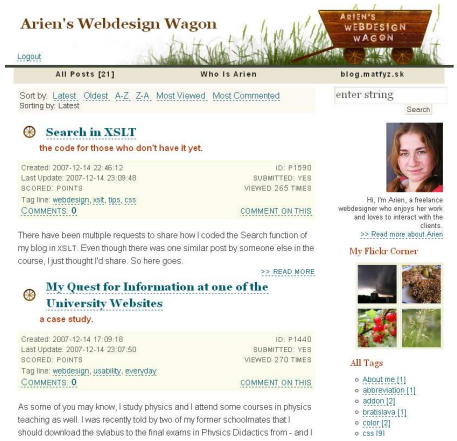

Figure 4: Another student's custom blog layout.

awarded some extra evaluation points for doing that. Every year some of the most active and creative students come up with entirely original ideas to implement on their blogs thus exploring blogs as a web design genre and publication media to the fullest. Another part of the blog which is evaluated is its compliance to the web design quality standards such as code validity, cross browser compatibility, accessibility and usability. It is not trivial at all to produce web applications that are both compliant with the quality standards and still neatly and attractively designed. What is more, this fact is still frequently ignored even by professional web developers; appealing design and cool user interface features are commonly preferred to accessibility and ease of use (Nielsen, 2008).

In this way students train XML, XSLT and CSS, they are acquainted with blogs and blogging as an important internet and social phenomenon that increasingly influences web design as a field, they master essentials of blog anatomy, community portal features, web page layout standards, and they are acquainted with web design quality standards as well.

5 EVALUATION

The course has already run three times in the form described in this paper. In Table 1 we provide some statistical data from each run of the course. Even if each student could get around by posting 3–4 articles, we can see that the average number of articles is higher than that. Also, the number of comments significantly outnumbers the number of articles, and we notice unusually high number of comments for the second year even if the number of participating students was low on that year. Indeed students' activity varies for each group but overall we conclude that students' involvement with these assignments has been significantly high, and they share interest in communication with others. In addition to measurable values we have observed several things related to the didactic goals of the course, as follows.

Table 1: Students' activity per one run of the course.

Year	Students	Articles	Comments
2006/2007	190	1183	1555
2007/2008	87	649	1406
2008/2009	101	663	1172

Competitiveness. We really care for boosting competitiveness. We believe that it makes participation in the course attractive and possibly even entertaining. It increases students' involvement and results into deeper understanding of the subject matter. In order to achieve this, we enforce by the learning agreement that students' name and intermediate evaluation is accessible to all the other students. Student's blog and her work in progress is also visible to them. While such a move may rise privacy concerns, we believe that our decision is justified by increased quality of learning.

Communication. The portal provides means to comment on each blog article to everyone (even to general public). Thus students are easily able to communicate with their colleagues. As they all cope with similar tasks, they can provide valuable feedback one to another. We also encourage students to document their progress by blog articles. This way they are immediately helpful to others and they can start discussion on the problems they encounter while coping with more difficult parts of the assignment.

Creativity. The task of developing one's own blog layout is a great opportunity to exercise creativity. The fact that everyone can easily see the work and

progress of others, further boosts one's will to create something beautiful and original (at least in some students). Thus a programming exercise which might have otherwise been boring turns out to actually be fun for many students.

6 CONCLUSIONS

In our university web design and web application development course we rely on the theory of learning by doing that builds upon constructionism of Papert (Papert and Harel, 1991). Students work on various assignments, so that they practically explore what they are taught during the lectures. The main assignment amounts to developing a personal blog. We have created a web-based platform that provides an integrated blog development environment to our students. The platform is part of a wider community portal used at our faculty. Students' interfaces are heavy XML-oriented, they develop their blogs by applying XSLT and CSS on XML data, thus effectively practising these technologies.

Students' blogs are not isolated, but they are instead interconnected within the portal. Communication means such as the possibility to comment on each and every article are readily available. This supports students' mutual interaction and contributes to their collaboration during the learning process. Thus a learning community is effectively formed. The participants of such a learning community are able to compare their work with their peers including the intermediate evaluation. This creates competition, improves students involvement with the course and increases their understanding and interest in the subject matter. We have observed situations in which individual students appeared to be dragged into the work on their projects by their peers or simply as they realized that others are already ahead of them. In additional assignments we encourage our students to publish meaningful articles on their blogs, documenting their work in progress and blogging on topics related to the course subject as well. Thus according to Mosel (Mosel, 2005) efficient subjective learning is stimulated and social knowledge construction is enabled. In addition these tasks require collecting and processing relevant information and communicating this information together with personal views and opinions. Hence the students' development continues in such areas as gaining lifelong learning habits, information gathering, analyzing, synthesizing and communication of one's professional opinions and stances. We conclude that use of blogging environments, for instance in the way that we have described in this paper and that we employ in our course, is particularly suitable to support such educational goals.

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LEARNING ABOUT SOCIAL ACCOUNTING IN THE KNOWLEDGE SOCIETY
A wiki-Webquest

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Abstract: This paper examines how new communication and collaboration technologies can influence university students learning process for the area of accounting and specifically for social accounting. Students should be able to know and understand that companies' reports must provide not only financial but also social information as a necessary complement to the first. Analysts are taking into consideration social issues when valuing companies and corporate governance, human rights or environmental behaviours have become key factors for investment decisions. In a general way, social accounting may be defined as the framework which allows businesses to account for their impact on society. For the Institute of Social and Ethical Accountability (1999), the terms social and ethical are taken together to refer to the organisational and behavioural systems within the organisation, and their direct and indirect impact on organisational activities with the stakeholders.

1 INTRODUCTION

Dodge (1997) defines a WebQuest as being a guided research activity, in which all or a large amount of the information that students use is obtained from the Internet. WebQuests are designed in order for students to make the most of the time by focusing on using information more than looking for it, and generating new knowledge through critical reasoning on different levels of analysis, synthesis and evaluation, as Dodge (2001) and Richards (2005) suggest. The possibilities offered by the WebQuest model in the development of student skills and abilities has raised interest among professors, who have implanted the method on different educational levels and in different areas (Donovan (2005), Sautter et al (2000) and Long and Stevens (2004) among others) and also among academics, who have analysed the pedagogical advantages of using said model and the development of its implantation process (Kanuka et al (2007), Zheng et al (2007), Allan and Street (2007) and Lim (2004)).

A large number of these studies coincide in affirming that the WebQuest model can (1) promote critical reasoning in students, as the WebQuest activity incorporates elements of reflection to be learned from, making it possible to compare, contrast and synthesise knowledge to construct new understandings; (2) facilitate the application of knowledge, as the proposed activity is developed in a setting that interests the students and is related with the problems that could arise in the real world; and (3) develop collaborative skills during the learning process as they require students to work in groups.

In this sense, different authors such as Johnson and Johnson (1990), Slavin (1992) and Biggs (2003), indicate that collaborative work generates positive effects on the students forming a group. According to Allan and Street (2007) collaborative work promotes student autonomy, making them responsible for carrying out one part of the project, as a contribution to the proposed discussion of the subject once the ideas and results have been pooled together. This, in turn, provides students with greater

fluency in the use of economic language and gets them used to working as a team, a work method that has been adopted by a large number of companies to deal with the complex problems that can arise in the kind of dynamic but uncertain environment that is so typical of a globalised economy.

However, according to Harrer et al (2006), a professor that wishes to implant a methodology based on collaborative work is faced by two challenges: controlling the time available to prepare the material and dealing with students' doubts, as well as examining and evaluating students' behaviour within the work group. To cope with this latter difficulty, we propose the use of Wiki technology. Dobrockey (2006) defines the Wiki as a web application that enables the user to create pages and/or edit the content of those that already exist, which favours the exchange and generation of ideas, and therefore, collaborative/cooperative work. The flexibility and ease of use offered by this tool has led to its incorporation in the business world, as shown by Dobrockey (2006) and Rahman (2006), as well as its application to education, as can be inferred from Parslow (2005). In this latter case, its implantation enables the professor to observe and revise the changes made and improvements incorporated by each of the students, and also to refine the content of the same by correcting any detected errors. So, Wiki technology is configured as a tool that enables the teacher (1) to follow the evolution of the acquisition and generation of the knowledge of the group and of each of its members and (2) to efficiently evaluate each student in terms of group and individual work done. Also, from the student's point of view, the use of this application leads to the development of teamwork skills, favouring adaptation to the business environment.

While exploiting the advantages offered by each model for the way students acquire skills and are evaluated, we shall now design and implement a WebQuest and a Wiki for the financial accountancy course taught in the first year of the Company Management and Administration Degree at the Universitat Autònoma de Barcelona (UAB). Its aim will for the students (1) to become aware of the importance of financial accountancy and annual accounts as elements of information on the transactions the company makes with its environment, within the context of corporate social responsibility, (2) to know how to interpret and evaluate the information that is provided and (3) to learn to use it to make decisions.

To optimise the aforementioned development of skills and abilities, as shown by Lim (2004), the WebQuest needs to be well designed. In this sense, Dodge (1997) and Zheng et al (2007) indicate that the WebQuest should be structured into at least six parts: (1) introduction, (2) task, (3) sources of information, (4) description of the process, (5) evaluation of the result and (6) conclusion. However, Young and Wilson (2002) and Allan and Street (2007) propose an adaptation of the traditional WebQuest structure in which an extra level is added. In said level, each group of students presents its other colleagues with the results it obtained, generating knowledge feedback and the exchange of ideas, which will help the professor to analyse the class as a group, and also each student's attitude within the class, and to make comparisons between groups. Additionally, in our proposal we added another level that consists of incorporating a Wiki application to the WebQuest to enable us to monitor each student's individual work.

2 DESIGNING THE WEBQUEST

The aim of the WebQuest we are proposing is to generate generic skills among first year students on the Company Management and Administration degree course, which will enable them to analyse and synthesise accountancy and ethical information, put the theoretical knowledge they have acquired throughout the course into practice, acquire computer skills that will familiarise themselves with the information technologies used in the business environment, acquire skills for working autonomously and develop the social skills needed to work as a part of a team.

In order to achieve said objectives, we propose the following WebQuest titled "Do we invest in destruction or in sustainable companies?" which we structure into five parts.

2.1 Introduction

In the introduction section we present the initial problem that students have to solve. To do this, we show the context in which the students are going to work, ensuring that we present a scenario that is in keeping with the realities of the business world in order to motivate the students. So, we propose a practical exercise to the students that simulates the kind of professional work they would encounter if they were employed by a real-life consultancy office, a pension fund management company or an investment management company.

To do so, we propose the following scenario:

The manager of an investment management

company decides to increase the range of products it offers and to provide its clients with a new product that is in increasingly greater demand: a socially responsible investment fund. However, in order to manage the fund efficiently, the solicitor needs to select a combination of titles that optimise the portfolio's trinomial of profitability-risk-social responsibility.

To do so, an Ethics Commission is constituted for the fund, mainly made up of independent people that are related due to experience or proximity to the fund's principles, which include professors from the UAB's Department of Company Economy. This commission is responsible for determining the values or instruments, whose companies are adjusted to the criteria established in the aforementioned principles. From among these values, the Managing Company will select those that optimise the profitability-risk binomial of its portfolio.

Given that there is such a high number of Spanish companies that need to be evaluated, the Ethics Commission has asked the students studying Financial Accountancy as part of the Company Management and Administration and Law and the Company Management and Administration degree courses to help them make a report recommending the Spanish companies in which they could invest the monies in the fund in consideration of their business behaviour.

Are Spanish companies socially responsible?

2.2 Task

In this section, we comment on the work that the students have to present following the research proposed in our WebQuest. In this case, the idea is to make a report on corporate responsibility and an oral PowerPoint presentation to be given to their classmates. We believe it is important for the students to have prior knowledge of the final product of the WebQuest, whose content is described as follows:

"The Financial Accountancy students, in commitment to society, the environment and ethical behaviour of companies, will provide their assistance to the Ethics Commission, and will make a report that evaluates whether Spanish companies carry out their activity in an ethical manner on the basis of the criteria of social, environmental and legal responsibility, and in respect of the social rights established in the ethical principles of the funds to be provided by the managing company itself.

So, the Ethics Commission will supply us with a directory of Spanish companies compiled by ESADE that groups companies into sectors, providing legal information in relation to their annual accounts, i.e. Balance Statement, Profits and Losses Account and Annual Report, as well as voluntary information relating to social responsibility, environmental reports and sustainability reports supplied by a large number of companies in the sector.

The students will make a group report, and will provide it in writing and present it in public before their colleagues, who will be able to ask questions and discuss the comments made. To do this, they should consult the Web, use the Wiki application to make the report, and make a PowerPoint presentation of the report."

2.3 Process

This section provides a detailed description of the preliminary steps to be followed by the students when preparing the report, and others related to the creation of the report on corporate responsibility and the presentation of the results. So, first, the work groups will be formed. In this sense, the number of students in each group needs to be determined, as well as the criteria for forming these groups.

With respect to the first issue, many academics, including Rue (2004) and Quinquer (1995) agree in saying that the perfect size of a group should be between two and four students, as this will promote discussion and the exchange of ideas without any of the members of the group taking a passive role. Given that the group to which the work is being proposed has a large number of enrolled students, groups of four will be used, which will help the professor to supervise the process.

As for the criteria for forming groups, Alfonseca et al (2006) comment that the mechanism for forming groups could influence their learning process. So, there are two possibilities: (1) let the students form their own groups, which as suggested by Johnson and Johnson (1975) would lead to the formation of homogeneous groups and (2) for the professor(s) to decide on the people who will go into each group and randomly form homogenous and/or heterogeneous groups.

Alfonseca et al (2006) go for the first option because the literature supports the hypothesis that students tend to form groups in accordance with similar characteristics and skills, which could favour the learning process. However, when students obtain their degrees and are incorporated into private companies, the chances are that the company's

employees will form a heterogeneous group in terms of skills and characteristics, which would imply the student having to integrate and adapt to the new situation if he or she wants to stay on in the job. So, to determine which work environment is most adequate, we apply each of the options to a large-group. In large-group A, the students voluntarily form groups in order to test the hypothesis made by Johnson and Johnson (1975) and Alfonseca et al (2006). In large-group B, the professors make the group classification by applying such criteria as town of origin, entrance mark, sex and age differences. The result of this experiment could be of major relevance for human resources departments when selecting employees.

After that, the details of the calendar for carrying out the project and holding meetings with the professor are drafted. Then the structure of the corporate responsibility report is specified, showing the content of each section where reference should also be made to the sources from which the data was obtained.

In this sense, the report is made up of five parts: (1) Introduction, which specifies the aim of the report and critically comments on the operative principles around which the fund's ethical principles are constructed, a link to which will be provided on the website; (2) Indicators, for which guiding values are given to make it possible to determine whether a company complies with what is established by the fund's ethical principles by taking as a reference the social, environmental and economic indicators contained in the Guide for the Creation of Sustainability Reports (GRI) to which a link is provided in the WebQuest; Also in this section and for each indicator, participants must comment on whether said information is obligatory or not and, if it is, where these regulations are given (3) Strategic map of the stakeholders, where the students should examine the information given by the company regarding its socially responsible activity and the options of the different stakeholders regarding the operative actions carried out by the company in order to determine whether it uses social corporate responsibility as a marketing strategy or whether it is a company value that is integrated in the company's mission; (4) Excluding criteria, where it is determined whether the company invests in other companies whose activity is injurious to human life, fails to respect human rights, promotes the destruction of peoples, deteriorates the environment, is damaging to public health, or does not act in accordance with ethical principles; (5) Evaluative criteria, where the student must examine whether the company being analysed invests in companies that show socially responsible behaviour in accordance with the established ethical principles; (6) Conclusion, where the students must recommend investment or not in the analysed company and justify this verdict.

To produce the aforementioned report, the students should consult legal information, i.e. Balance Statement, Profits and Losses Account and Annual Report, along with voluntary information provided by the companies in the form of social, environmental and sustainability reports. However, companies might manipulate their reports of results and voluntary reports on corporate social responsibility in order to cover up irresponsible or illegal behaviour. To deal with this, in addition to the information provided either voluntarily or under obligation by the company, the students should also use other sources of information. In this case, we propose making a search of a base of magazines in which the students must seek out journalistic articles providing information about the company.

So, each step implies exploratory work whose objective is to construct knowledge through critical reasoning regarding the questions being asked regarding the structure of the company's accounts, economy, finance and corporate responsibility. To do this, comments are established that are designed to act as "conceptual scaffolding", which help guide the students through the execution of the project.

This section also details the way in which the report should be presented. In this sense, students are told that the report should contain no more than 20 pages, using 1.5 spacing, size 12 fonts in Times New Roman, margins of 2.5 cm and numbered pages. The first page must show the name of the company being analysed, the details of the students in the group (surnames, names and enrolment group), and the dates when the work was completed and handed in.

2.4 Evaluation

This section contains the items that are evaluated and the scores that are given to each. The idea is to evaluate the skills acquired by the student in the proposed learning process. To do this, we distinguish between skills of a transversal nature that could be applied to many other subjects but which are no less important because of that, and specific skills related to the knowledge being worked upon here.

Among transversal skills we could cite:

a) critical reasoning,
b) good communication,

c) autonomy
d) creativity.

As specific skills involving the proposed subject we have:

a) basic knowledge of the field of study
b) capacity for analysis and synthesis,
c) capacity to put knowledge into practice,
d) teamwork
e) decision making

To evaluate how students acquire skills, Baker (2008) compares different instruments showing that they are all reliable. However, said author focuses only on the joint evaluation of the group without taking into consideration the individual work done by each student within the same. Therefore, in the present work we evaluate the skills acquired by the students, assessing:

(1) the individual work done by each member of the group, which we observe by analysing the Wiki page. This enables us to evaluate the knowledge acquired by the students, their capacity for analysis and synthesis, their autonomy, their capacity to put knowledge into practice and their critical reasoning.

(2) the work done by the group, where we take into account punctuality when respecting hand-in dates, and the quality and originality of the work. This also enables us to evaluate the aforementioned skills, teamwork and decision making.

(3) the oral presentation both to the tutor and to the other participants. On the basis of the oral presentation we will evaluate the participants' communication skills both individually and as a group, as well as their capacity to adjust their presentation to a certain time and structure.

The evaluation will be marked from 1 to 4 for each of the three proposed sections.

2.5 Conclusion

After doing the task that we proposed, the students will be able to analyse and synthesize a company's the financial-economic-accountant information. The students will also be familiar with the accounting terminology, will know some databases which contain companies accounting information, will be able to put their knowledge into practice through critical thinking and will be able to coordinate themselves to work as a team and will have to skills for explaining their work in public. Besides, the students will be able to make decisions on where they could invest on the basis of companies' the corporate and social behaviour, will be able to skilfully handle the tools pertaining to the knowledge society to elaborate reports, will solve moral dilemmas that could arise in the business environment and will get into research skills.

Finally, they will have abilities to do research on corporate social responsibility. That's the reason why we challenge them to think about important questions in accounting area: Do you think that the companies should include corporate social responsibility's information in their annual reports? How could the companies include this information?

3 PRODUCTION OF REPORT USING WIKI APPLICATION

The production of the report on corporate responsibility is made using the Wiki application, as this offers advantages through being easy to make and use, and enables the professor to control and modify the content of the same. Access to said application is made via the WebQuest, via a link in the "Process" section.

So, each work group will have one Wiki consisting of four parts: (1) project page, where the corporate responsibility report will be made following the criteria established in the fund's ethical principles, (2) discussion, a space to be used by students to introduce their comments in relation to compliance or non-compliance with the excluding and evaluative criteria, as well as what they have found in journalistic articles and judicial sentences; (3) source or edition code, which makes it possible to make modifications to the project and discussion pages and (4) history, which enables the professor to monitor the individual work done by each member of the group and observe the development of the members of the same.

Said report will then be presented in writing in accordance with the aforementioned rules for delivery.

4 CONCLUSIONS

In this study, we propose the use of two tools pertaining to the knowledge society, namely a WebQuest and Wikis, to promote innovation and progress in the knowledge university students have of the financial and social accounting of companies and their responsibility towards society. Raising student awareness of issues of corporate social responsibility seems to us to be a fundamental part of their human and ethical training, and for preparing them for their future careers. Furthermore,

the use of the WebQuest enables students to become actively involved in the learning process, acquiring skills, competences and abilities that will be of use when they complete their studies and go into employment. When the proposed activity is completed, the students will have become familiar with ways of handling the accountancy reports provided by companies, developing a sophisticated level of knowledge in the area of accountancy, generating ideas and knowledge as a result of the experience, and developing social skills and capacities as a consequence of the interaction between the members of the work group. They will also be familiarised with information technologies, which are fully integrated in the business environment they will be joining in the immediate future. This methodology also combines a web environment with other sources of knowledge beyond the traditional ones that students can use and which are also detailed in the WebQuest, which enables them to broaden their horizons and come into early contact with tools that will be of great use to them in the future.

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HOW DESIGNERS USE THE WEB IN TEACHING
A Case Study

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Keywords: Design, Web, Design process, Pedagogy.

Abstract: This paper looks at how experienced design teachers use the Web in teaching students in studio environment in the Bauhaus tradition. It develops a framework for understanding possible functions of the Web over the design process, and examines Web use practices in one of Europe's largest design programs, situated in Helsinki. In the absence of department policy, instructors have developed various ways to integrate the Web to teaching. In particular, the Web is used at the more industrial end of education, reflecting changes in design over the last few decades.

1 FROM STUDIO TO THE WEB

Teaching designers at universities largely takes its cue from traditional crafts enriched with a dash of art following principles crystallized in Bauhaus. Essential to teaching is that it takes place in the studio rather than the classroom (Blashki 2002; Hummels & Frens 2008). This paper is a case study of how designers have integrated the Web to teaching in one of Europe's largest design programs.

With the exception of classes in philosophy, art history, and computer science, in which learning is based on models stemming from the mother disciplines, in such traditional design disciplines as ceramics and furniture design, knowledge is transmitted from one generation to the next mostly using a traditional master-apprentice model. A typical design class begins with an intensive classroom period, and continues through concept design to prototyping, which is done in studios. Throughout, crucial to the success to this creative, constructivist, and multi-sensorial process is a close connection between teachers and students.

However, even though the basis of design education has not changed much over the last 70 years, globalizing economy and changes in student population have brought about a few changes. In particular, design education stresses multidisciplinary teamwork, multiculturalism, new technology, and research. Most design tasks today are "wicked" (Rittel and Webber 1984) and require a multidisciplinary team. Multiculturalism is based on two trends: the increasingly global nature of academic teaching, and to the fact that globalizing economy requires people who are able to negotiate their way through multiple cultures. Designers have been in the forefront in adapting new technologies to their work, and new working methods such as user studies and system analysis are a routine part of design (see Valtonen 2007).

For many reasons, then, intensive communication is at the heart of the educational process. It is necessary for success in master-apprentice relationship, but also in today's complex teamwork processes. Obviously, it is also at the heart of many other processes, including the key process of socialization into the design profession, reflection (Schön 1983), and the creation of dialogue necessary for creating and maintaining a community of practice (Lave and Wenger 1991; Fischer et al. 2007; Stahl & Hesse 2006). On one hand, design education has many "affordances" – like communication – that favor adopting the Web; on the other, it has many affordances – like multi-sensoriality – that work against the Web (for affordances in design, see Norman 1998).

How, then, is the Web integrated to this environment? This paper analyzes design education in one of Europe's leading design schools, and looks at how the Web is actually used in the classroom to support education. Specifically, it probes two questions: (1) how experienced design teachers use the Web in their work; and (2) what explains these variations. However, this paper focuses on

traditional designers, who build chairs, spaces, products, and interactive systems, not media designers or software engineers. This paper focuses on designers trained in art rather than technology.

2 INTEGRATING THE WEB INTO DESIGN PROCESSES

Despite changes described above, design pedagogy still largely follows traditional master-apprenticeship model. In preparing for classes, teachers typically construct the design task often with companies, organize funding, materials, find and schedule expert lecturers, book studio and machine time, and organize access to possible equipment outside university studios from universities' outside networks. From the student standpoint, a typical design class starts with an introduction, which consists of lectures, readings, and other knowledge content that guide students to the topic of the class (i.e. issues like sustainability or banking services). This phase typically takes place in the classroom. This phase is followed by the design phase, which consists of:

- *Concept design*: students create concepts, often through a user-centered process. This typically takes place in meeting rooms and open spaces with a lot of wall space that becomes a knowledge environment (Nugent et al. 2008).
- *Studio phase*: often called prototyping, the focus is next on constructing the ideas. This typically takes place in studios and workshops.
- *Presentations*. During the class, there are gates for feedback, and at the end of the class is critique. Students typically prepare presentations of their work and rehearse pitching their ideas in front of the teachers, fellow students, and sometimes also experts who come from the outside.

After the class, disseminating design work usually borrows its methods from art and industry rather than science. Thus, its main "centers of coordination" (Latour 1990) are not only articles and books, but also exhibitions and expos. With fashion schools leading the trend, design work is increasingly exhibited on the Web (see fashion shows of Central St. Martin's, London at http://www.csm.arts.ac.uk/37495.htm).

Given this background, the Web may have several functions in design classes, if integrated to the process. At the heart is the design process, which provides for the structuring of Web use.

- *Knowledge content*. Most design classes inject knowledge that has its origins outside the design world. This knowledge can be communicated early on in the process, but also later using the Web.
- *Teamwork*. More often than not, design requires teamwork. The Web can assist in communication beyond just e-mail.
- *Design work*. Web tool may be used to support design work provided that it supports design methods that are typically visual and tangible, requiring a multimedia-based rather than a textual-only environment. (See Dreyfus 2001).
- *Reflection*. Modern pedagogy sets a separate set of requirements. The aim of design education is to raise professionals capable of analyzing problems and solving them in a reflective dialogue with materials, equipment, mentors, and customers. To these ends, design classes typically utilize tools that encourage dialogue and reflection, including blog and studio diaries (see Enyedy and Hoadley 2008; for example, see Tisch School of the Arts at NYU at http://itp.nyu.edu/itp/).
- *Communication*. Finally, for any design work to have any impact, it has to be communicated to outsiders, which sets another set of requirements for using the Web. Typically, designers prepare interactive multimedia presentations and videos to communicate their work.

Combining the process and these functions of the Web gives the following framework for integrating the Web into teaching. (Table 1).

Table 1: Framework: The Web in Design Education, Phase by Function.

		Knowledge content	Teamwork	Supporting design	Supporting reflection	Communicating to outsiders
	Preparatory phase					
Design phase	Introduction					
	Concept phase					
	Studio phase					
	Presentations					
	Aftermath					

There are many things that ease integration of the Web to design education. Designers are typically agile with technology and even if not technically

agile, they are typically favorably predisposed to technology and interested in investing time in learning it. They learn complex 3D modeling programs like Ideas, Rhino, or CATIA. Designers are well versed in 2D graphic programs such as Photoshop, Illustrator, and layout programs like InDesign, and although design is not a visual form of art, a good deal of design works with visual representations such as sketches, technical drawings, and prototypes that can only be communicated with photographs, animations, and videos. Most designers are taught far more complex e-communication skills than most university students, including knowledge of multimedia programs and even programming, sometimes databases, elementary Web skills (elementary HTML and scripting language (typically JavaScript and ActionScript)).

However, a set of other reasons makes the integration slower, some of which are familiar from other fields of e-learning. To mention only a few, *personal reasons and tradition* consist of issues like IT skills, interest in developing teaching, and teachers' preference to traditional studio-based teaching methods. For example, knowing 3D software does not make one an expert in designing for the Web, and especially among older designer generations, Web skills may be wanting, and many things important in design are difficult to deal with on the Web, including the tangible feel of shapes and materials, and the interplay of the hand and the eye. *Organizational reasons* consist of issues like the encouragement and support from management, IT security policies, and access to resources outside one's immediate work real, like virtual teaching platforms and CSCL support staff. *Work-related reasons* affect whether Web can be used or not. For example, some classes require extensive teamwork and media use, and some classes are taught from the distance, which makes Web use almost necessary, while studio-based classes in, say, glass design, have qualities the Web can support only in a limited sense. Depending on the particularities of the design program, these factors play out either for or against using the Web extensively. For example, traditional design schools typically work mostly in studios, and place stress on the skills of the hand rather than teamwork, communication and presentation skills.

3 DATA AND METHOD

This study is conducted at the School of Design in the University of Art and Design Helsinki. By European standards, the School of Design is large. It has about 800 students, and annually, on average 160 students graduate from its programs. This paper focuses on its MA programs rather than BA and doctoral students. At that level, it has five programs: industrial design, applied arts (glass, ceramics, and exhibition design), furniture and space design, and textile art. Approximately 40-50% of students admitted to the School are not native Finnish or Swedish speakers, making English the language of choice in teaching.

The curriculum is organized into three on average nine-week "modules," the first one starting in mid-October, the second in early January, and the third in mid-March. In addition, there are joint studies from early September to mid October. At each module, there are typically 5-7 alternatives from which students can choose, in principle freely, but in practice following their selected specialty. Thus, a textile design student typically takes classes in textiles rather than in glass design.

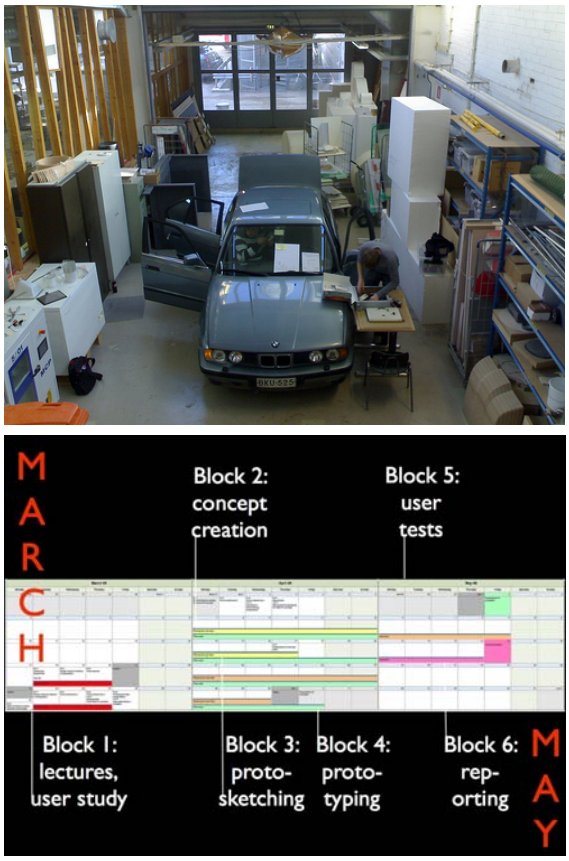

Figure 1 and 2: Up: Studio Space, with Students Building an Embedded System into a Car. Down: The Structure of a Module (Module 3/08, March to May).

In 2008-2009, the School offers 22 modules. With the exception of two modules that are based on

lectures, all other modules have a significant practical component that takes place in studio environment. Picture 1 is from a studio and Picture 2 describes one module in Spring 2008.

Teaching staff can be categorized into three main groups. Professors coordinate and often teach modules. Currently, there are 12 professors who teach. The School's 18 lecturers and 2 assistant professors focus on BA education, but also participate in MA modules. The most numerous group consists of part-time teachers, who are typically either practicing designers, visitors from local universities, or foreign guests. They typically run shorter than a-week-long workshops, and deliver lectures and lecture series on knowledge-based contents.

Data for this paper was collected from three sources. First, I went through the Web page of the School, and other documentation on paper for the academic years 2007-2009. Second, I sent a question to secretaries responsible for coordinating teaching, as well as computer staff responsible for running the Web (N=6). Third, I interviewed deans and those teachers who have integrated the Web to teaching more closely to analyze how they have used the Web (N=7). Since the number of cases was low (the maximum number of modules was 22), analysis was qualitative, following Miles and Huberman's (1994) suggestions for analyzing qualitative data.

With one exception, no integrated e-leaning platforms (for example, Scardamalia & Bereiter 1996) have been used in the School. This exception was one part of the joint module in September, between 2001-2004, which used a learning environment developed in Media Lab, a sister School in the University. The program is not used anymore, for it proved to be unreliable, its usability was wanting, and its pedagogic model proved not to be suitable for design education. The university offered Virtual University services between 2003-2006, when the service closed.

For ethical reasons, I will refer to modules using numbers rather than their names.

4 DESCRIPTION: HOW DESIGNERS USE THE WEB IN TEACHING

Currently, there is no School-wide strategy for adopting the Web, and currently, no support or incentive to integrate the Web to teaching exists. Thus, the current structures stems from the teachers' interests and independent actions. At the moment, 6 BA classes and 9 MA modules have a Web page. Another observation is that there is a clear dividing line between BA and MA education what comes to education on the Web. At BA level, all six classes are integrated to the Virtual University; at MA level, none of the classes uses this service. Only a handful of the School's more than 40 teachers have training in higher education and didactics. Perhaps not unsurprisingly for a design school, at higher levels of education, classes reflect teachers' interests and personalities not only what comes to the main contents, but also to adopting teaching methods and tools.

Table 2: Integration the Web to Design Process. Columns: 1. Preparation of the class; 2. Introduction; 3. Concept phase; 4. Studio phase; 5. Presentations; 6. Aftermath. No data could be found for module 6 due to non-response.

M	1	2	3	4	5	6	∑
1	-	+	+	+	+	-	4
2	+	+	+	-	+	+	5
3	+	+	+	-	+	+	5
4	-	+	+	-	+	-	3
5	+	+	+	+	-	+	5
6	n.d	n.d	n.d	n.d	n.d	n.d	n.d
7	+	-	-	-	-	-	1
8	+	-	-	-	-	-	1
9	+	-	-	-	-	-	1

Table 2 looks more closely at Web usage at the School through the framework exhibited in Table 1. Table 2 shows that in terms of the design process, teachers use the Web consistently in the early phases of the design process (i.e. phases 1-2), but with much less intensity later in the concept design and studio phases of the process. Early in the process, teachers use the Web to advertise their modules to students, and after students have registered to classes, to share content, materials, structures, and news for students. In essence, the Web is an information-sharing device. Also, there is a clear line between heavy Web users (modules 1-5) and other modules. It is as if the Web is either used, or used only minimally.

Table 3 takes a closer look at the functions of the Web. It has two important messages. First, it elaborates Table 2 in one important respect. The Web is mostly used for delivering knowledge content – like sharing lectures, schedules, and other instructions in PDF format – and only occasionally

for other purposes. Second, it elaborates the division line observed above still holds: heavy use concentrates on Modules 1-4, which also have integrated the Web extensively into the design process.

In terms of which kinds of Web techniques are used, only two classes are currently using the Web in an interactive way. In Module 1, the instructor has been using a commercial served based in Switzerland for sharing materials and for communicating with students. The instructor of Module 4 lives in Spain, and flies into the country every few weeks. In her absence, students are required to keep a blog for keeping the process going.

Table 3: Functions of the Web. Columns. 1. Knowledge content; 2. Teamwork support; 3. Supporting design work; 4. Supporting reflection; 5. Communicating to outsiders. No data could be found for module 6 due to non-response.

M	1	2	3	4	5	∑
1	+	+	-	+	-	3
2	+	-	+	-	+	3
3	+	+	+	+	-	4
4	+	+	+	+	-	4
5	+	+	+	+	-	4
6	n.d	n.d	n.d	n.d	n.d	-
7	+	-	-	-	-	1
8	+	-	-	-	-	1
9	+	-	-	-	-	1

The other two modules that use the Web throughout the process use it mostly as a bulletin board rather than an interactive forum for, say, sharing mid-term reports, or for doing interactive exams. It is used to deliver information about the class from teachers to students, and if information from students are delivered, it is filtered through teachers. At the School of Design, the Web is mostly a top-down technology rather than a marketplace of ideas, or a forum of dialogue between teachers and students.

5 TOWARDS EXPLANATIONS

There was no rank-order correlation to how the Web is used to any standard background variable like the age or the gender of the instructor, nor to the properties of the class like the number of students, or the age of the class. It was impossible to predict the reasons for adopting the Web using these background variables.

However, a few recurrent things were related to Web use. Most importantly, with one exception, industrially oriented designers have adopted the Web quicker than others. As Table 3 shows, at MA level, the rift between industrial designers and others is pronounced. At BA level, out of 6 classes using the Web, the same division line is just as apparent. One of these classes was in industrial design, and three in textile and fashion design.

The most likely explanation lies in some of the features typical to these design subspecialties. Both of these specialties are oriented to teaching designers capable for working in industrial settings. They put a premium on teamwork, process, and communication skills, and often prepare students for working in international companies in which IT is essential in coordinating design work. The main difference between these specialties is that industrial design works in 3D digital environment, while textile design is easier to integrate to the two dimensions of the Web. The difference is not crucial, though. In contrast, more artistic disciplines place premium on artistic skills and the skills of the hand that afford integration to the Web with difficulty. Interactive uses of the Web mainly take place in industrially oriented modules. (Table 3).

Table 4: Breakdown of Web Usage by Design Discipline.

Sub specialty	Modules using the Web (%, freq)	Interactive techniques (N)
Industrial and textile design	50% (3/6)	2
Other department	25% (4/16)	1

However, two qualifications are needed. First, it is important to note that even in the more industrial end of design, Web use is still fairly low. These affordances do not explain Web usage as such. Using the Web is far from a standard thing to do at the School of Design; to understand the Web, we have to look at variations between how individual teachers orient to teaching and using technology in teaching. Second, there is an interactive blog environment created for one module (Module 4 in Tables 2-3). This module makes an exception among the more craft-oriented programs. The instructor's response to my query concerning use illustrates well the prevailing attitude among instructors:

> In this class, we got tired of the stiffness of "official" net leaning environments, and built an own one. We have a student tutor who set up the system and maintains it. The

> idea has been to build on open services people already use for other purposes that do not require teaching. We sought an environment for contents, not the other way around. We use blog and Skype. (27 Nov, 11:11).

The absence of policy and managerial support, varying programming skills, restrictive university-wide security policy, and practically non-existent IT support staff leaves adopting technology to personal initiative. These reasons are mostly personal. As already mentioned, one instructor lives in Spain, which makes using the Web a necessity for her. Another instructor uses the Web for sharing his lectures to make it unnecessary to keep a physical folder in library. The third instructor uses the web because his classes teach teamwork, and are too big to be handled without technical devices. The fourth instructor uses the Web to share materials because she brings many people from the industry to the classroom.

6 DISCUSSION

Design as taught in art schools following tradition crystallized in Bauhaus presents an interesting case for those interested in using the Web to support teaching. Design teaching is essentially learning by doing: the crux of pedagogy is doing and integrating knowledge to designs through a controlled process. This process is sometimes based on a traditional master-apprentice model, but modern design goes beyond this model in not only bringing art to the classroom like in Bauhaus, but also in working in multidisciplinary and multi-cultural teams. These processes have properties that make integrating the Web both easy and difficult, through variously at various phases of the design process.

This paper has looked at the Web in one of Europe's largest design programs at the School of Design in Helsinki. At this department, using the Web is not governed by policy or by pushing one particular pedagogical philosophy (see http://www.edb.utexas.edu/csclstudent/dhsiao/theories.html#situated). Rather, instructors at the School are largely left to their own devices what comes to using the Web – or any other technology – in teaching.

The paper has built a simple framework for analyzing the Web at the School. The framework breaks the uses down by two dimensions, by a typical design process and by possible functions of the Web during the process. What we have learned through an empirical analysis is that Web use is unevenly distributed – that is, there are instructors who have adopted it to teaching extensively, while many instructors do not use it at all.

If there is one background feature that seems to explain Web use in the School, it lies in design subspecialties: the more industrial end of design education has integrated the Web more readily than the more craft and art-oriented end of design. Reasons behind this pattern are probably related to the way in which designers at the industrial end work, stressing communication and team working skills rather than skills of the hand or individual personality. However, there are significant variations at work behind this division line. The main conclusion has to be that Web use mostly goes back to the preferences and IT skills of teachers and to the type of the class. For example, the largest classes of the School routinely use the Web throughout the process.

Still, this is only a propensity. The main result has to be that even though the Web certainly has many uses in teaching design, it is far from being the tool of choice for design instructors. Why? Is there something in the nature of design that makes it difficult to use the Web? Can we bring the studio to the Web?

Apparently, our data suggests that there are natural limits in this transition. The affordances of the Web are some ways highly limited what comes to what sophisticated design requires. Issues like touch, feeling, hand, bodily skills, and being able to get immediate bodily feedback, are crucial for designers. Design is not just visual, but also a tangible and bodily. Especially in the artistic end of design, some designers take these qualities seriously, and see the Web as too limited a tool to be really helpful; for them, it may actually misdirect design.

However, some other things can be externalized easily, including dialogical issues like communication, coordination, and instruction (Eneydy & Hoadley 2006). Also, some design fields work through digital means, esp. industrial design, but also textile design; more generally, those design fields in industrial practice is digital (Valtonen 2007). When these skills are in the center of the profession, then the Web gives attractive options for education. Furthermore, some features of design education almost necessitate using Web-like tools. In particular, modern design is increasingly dispersed over a vast geographic area. Coordinating a class in Helsinki while the instructor lives in Spain would be practically impossible without the Web. It has a place in design education, and no doubt will

grow in importance.

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OPEN PUBLICATION SYSTEM
Evaluating Users Qualification and Reputation

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Keywords: Reputation, Collaboration, Trust, Quality assessment, Cooperation.

Abstract: In cooperative editing environments (e.g. Wikis), users can create and edit documents in a freely and cooperatively manner. However, sometimes it is interesting to identify if the contributions made by one user are really reliable, since users don't trust each other in an explicit way. This point is a central discussion about the open publishing truthfulness. While it is difficult to automatically identify the relevance of each user contribution, it is more plausible to evaluate their reputation as perceived by the community. In this paper we describe a model to evaluate the user's reputations in a Wiki community and the prototype developed for its evaluation. The basic assumption is that we are dealing with a homogeneous cooperative group on a limited knowledge context. This environment exists, for instance, in a cooperative group trying to consolidate organizational implicit knowledge into documents as a class-based report generation. This kind of environment is very useful to stimulate collaborative learning.

1 INTRODUCTION

The consolidation of Web 2.0 (Millard, 2006) brings more attention to open content edition environments. These environments work with spontaneous user's contributions to enlarge their contents. Wikipedia, the most successful Wiki application on the web, is equivalent to paper encyclopedias in terms of contents and, according to Giles (Giles, 2005), may be considered as trustful as closed revision environments. Apart from this evaluation, some criticisms arrive when we try to mix conflicting points of view maybe influenced by conflicts of interest. For instance, similar subjects may be interpreted with antagonistic perceptions or even ideological back-grounds.

The combination of the potentials of Wiki environments and the production of scientific knowledge developed in a collective manner allows productivity growth, researcher's integration and the development of a review process that is more transparent and interactive. Wiki environments, however, have problems related to the lack of trustworthy among users, since they generally don't know effectively each other. Trust is basic to any relationship in which the attitudes of the involved parties cannot be controlled (Jarvenpaa,) and it is usually addressed by reputation systems. These systems collect and distribute information regarding the behaviour of the individuals (Resnick, 2005).

In this sense, we developed a dynamic qualification mechanism based on reputation evaluation techniques. This mechanism can minimize the lack of trust problem in Wiki environments and qualify the users of a homogeneous community. This mechanism analyzes the user's reputation, and it is based in quantitative and qualitative data obtained from the Wiki environment and from other users' evaluations. With this information at hand, it is possible to create a rank to be employed as a relative index of users' reputation and to increase trust or confidence among users. An extension to the MediaWiki system was created to implement and evaluate the proposed qualification mechanism.

This research started from the experience of the last author with collaborative learning based in a research report generation by graduate students employing the Google Docs. All work was peer evaluated at the end of the course in a manual way. With the open cooperative editing environment the user reputation evaluation stimulates the individual work quality by a continuous ranking.

2 BACKGROUND

Reputation systems can be described as a computational implementation of the word-of-mouth information dissemination mechanism (Hu, 2006). These systems collect, distribute and aggregate feed-back about users' past behaviour. Their application can assist people in getting trust about other people, even if they don't previously know each other, or if they have a limited knowledge of the partners. According to Resnik et al. (Resnick, 2005), “Reputation systems seek to establish the shadow of the future to each transaction by creating an expectation that other people will look back on it”.

Auction and e-commerce sites apply variations of reputation systems to provide some insurance to users. Collaborative environments can use variations of reputation systems to increase trust among its users. The community qualification assessment of individual researchers was recently considered as one of the central criteria for the evaluation process. Not only individual researchers are under social evaluation but also the conferences and journals are receiving evaluations based in the social perception of their importance (Butler, 2008).

We developed an alternative editing process that uses the approach developed in our group to support the open reviewing process (Oliveira, 2005). In this case, users can edit, comment and review documents created by other users. In this approach, the process is centered in the open edition and reviewing of scientific papers, which is an alternative approach to the blind or double blind review system, mostly adopted by the academia. Within this approach, the knowledge is collectively generated and reviewed in a transparent way.

We decided for existing Wiki environments to the production of scientific and technical documents, since they have the needed framework to manipulate texts, besides a good user management and version control. The main problem found in these environments is that most users have a limited knowledge of the members of the process (i.e., they may not know the other members). In an intercontinental research project that includes many participants, for example, this situation also happens. This is a consequence of the fact that interactions are mostly restricted to the exchange of data over the web, as physical meetings are very expensive, affecting how confidence or trust among authors/partners is established.

Reputation systems are employed to minimize this problem, and they create confidence between users of these systems. Recently, Google started the Knol service allowing users to write, evaluate, comment, review and contribute to other authors’ works. Authors can accept or not the contributions made on their work by other authors, but the evaluations and reviews regard the whole document, not individual contributions or comments.

In our approach, every user knows what and who edited and contributed to each document, and they can evaluate other user’s contributions and comments. One important point is that the process is still peer-reviewed, and reputation and confidence are yet important factors, but they are built on the bases of the social network. To evaluate this approach, we have extended the MediaWiki environment, incorporating some features, which are described in the next section, to implement the proposed reputation model.

It is important to state that this paper is based on the qualification mechanism conceptually developed in (Oliveira, 2005), which describes an open editing model in which there are three types of users: author, commenter and reviewer. When a person creates an account, he or she receives the ‘commenter’ status, which gives the ability to annotate documents, after a ‘commenter’ may be promoted to ‘reviewer’. The basic idea to support this promotion is based in a comparison among the user rating and the paper rating, if the user has a rating that is equal or higher than the paper’s rating, he/she will be allowed to review directly the text of the paper. This is an approach slightly different than the traditional Wiki process, in which every user can edit every page except for certain pages that are consolidated and blocked. Authors can comment and create new documents.

Reviewers are more qualified users that can also edit others documents. The role of a reviewer is also different from the role of the traditional reviewers involved in the academic reviewing process. In the traditional closed reviewing process, they may suggest changes to improve quality. Here, they directly contribute to the quality of the document by editing the text. Each person participating in the process is identified and all the actions are registered; the authors may accept or reject the received contributions.

We will validate the real-world operation of this approach in an on-going project for the publication of an experimental open edited version of a computer science journal, where the best papers, written by Ph.D. students, will be published using collective authoring, with the first author being the original writer of the document.

Next section describes our reputation model and how the user qualification is measured. It is important to state that, in this paper, we only address the roles of authors and reviewers.

3 REPUTATION MODEL

The qualification mechanism conceptually developed in (Oliveira, 2005) and implemented by our prototype give points to users according to their interaction with the system and also takes in account the evaluation their documents receive from the community. This is a continuous grading mechanism that allows a user to start from nil recognition and reach the better grade by a peer-to-peer assessment process. Considering previous evaluations, we expect to minimize Sybil attack problems. The Sybil attack is common in peer-to-peer systems when one entity responds by more than one identity, creating information bias (Doucer, 2002).

Interaction is a source of quantitative data. Each time a user access one page, we count one hit of this user in that page. User pages and documents created by the user are not taken in account. Consecutive accesses to the same page are computed if the interval between the accesses is greater than 24 hours; this is a heuristic to identify different accesses, perhaps composed by multiple pages reads during a specific time-period. The access rate is an indicative of the popularity of the document. It is clear that popularity is not an absolute quality indicator, but this happens also in the generally accepted impact index. In the extreme case, a paper may be referenced a lot of times as a counterexample but the reference counter is increasing. The discussion is related to a conceptual and philosophical debate about what quality and popularity are; then we decided to take the commonly accepted approach that a large amount of access indicates a good content.

On the other hand, qualitative data is based on user´s evaluation. All the documents available in the environment can be evaluated by any registered user. This approach is similar to the model found in reputation systems, in which evaluators indicate their grade of satisfaction in relation to the evaluated resource. To enable this evaluation, one effortless visual component containing five stars (Figure 1) was inserted on each page. Each star, from left to right, corresponds respectively to ‘very bad’, ‘bad’, ‘neutral’, ‘good’, and ‘very good’ in a five points Likert scale.

Figure 1: Visual evaluation component.

Qualitative evaluation measures the opinion of each user in relation to one specific document. When a document is evaluated by different users, there is a probability that it will receive different evaluations. However, as each user has a different qualification and reputation, the evaluation he or she gives must be related to this attribute; the most considered users, with great reputation, are more valorised in their opinions than the less considered ones. The underlying supposition is that we are working with a homogeneous cooperative group. For heterogeneous groups, with different and conflicting points of view, clustering mechanisms may be employed to identify diverse sub-communities.

We developed a method named EQ1 to deal with the different qualification of users. In this method, one positive evaluation of a more qualified user will count more than few negative qualifications of less qualified users. The purpose of this method is to generate confidence among users by an open and socially constructed reputation ranking. It is more plausible to have a more relevant and important evaluation from a well qualified user to the cooperative community, since this user has more social appreciation and reputation. We also worked with a method that does not take into account the user qualification for comparison purpose. It is named EQ2 method. Both methods are presented bellow.

3.1 EQ1 Method

Most qualification approaches are only quantitative-based, considering the quality as a side-effect of the quantitative data. The approach presented here is also quantitative, since it takes in ac-count the number of interactions performed by the users. However it is also explicitly qualitative, since it is based on the evaluations performed by the community about the level of approval of each document and on the evaluator’s reputation. EQ1 method was designed for the specific application described before, in which a Wiki system is employed to allow researchers edit and review documents in an open process, but it can be extended or adapted to other applications.

The qualification points produced by the EQ1 method generate a users ranking. This ranking is employed to generate a social confidence index, which is the central factor in this context. The

confidence points are also applied to suggest the quality of the documents assessed by the community. EQ1 aggregates characteristics from reputation systems, since it takes into account the evaluator competence or qualification in the evaluation. Then, better qualified users (or users with better reputation) give or take more points than lower qualified users (with low reputation).

The EQ1 algorithm adds to the document's author qualification the product of the normalized evaluator qualification by the given qualification value. This qualification is computed by the following equation (1).

$$PA = P'A + (F \cdot N(PE)) \quad (1)$$

In this equation, given that A is the author of the document being evaluated and E is the evaluator, PA is the resulting qualification of the author, and P'A is his previous qualification (all authors start with a neutral qualification of 1). F is the multiplication factor, which can be -3, -2, 1, 2, and 3. These values correspond to the five criteria of evaluation, already stated: very bad (-3), bad (-2), neutral (1), good (2), and very good (3). N(x) is a normalization function employed to map the evaluator's qualification (x) to values between 0 and 1. Thus, N(PE) returns the normalized qualification of the evaluator, and consequently the final score is also ranged between -3 and 3.

Figure 2 shows an example of this process. The evaluator chooses his grade of satisfaction for the document he has just read, clicking on the corresponding star. This is translated to the corresponding numeric value and used in the equation.

Figure 2: Evolution of an author´s qualification.

3.2 EQ2 Method

This method does not take into consideration the evaluator's qualification, and was defined as the base-line of our system. Then we can analyze and compare the behaviour and the tradeoffs of our system against the basic method. EQ2 is computed by Equation 2.

$$PA = P'A + F \quad (2)$$

In this equation, as in the previous, PA is the resulting qualification of the author, P'A is his previous qualification and F is the qualification given by the evaluator.

4 QUALIFICATION FEEDBACK

The reputation of a user is created by the qualification mechanism. In the prototype, we have implemented two forms of user qualification feedback: the user qualification ranking and the user dashboard.

User Qualification Ranking. In this ranking, users with greatest qualification are located at the top of the list. The ranking consists on an ordered list, composed by the user identification and the associated qualification.

The ranking uses a decreasing order of qualification, and is dynamic generated. It is based on data available at the request time. To achieve better positions in the ranking, the user must access and write documents. These documents must be accessed and evaluated by other users to generate ratings. These ratings are added to the user's qualification to change the position in the ranking. The ranking is available to all users.

User Dashboard. Dashboards are graphic representations that allow quick visualization and comprehension of a data series (Butler, 2008). Dashboards are employed on business environments, keeping critical information available for decision takers.

In our case, dashboards are used to aggregate quantitative data about users and documents. They were implemented as a MediaWiki extension, and can be accessed from any user page, using a loupe icon. When someone clicks on the loupe, two graphs are shown: the bullet graph and the bar graph.

Bullet graphs (Figure 3) were created by Stephen Few (Few, 2006). A bullet graph can represent complex information. The graph is composed by a central bar that shows the results for the analyzed user, the vertical strong black line signs the mean achieved by the user and the small horizontal black line represents the average rating of the population. The graph also has a shadow area (the central region) that presents the standard deviation of the population. Figure 3 presents a bullet graph for the User A. Analyzing this graph, we can perceive that this user has good qualification, since the dark vertical central line (representing the individual User

A qualification) traverses the central horizontal line (representing de average qualification for all users) and also leaves behind the standard deviation, which is between -1 and 1, in this particular graph.

Figure 3: Bullet graph showing information about 'User A'.

The bar graph (Figure 4) is used to compare values, and in our case it is used to show five vertical bars representing the amount of evaluations the user receive on each qualification level ('very bad', 'bad', 'neutral', 'good', and 'very good'). Figure 4 shows the amount of evaluations that another user (User B) received on each category. Users with well evaluated documents will have the bars on the right higher than the on the left.

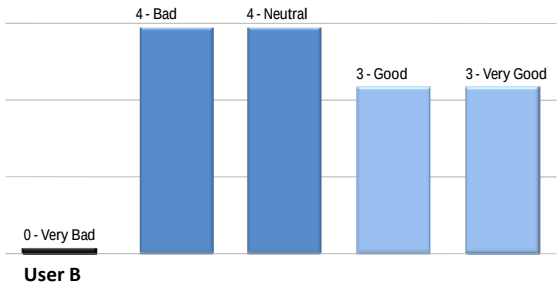

Figure 4: Bar graph used to show the amount of evaluations given for User B, on each category.

5 EVALUATION

To evaluate the proposed model, we have designed an experiment in which users were invited to evaluate the documents of other users. Data about their interactions and evaluations were collected and analyzed using EQ1 and EQ2. We were searching for variations in qualification rankings that confirm EQ1 effectiveness.

The experiment was composed by 10 pseudo-authors (users A to J) generating news about sports. To abbreviate the process, the texts were extracted from two main on-line Brazilian sports news services, O Globo and UOL , and their contents were related to nine soccer teams (teams T1 to T9) as if they were written by the ten writers. The central idea of the experiment was the evaluation of the ranking procedure not the writers' quality. After the document generation phase, each real user would focus on the evaluation of other user's documents. There were thirty documents in the total, some concerning local teams, from the same region of the users, and others involving teams from other regions of the country. Three documents were associated to each user, in the following manner: as there are three teams in the users' region (T1 to T3), users A, B and C received one team each; user D received one document from each team; moreover, the remaining users received documents from the other teams in a random fashion. We must state that T1 and T2 are from the same city and have large rivalry, T3 is neutral and the other teams are from different and distant regions. To have a homogeneous population, we have chosen the most part of the participating users to be supporters of T1. The distribution of documents concentrates documents from T1 in user A and from T2 in user B. If EQ1 is a method that overweight qualification of consensual users, the distribution that we use on the experiment will create a very qualified user (A) and a weak qualified user (B).

After the experiments, we confirm that most users have the team T1 as their favourite team and that is why User A received better evaluations, since his documents were from this team, and user B is negatively evaluated, since his documents are from team T2. The Figures 6 and 7 show the resulting normalized users´ evaluations, using, respectively, EQ1 and EQ2. The first three positions (bottom to up) are the same, but user B changes from the last position (using EQ1) to the seventh position (using EQ2). The graphs presented in these figures demonstrate that EQ1 privileges the consensus and the evaluations given by the more qualified users.

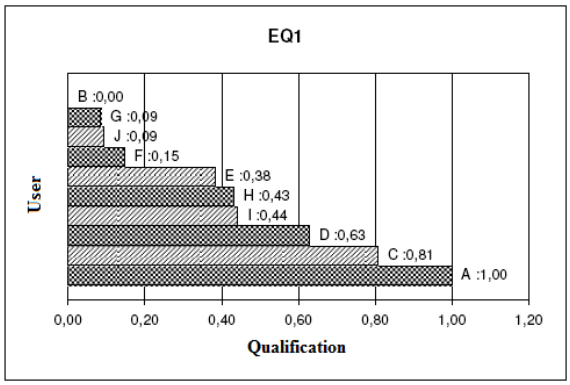

Figure 6: Users´ qualification using EQ1 (normalized).

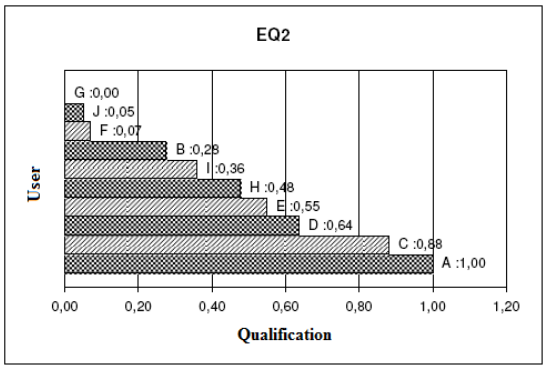

Figure 7: Users´ qualification using EQ2.

6 CONCLUSIONS

The open reviewing of documents is an open issue. A huge effort is being developed for the implementation of open access libraries but the quality assessment of this production needs to be assured. An interesting possibility is the open reviewing process. A simple alternative is the one proposed by Wikipedia, where all modifications are logged and a comparison among versions may be performed by user request. The main problem, in this case, is the absence of a clear acknowledgement of the reviewer's competence and trustfulness. A more recent proposal is the Google Knol service, in this case the authors and rewires must be identified and the revisions verified by the author. Our model and prototype offer a complete alternative to open publication and open reviewing of Web publications. With the social competence assessment of the participants, it is possible to develop a fair and independent papers quality evaluation.

The dynamic qualification mechanism present in this paper is an alternative to the generation of truth (confidence) among users of a Wiki system. It also addresses an interesting extension to the MediaWiki system, and users can edit, comment and review the documents created by other users, giving more transparency to the scientific knowledge production process.

The choice of the MediaWiki environment was appropriated, since it offers full Wiki functionality, including user and document management, version control, concurrence and consistency control, minimizing our development cycle. Besides that, it has interesting extension mechanisms that were used to carry out our qualification method. Finally, the MediaWiki environment is already known by many users, which minimizes the impact usually involved with the adoption of a new system.

The system has also other interesting applications, such as supporting collaborative work in graduation courses. In the case, students could use the environment to publish their works and to contribute in their colleagues documents. More qualified users should act as reviewers, giving more specific contributions and evaluations. Another interesting open possibility consists of employing the sys-tem as a submission and reviewing system for a scientific conference or journal, in order to analyze the differences between the traditional process and the proposed one.

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BRINGING SCIENCE AND ENGINEERING TO THE CLASSROOM USING MOBILE COMPUTING AND MODERN CYBERINFRASTRUCTURE

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Keywords: TabletPC, Wiki, Multidisciplinary education, MARIACHI, Ultra-high energy cosmic rays, Mobile technology.

Abstract: This paper reports on the creative educational and research program of MARIACHI (Mixed Apparatus for Radar Investigation of Cosmic-rays of High Ionization) at Stony Brook University, a unique endeavor that detects and studies atmospheric phenomena (lighting, meteors, or cosmic rays) by using a novel detection technique based on radar-like technology and traditional scintillator ground detectors. During the past and current academic year, our program has been effectively modernized and streamlined in both research and educational aspects with the implementation of mobile technologies by the use of TabletPCs and wireless data collection systems as well as emerging cyberinfrastructure based on dynamic services as wiki, blog, and Internet-based video conferencing.

1 INTRODUCTION

This paper reports on the latest efforts of the MARIACHI (Mixed Apparatus for Radar Investigation of Cosmic-rays of High Ionization) program (Takai, 2008) at Stony Brook University, a unique endeavor that detects and studies atmospheric phenomena (lighting, meteors, or cosmic rays) by using a novel detection technique based on radar-like technology and traditional scintillator ground detectors. The program provides intensive engineering, science research and educational experiences for students at all levels (high-school, undergraduate and graduate) working with a multidisciplinary team of scientists, engineers and educators (Bugallo et al., 2008).

Using atmospheric phenomena as vehicles to motivate research and educational activities, we develop innovative hands-on modules in physics, engineering and cyberinfrastructure based on a learning by doing philosophy with particular emphasis on radar technology (Bugallo et al., 2009). Students participate in research projects, seminars, and workshops, where they learn to use tools needed in MARIACHI. We create a natural chain of instruction where undergraduate and graduate students in the program participate in the instruction of high school students. To broaden the impact of the project, many activities are offered to a wide audience, with particular emphasis on traditionally underrepresented groups. The latter commitment is possible primarily due to the partnership of MARIACHI with the Stony Brook Center for Science and Mathematics Education (CESAME) (Bynum, 2008), an award winning science education organization, and the Women in Science and Engineering (WISE) program (Miller, 2008).

The current instruction of the educational activities offered by the MARIACHI team has been substantially improved by the use of mobile technologies in the form of TabletPCs. Our research and educational facility is a large laboratory with an area for theoretical lectures, a radar set-up, a scintillator ground site, and a data-acquisition room. Students participating in our offerings need to move from one place to another to take notes, develop different experiments, or attend seminars. The use of the TabletPCs has allowed for advancing the teaching/learning activities of our study program, and favor the joint use of facilities and expertise among not only students but also the rest of participants. Moreover, the physical separation of participants (high-schools, research sites, or classrooms) has required implementation of a reliable and secure data collection system and efficient tools for

information exchange and communication. Emerging cyberinfrastructure based on grid technology has allowed for secure data exchange as well as for sharing of common knowledge and interactions among participants through dynamic services as wiki, blog, and Internet-based video conferencing. Our goal of bringing science research to classroom is achieved while students are exposed to cutting edge technology.

2 TEACHING & LEARNING MARIACHI

The science of MARIACHI requires the collection, processing and analysis of signals using radar-based technology and scintillator ground detector sites[1] (see Figure 1).

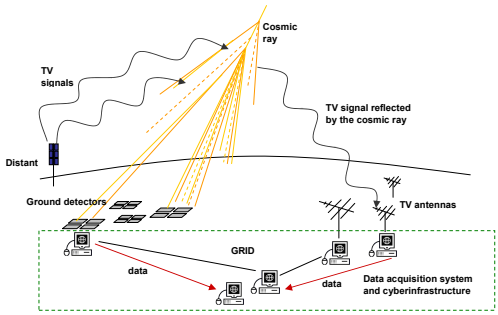

Figure 1: The MARIACHI experiment.

Through our educational offerings, students are not only exposed to the theoretical aspects of the project through regular lectures but they also experience all the practical phases of experiments with hands-on activities and by directly collaborating with physicists and engineers. The range and variety of activities is large and comprises from understanding concepts like frequency or cosmic rays to calibration of antennas (which are outside the laboratory) used for data collection, counting of events with ground detectors, collection and analysis of data, or reporting of results. Here we describe some of the main educational activities of the program.

2.1 Workshops

Through a one-week summer workshop and several one-day activities, high-school teachers and students learn about the main elements of MARIACHI and build scintillator ground detectors to be installed later on in their schools with the purpose of collaborating in the data collection and analysis (see Figure 2). The workshops are a combination of training, brainstorming, and hands-on sessions and are instructed by faculty, technicians, postdoctoral students, graduate students and high school teachers. Once the setup is installed in the schools, students are introduced to various data analysis tasks, for example the study of cosmic ray rate dependence on barometric pressure.

Figure 2: Left: Building a scintillator ground detector. Right: Brainstorming session.

2.2 Undergraduate Offerings

The undergraduate activities combine regular courses and research projects:

- An introductory course on scientific method, technology and modern cyberinfrastructure uses the atmospheric phenomena to motivate students in research activities. The objective is to introduce the different components of the project and let students propose their own topics of research and carry out a complete experiment.
- Various eight-session four-week inquiry-based courses through the WISE mentoring program are offered. The objective in this case is to provide with series of basic exercises for data analysis and comparison using the new technology.
- Engineering students have shown interest for the radar-like detector research and conducted their senior design project (one year duration) under the supervision of our engineering team. Last year a group worked on calibration of the instrumentation for signal acquisition, and currently another group is working on data analysis of radar data.

2.3 Research Projects

Some high school students have developed their Intel projects[2] under the supervision of MARIACHI researchers. MARIACHI has also offered the opportunity for teachers to participate in the ongoing research

[1] For a more detailed explanation of the MARIACHI research experiment please refer to (Takai, 2008).

[2] The Intel Science Talent Search is a US pre-college science competition.

experiments with many possibilities for personal as well as professional growth. As mentioned in the previous section, some undergraduate students have carried out their senior design projects in radar topics as well as some master students who are preparing their dissertations in data acquisition or cosmic ray detection, localization and classification.

3 MOBILE COMPUTING AND CYBERINFRASTRUCTURE

MARIACHI is a widely geographically distributed experiment and run by students and professionals of different backgrounds. The body of data collected by the experiment requires the use of modern day computer and network technology. The participants need to be trained in both the use of hardware and software to fully take advantage of this technology. The challenge of a widely distributed system is to provide mechanisms to guarantee data integrity and secure transfer. This is especially true when a diverse group is involved. The collaboration also needs secure collaborative tools such as the wiki and secure email.

In the context of the Mariachi project, cyberinfrastructure has several facets. Learning how to handle these tools is an essential step to perform experimental work in any area of science. Training and educating participants to use these tools is one of the main objectives of MARIACHI. This process takes place while the experiment explores its science.

Due to the physical separation of the experiment resources and participants, in the past the offered courses, workshops and projects needed a well defined set of activities that could not be properly combined and developed to full extent. The integration and exploitation of mobile technologies as well as modern cyberinsfrastructure tools has facilitated enhanced teaching and learning and efficient communication.

3.1 Use of TabletPCs

At the MARIACHI home, the exploitation of portable computing technology in the class provides with many opportunities for students to move from activity to activity writing notes easily, storing data, sharing results, asking questions, or presenting results (see Figure 3). Mobile computing in the form of TabletPCs has allowed for integration of the theoretical and practical components of the deliveries in only one classroom. All the needed resources are available to perform theoretical explanations, programming experiments, or research activities.

Figure 3: Use of a TabletPC during the summer workshop.

The use of TabletPCs has also enhanced the teaching and collaborative learning by providing multimedia support for friendly explanations and presentations. By connecting the TabletPC to a projector, we have a fully interactive presentation system that allows for delivery of highly visual and dynamic lectures with multimedia presentations and demos. Besides, all the notes, students' exercises, and live elements of the discussion sessions are saved, which facilitates keeping more accurate records of students' progress. It also allows a more individualized attention to the students. At the conclusion of the offered activities the participants are able to use the TabletPCs in a mobile situation to collect, share and compare experimental data from both the scintillator sites and the radar set-ups.

The communication between the instructor and the students and among students as they move from setup to setup has also been improved. Students and instructors are able to communicate even if they are carrying out different activities in different locations.

Finally, the TabletPCs are particularly good in MARIACHI for field work where connectivity is available and are used for field data collection and recording. In training sessions mobile technology is very useful for participants to perform different experiments at different stations in a laboratory setting while recording information.

3.2 Cyberinfrastructure in Action

MARIACHI has established a Linux-based server for data repository and dynamic web content services. One of the first projects undertaken was the creation of a website based on two growing and popular concepts: wiki and blog (Takai, 2008). The website is publicly accessible, but contributing and editing is restricted to registered MARIACHI users. The website has been enthusiastically received and many people have made substantial contributions. In particular

many of the participants have created their own personal user profiles which constitute an evidence of the diversity of the group. We are increasing the level and frequency of participation by assigning editors to specific areas of the wiki.

MARIACHI requires radar and ground detector sites with cyberinfrastructure for data collection and analysis. We demonstrated the ability to produce complete ground detector kits, build and install detectors in high schools, install antennas, and upload data to the MARIACHI server. The detector assembly workshops continues until the installation at currently affiliated high schools is completed. After the mechanical installation of each system, detectors are commissioned and calibrated in situ. Data uploading from behind high school firewalls has also been accomplished. This step is significant for the progress of MARIACHI as high school firewalls are extremely secure and protective. Interactions with information technology personnel from several schools were very important in this task. The data collection is now being implemented and the status of each site is displayed on our website (see Figure 4).

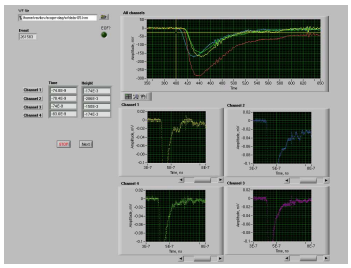

Figure 4: Oscillogram of signals and data collected from four detectors in a classroom.

Though the data rate is not very large, the nature of the experiments and searches to be performed require participants to become familiar in handling statistical data analysis. While spreadsheets such as Excel provide preliminary analysis, we are introducing modern statistical data analysis packages, such as R.

Finally, videoconferencing has proved to be a useful cyber tool to establish communication between MARIACHI sites. Its educational potential was demonstrated when Ward Melville High School students joined in a CERN (European Center for Nuclear Research) Masterclass program (Pregernig, 2008) using internet videoconferencing to discuss particle physics with students from Poland, Slovakia and Greece. We have installed and evaluated commercial software used by educators. Tests were conducted with local high school teachers and internationally with the University of Rio de Janeiro and CERN with positive results for audio, video and whiteboard.

4 CONCLUSIONS

MARIACHI's goal of bringing science and engineering research to classroom is achieved while students are exposed to cutting edge technology. For the participants, this infrastructure brings added flexibility, excitement, and innovation in their process of learning and support programs that are necessary for running the educational and research activities, and facilitates the communication between them (e.g., e-mail, instantaneous messaging, wiki).

The structure of the program has attracted additional sites not only nationally but internationally located. These new participants have already attended some of the workshops and courses and are implementing similar activities with the collaboration of our faculty, researchers and teachers.

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HELP DESIGN FOR THE METACOGNITIVE GUIDANCE OF THE LEARNER

A Proposition of Computer-Based System

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Keywords: Learning, Distance education, Computer supported education, ICT, AIED, Modelling, Help, Guidance, Metacognition, Metacognitive guidance, Multiagent system.

Abstract: This paper presents the framework and the software system we have built in order to provide metacognitive guidance help in Computer Supported Education. The goal is to assist self-regulation of the learner thanks to a dynamic help system which takes into account in real-time the learner's behavior and his profile. The software system is a multiagent system which captures the learner's behavior, analyse it and define the help. Used currently in the step of conception, the software system will become the learning system by successive learning and enrichment. We present its principles and its operational aspects. The application field of this work is the French certificate “C2i”.

1 INTRODUCTION: SELF-REGULATION AND METACOGNITIVE HELPS

We are in the context of learning throughout life supported by Information and Communication Technologies (ICT). Students, workers, retired people are more and more often faced with learning alone, at home or on their workplace. In this context, there is usually no teacher present to monitor and assist them. To meet this need, a lot of learning is given through computer-based learning systems: online tutorials, courses, or more integrated systems (Learning Management Systems, Learning and Content Management Systems). In this way, learners have spatial (through remote systems) and temporal (the learners can learn according to their availability) autonomy. If they are properly designed, these systems allow education adapted to the profile of the learner: his knowledge, learning experience, metacognitive profile.

Unfortunately, it is now clear that these systems do not often achieve their goal (Osman and Hannafin, 1992; Winne and Stockley, 1998). One of the problems of the effective use of ICT for learning is that these systems require that the learners regulate their own learning (Avezedo, 2005). Few of them have the required skills for taking in charge ones cognitive functioning (e.g. Hannafin & Land, 1997). Acquiring new knowledge and ability appeals not only to cognitive processes (activation of knowledge, use of adapted learning strategies, and memorization of new knowledge) but also to metacognitive processes (planning, self-evaluation, learning regulation). In face to face education, some of these metacognitive activities are provided by the teacher; in the context of computer supported education, they fall to the learner. It is why we speak about self-regulated learning for this kind of learning.

To help learners to regulate themselves, the designers of computer-based learning systems have added learning helps to support planning, self-evaluation and learning regulation. The table 1 gives some examples of help available on computer-based learning systems; we can see what may be provided by the teacher (in face to face education) and what is left to the learner in the context of computer supported education.

Table 1: Examples of helps.

Metacognitive activity	Help provided by the teacher (in face to face education)	Help available in computer-based learning systems
Planning	The teacher defines the purposes and the duration of the lesson. The teacher defines the distribution of learning activity.	The system asks the learner to define a priori his learning time.
Self-evaluation	The teacher defines exercises or questions to verify the control of a concept or a part of the lesson. The learner can ask questions to the teacher or to other learners.	The system provides exercises, questions and feedback. The learner can ask questions to the teacher or to others learners via the forum.
Regulation	If the learner meets with difficulties, the teacher can provide help (for example, an explanation in a scheme-form), an advice ("read again a chapter"), an indication ("look for the definition of a concept"), an answer (a solution). The learner can approach other learners.	Depending on the answers to questions, the system may propose to the learner to revise a concept. The learner can approach other learners via the forum.

However, the efficiency of these learning helps has not been really evaluated and some recent works show difficulties in their use. We can notice that some of them are underused or even unused (Narciss, Proske, Körndle, 2007; Narciss, Körndle, Dupeyrat, 2002). Other works highlight inadequate use of help; it is what Roll et al. call metacognitive bugs (Roll et al., 2005): for example, unorganized over-use of help (Roll et al.,2005), exclusive use of help that provides an answer rather than an indication to look for the answer (Aleven et al., 2003).

This rather disappointing acknowledgement raises questions about the metacognitive abilities which are necessary for adequate use of help: to be aware of needing help, to choose an appropriate type of help, to detect the usefulness of help, to realize when help is necessary, and, after failing, to detect which help to revise (Aleven and al., 2003 ; Puustinen, 1998). Works in metacognition field show clearly the difficulties to acquire and to apply such metacognitive abilities, even in face to face education. They show also that these skills change according to factors like learner's knowledge and age.

2 THE CEAGMATIC PROJECT

2.1 An Original Project

Our work is a part of the CEAGMATIC project of the French National Research Agency (ANR). Researchers involved in this project are members of the CLLE-LTC (Laboratoire Travail et Cognition) and IRIT (Institut de Recherche en Informatique de Toulouse)laboratories.

The main goal of this project is to design and build a help guidance system to improve learners' metacognitive abilities. This system has to analyze the learner's profile and to react in real time to learner's behavior. The project team is composed of researchers in the fields of cognitive psychology and computer science.

To the best of our knowledge, only one research center has made such a system (the Human Computer Interaction Institute of Carnegie Mellon University, Roll et al., 2005) but with only one kind of metacognitive guidance. Our system will go further by proposing and comparing many kinds of guidance: one proposed and then accepted by the learner and another one, imposed by the system (in order to compensate for a learner's metacognitive lack or inappropriate behavior).

Another important part of this project is the learners' profiling. We take into account learners' demographics, cognitive and metacognitive profiles: the system will build a learner profile through questionnaires and real time activity analysis. This profile will be used in order to select how and when to help and to guide the learner. It will evolve according to the effectiveness of the helps and guidance. This designing choice allows us to target heterogeneous categories of learners (workers, students, …) as we can adapt the system's help and action to the learner's profile without overloading him with useless interactions and documents.

Moreover, we can provide the help progressively, when the learner (in fact, his profile) evolves.

2.2 The Project's Steps

The project begun on 2007 and will end on 2011. In order to design and build the help and guidance system, we have defined the following steps:

- Preliminary: Defining learner's regular and inappropriate behaviors by analyzing learners' behaviors on provided interactive lessons and exercises (the first version of the system does not provide specific helps) ; this step is completed
- Providing Cognitive Helps: Adding helps devoted to "inappropriate behaviors" identified during the previous step. Then analyzing again learner's regular and inappropriate behaviors integrating these new helps (we will target bad use of these helps as the "metacognitive" inappropriate or missing behaviors) ; this step is in progress
- Providing Metacognitive Helps: Adding metacognitive guidance actions devoted to metacognitive needs identified in the previous step. These actions will be either guidance actions or metacognitive profiling actions.

In order to support these 3 steps, we have built a multi-agent system which can capture and analyze learners' behavior while they study. This system has to provide the lessons and exercises to the learners (Figure 1). The main goal of this paper is to describe and explain how and why we are building this system. The other results of our experiments will be presented later after step 3 will be finished.

2.2.1 Step 1: Preliminary

- A psychologist has studied and analyzed learners' behaviors during face to face lessons
- Experienced teachers have specified the learning activity and the optimal behavior in terms of tasks and knowledge (Paquette and al. 2002)
- e-Learning engineers have built an online course according to the previous specifications
- The online course has been tested over 100 learners and the multi-agent system has recorded all the learners' behaviors into activity graphs (Figure 2)
- Psychologists are analyzing the activity graphs of each learner in order to identify the characteristic behaviors e.g. the learners' regular and inappropriate (mistakes) behaviors while doing exercises.

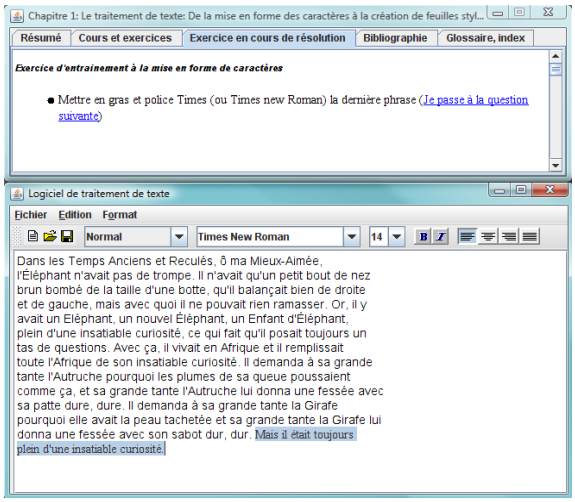

Figure 1: User interface of the multiagent system.

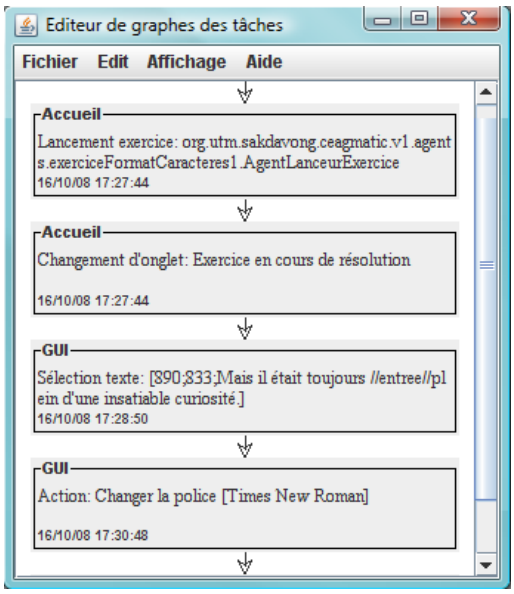

Figure 2: Activity graph recorded by the system.

2.2.2 Step 2: Providing Cognitive Helps

This step consists in conceiving actions associated with each characteristic behavior identified during the step 1. These actions will help the learner when he makes "cognitive mistakes".

- The cognitive helps will be designed by psychologists
- These helps will be included in the multi-agent system as helper agents

- The online course including helps will be tested over many groups of learners and the multi-agent system will again record all the learners' behaviors into graphs
- Psychologists will analyze these activity graphs in order to identify the characteristic behaviors while using the new helps e.g. the learners' regular and inappropriate regulation actions while doing exercises (for example, a learner who never accepts to read again the lesson when the helper agents propose to do it).

2.2.3 Step 3: Providing Metacognitive Helps

This step consists in conceiving metacognitive guidance actions associated with each characteristic behavior identified during the step 2 e.g. bad use of helps. These actions can be assistances but also refinements of learners' metacognitive profiles. Thus, the system will progressively build precise profiles.

We speak here of "metacognitive guidance" because our hypothesis is that if learners do not use correctly the helps, it is because they have a lack of metacognitive abilities: they do not regulate correctly their learning behavior.

Two types of metacognitive guidance will be proposed:

- A suggested guidance that the learner can accept or refuse (Noury and al., 2006), (for example, "you should look at the glossary"; "You should do the exercises before doing the test")
- An imposed guidance if the system identifies a recurrent metacognitive mistake or lack. (for example, a definition from the glossary is presented to the learner)

This is the principal specificity of our approach from the point of view of psychology.

Then:

- The two types of metacognitive guidance will be included in the multi-agent system as new helping agents
- The online course including guidance will be tested over many groups of learners and the multi-agent system will again record all the learners' behavior into graphs
- Psychologists will analyze the graphs of learners' behaviors in order to check if the metacognitive helps are useful.

2.4 Experiment: The Chosen Target Learners

- To experiment, we have chosen the French certificate "C2i (level 1)" (Computer Science and Internet Certificate). The learners have different backgrounds, levels of study and ages.
- Moreover, we have a large population of students for testing and teachers experienced in this training (in the universities of the two involved research laboratories).
- After having analyzed the results over the tests of C2i, we have chosen to target the "Formatting documents with style sheets" lesson. Indeed, this lesson presents cognitive and metacognitive difficulties which can be supported by the help guidance system.

3 DESIGN PRINCIPLES OF THE COMPUTER-BASED SYSTEM

3.1 Dynamics, Flexibility and Scalability of the System

Our system is based on the observation and analysis of the learner's behavior. So, it is based on a dynamic component (the activity) from which the help is constructed dynamically (by observation and analysis). Therefore, the system has to be able to observe, analyze the learner's behavior and to construct real-time help.

Moreover, we propose a general help principle which can be used in any learning situation. Therefore, the system has to be easily adapted, keeping the generic functions of the system, just modifying the learning situation. For example, in the experimentation, it is used for the learning situation : "Formatting documents with style sheets". It should be used for other learning situations like "Using of table of contents or index" or, beyond word processing, like "Using functions in spreadsheet".

Finally, while the system is currently used as a workshop which allows psychologists to observe the learners' behaviors, it will be able (in the third step) to integrate into a dynamic whole the observation-analysis-help process.

3.2 Bootstrap, Grading and Regulation of the System

To analyze the learner's behavior, we use the description of the regular activity and of the possible

deviations which are linked to the knowledge and the ability of the current exercise. For example, "Formatting a paragraph" is linked to paragraph and alignment concepts (knowledge), and to the designation of a paragraph and of an alignment (ability). The regular activity and the possible deviations compose the system's bootstrap.

They are completed and refined during the analysis of the activity by the psychologists. This analysis allows also designing the action system: an action (cognitive profile modification, help suggestion) is associated with each characteristic behavior. It is what we call the grading of the system.

Finally, the regulation of the system consists in adapting the help as the system runs. Ideally, it should be a self-regulation of the system. But for the project, we will allow only a dynamic regulation within the action system defined by the psychologists in the second step.

3.3 Functional Aspects

Our help system is based on the observation and analysis of the learner's behavior. Therefore, it is necessary that it places the learner in a position to do and can observe his actions. It is why the system has to integrate learning interactive tools. For example, we have integrated a text editor for the experimentation.

To analyze the activity, we have integrated a tool which allows the observation of the learner's behavior. We wondered about the granularity of the observed actions. Technically, it was possible to observe elementary actions (click, mouse moved, …). But, after a first test, we realized that the important actions were:

- Actions on interactive objects ; for example, a selection in a menu or the validation of a dialog box
- Semantic actions linked to the learning context; for example, putting a word in italics

Therefore, the system observes and records these actions which are analyzed by the psychologists, observed and then processed by the system to generate the help in the next step.

The psychologists analyze the learner's behavior in relation to the regular activity. To make the analysis of the activity easier, we have integrated tools to describe the regular activity and to represent the observed one with the same graphic formalism; these tools can also represent the differences between regular and observed activities.

Finally, the system contains a tool of automatic analysis of the activity which allows detecting characteristic behaviors, and an action system able to activate help and to modify the profile.

All these functional aspects have been integrated to the computer system.

4 SOFTWARE ARCHITECTURE OF THE MULTI-AGENT SYSTEM

4.1 Why a Multi-Agent System?

We have implemented the device to deliver online course and to provide helps as a multi-agent system (Wooldridge, 2002). This choice of implementation allows us:

- To have software elements (agents) able intrinsically to observe the activity and to produce a behavior, also to communicate between them;
- To obtain a dynamic behavior of the device, creating agents during the learner's behavior (for example, creating a new helping agent when an exercise starts) or modifying in real time the behavior of agents (for example, an helping agent can change of behavior according to an evolution of the learner's profile);
- An incremental construction of the device;
- A flexible and dynamic construction of the device; for example, we can replace the agent "text editor" by an agent "spreadsheet" according to the situation of training, without modifying the remainder of the device;
- To consider a distributed runtime of the various elements of the device on various computers (the learners' computers, the LMS's computers and the learners profiler computer).

We have used the framework JADE (Bellefemine, F. and al., 2004) and programmed the agents in the Java language.

4.2 Agents of the System

The system is composed by several types of agents:

- "Principal", "Exercise" and "Applicative" agents which constitute the LMS (Learning Management System);
- An "Historical" agent;

- ”Helper”, “Scrutinizing” and “Profile” agents which constitute the system of analysis and the system of help.

The LMS includes a “Principal” agent which implements the teaching scenario. The figure 1 shows the human-computer interface of the LMS: the summary (“Résumé”), the course and the exercises (“Cours et exercices”), the self-assessment (“Autoévaluations”), the external references (“Références”), the glossary and the index “(“Glossaire, index)”. When the learner chooses an exercise, the “Principal” agent creates an “Exercise” agent implementing the scenario of the corresponding exercise; we can have thus simultaneously several “Exercise” agents An “Exercise” agent is always associated to an “Applicative” agent which implements the interactive system necessary to the realization of the exercise; in the current project, this agent implements a word processor.

The “Historical” agent records the learner’s behavior as a sequence of actions (the activity graph). It thus communicates with the previous agents: it records the activity with respect to the full teaching scenario (for example, it records if the learner consults the exercises, then reaches the course), to the scenario for a particular exercise (for example, when the learner answers the first question, then the second one, then returns to the first one), to the “Applicative” agent (for example, the learner selects a paragraph then clicks on the shortcut button “centering the paragraph”).

“Scrutinizing” agents allow observing and analyzing the activity of learning. These agents are charged to identify characteristic behaviors, according to the profile. They are created dynamically by the “Exercise” agents. They have a mechanism of subscription which enables them to receive from the “Historical” agent the sequences of actions they are charged to analyze. According to their analysis, they will create “Helper” agents or will communicate with the existing “Helper” agents. They will also communicate with the “Profile” agent charged to dynamically adapt the profile of the learner.

The “Helper” agents provide the assistance by giving feedback, displaying solution, procedure, chapter corresponding to the difficulty, asking questions to the learners. In the last step of the project, they will give the metacognitive guidance to the learners. They also will communicate with the “Profile” agent.

5 CONCLUSIONS

We have presented the process and the software device that we have developed, associated to the design of a new kind of help. The multiagent architecture used to implement the software system is an original way to deal with the complex problem of a dynamic and contextual learning help. It allows to meet the dynamic, flexibility and scalability requirements of the device.

We are testing it with the learning of the C2i certificate. At present, we have realized the first step of the process (we have defined the regular behavior and the possible deviations) and constituted the bootstrap of the software device. Then we have recorded the behavior of a troop of learners with the software device. Currently, a psychologist is analysing these recordings (step 2 of the process). Afterwards, the results of this analysis will be integrated into the system and will be evaluated.

At the same time, we are working on the specification of « Helper » agents to add syntactic analysis abilities to them: each « Helper » agent will be defined by an abstract grammar which will be specific to a learning behavior. Then, the psychologists would just have to define abstract grammars and associated semantic actions.

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v-LEARNING
Using Voice for Distant Learning in Emerging Regions

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Keywords: WWTW, VoiceXML, Transcoder, Asterisk.

Abstract: At present, accessing the internet through visual interfaces is the most common approach. However, it requires some basic resources such as a computer or web-enabled mobile device, an internet connection, electricity and some amount of IT literacy. Because of the relatively high cost of this set up, underprivileged users are unaware or have no direct access to the internet. Since voice communications through telephony systems do belong to the growing trend, people make use of telephones for various purposes. Among them, accessing web through telephone devices is explored. In this paper, we present an approach to access the learning materials of the Learning Management System (LMS) of University of Colombo School of Computing, Sri Lanka through interactive voice driven applications.

1 INTRODUCTION

World Wide Web (WWW) has become the major information source around the world. People access the web for various purposes such as learning, communication, entertainment etc. As a result, web has grown to be one of the most popular media in the world. But, in order to access the internet, it requires essential resources. Basically, it needs a computer (or modern mobile device, internet kiosks etc.), an internet connection (broadband, wire-less, dial-up etc.), a telephone, electricity and some fundamental IT skills.

Buying a computer and obtaining a fixed internet connection might cost around LKR 80,000 (US$800), which is unaffordable for many people in developing countries. At the same time, such internet connections are not available in the rural areas. Majority of the people in developing countries do not even have electricity in their homes. Due to lack of resources, it is an overhead for a majority of people in the world to access internet directly.

According to the internet world stat (Internet world stat, 2008), approximately 22% of the people in the world have access to the internet (Table 1). The table 1 shows that most of the emerging regions such as Africa and Asia have limited access to the web. It implies that most of the people in the world (78%) are still untouched to these sophisticated facilities.

Table 1: Internet Usage and world population statistics for June 30, 2008.

World Region	Population	% Population (Penetration)	% Usage Growth 2000-2008
Africa	955,206,348	5.3%	1031.2%
Asia	3,776,181,949	15.3%	406.1%
Europe	800,401,065	48.1%	266%
North America	337,167,248	73.6%	129.6%
Middle East	197,090,443	21.3%	1176.8%
Latin America/Caribbean	576,091,673	24.1%	669.3%
Oceania/Australia	33,981,562	59.5%	165.1%
World Total	6,676,120,288	21.9%	305.5%

According to the statistics, internet penetration is around 2.2% in Sri Lanka, 2007 (Sri Lanka Internet world stat, 2008). It is relatively a low rate with compared to other educational facilities in Sri Lanka. The situation is raised due several reasons. The most critical issue is the unavailability of electricity and internet connectivity facilities in rural areas. In order to improve these factors, an infrastructural development should be done which requires a huge investment.

As an alternative, government and private sectors have invested on public internet accessible places such as Internet cafes, Public Internet Kiosk etc. Some of these solutions are still not possible for underprivileged users as these solutions are also costly.

Table 2: Internet usage and population statistics in Sri Lanka.

Year	User	Population	%penetration
2000	121,500	19,630,230	0.5%
2007	428,000	19,796,874	2.2%

Since mobile technologies have been rapidly growing, people make use of their mobile devices to access the web anywhere in the world. This will reduce the overhead of buying a PC with an internet connection and the expenditure for electricity. Accessing wire-less networks also requires high charges, which is not affordable for the people in developing regions.

Apart from that, accessing internet through mobile devices also has some additional limitations. Firstly, buying a featured phone is not less expensive in Sri Lanka. At the same time, the GSM/GPRS coverage does not exist in rural areas. The mobile device is not always user friendly since it has a small screen and a tiny keypad. All of these limitations will distract people accessing the web through their hand-held devices.

All the above mentioned techniques require browsing the internet through a visual interface such as a web browser. Due to the above mentioned limitations, some researchers have explored the possibility of accessing the web through voice communication. The basic voice communication has had a larger penetration among the world population as well as in Sri Lanka. Therefore, IBM Research Laboratory (Kumar, 2007) has conducted a research, which uses voice to access the internet. This concept is called World Wide Telecom Web (WWTW) (Kumar, 2007). In this model, the voice sites are developed instead of typical web sites. Those voice sites are implemented using a language called VoiceXML (VoiceXML, 2008). VoiceXML is a markup language derived from XML. Users are allowed to call to the voice site which is a collection of VoiceXML pages.

The preliminary attempt of this work is to build an interactive voice learning environment for the undergraduates of University of Colombo School of Computing (UCSC). Since the cost of basic voice communication through telephone is relatively low, accessing web using voice is encouraged. This will be beneficial for underprivileged students who have no direct access to the teaching and learning materials in the web.

This paper is organized as follows. In section 2, the work related to World Wide Telecom Web is discussed. Our proposed architecture and overview of the system is detailed in section 3. The system functionalities are explained in section 4. Finally the proposed system is summarized in section 5.

2 RELATED WORK

WWTW (Kumar, 2007) is a tremendous concept of IBM India Research Laboratory, where voice-driven eco systems are developed parallel to that of the WWW. The approach enables deprived population to become a part of the networked world through low cost voice communication. This concept was the basement for various researches related to voice-enabled applications.

Interactive Voice Response (IVR) systems are currently most widely used voice-driven applications in the world. Air-line, hotel reservations, telecom service providers commonly use these fixed menu-driven, user input (DTMF) based applications. These automated systems require high investments and it is not supportable for non-profit organizations and the government education sector.

Researchers have developed a low cost IVR by integrating the existing open source applications and tools (King, 2006). This system is a hybrid of OpenVXI (Carter, 2002) and Asterisk (Asterisk, 2008). OpenVXI (Carter, 2002) is a VoiceXML interpreter developed by speech group at CMU. It provides APIs for speech synthesis, speech recognition and telephony services. Asterisk (Asterisk, 2008) is the mostly used opensource PBX system in non-commercial applications and Voiceone (VoiceOne, 2008) is the web based GUI for Asterisk PBX. The gateway can be utilized to replace the existing high cost IVR systems.

VOIGEN (Kumar, 2007) enables telephone subscribers to access voice-driven systems through ordinary telephone lines. It permits individuals to create, host and deploy customized voice driven services. VOISERV (Kumar, 2007) is similar to VOIGEN (Kumar, 2007) where VOIGEN (Kumar, 2007) create and deliver data services and VOISERV (Kumar, 2007) delivers converged services. Both the systems create their own customized voicesites.

The IBM WebSphere Transcoding Publisher (WTP) (Lamb, 2008) is a commercially available product that can be used to convert HTML to VoiceXML. A group from Virginia Tech, VA has conducted a research to transcode HTML to VoiceXML using annotations (Shao, 2003).

3 PROPOSED SYSTEM

In order to experiment voice based solutions for distant learning, we have proposed an interactive voice driven system which is explained in this section. Our proposed approach will be developed in 3 stages as listed below,

1. A voice component which gives access to practice quizes in the Learning Management System (LMS)
2. Voice site parallel to existing UCSC Learning Management System (http://www.ucsc.cmb.ac.lk/lms)
3. Voice module for open source moodle project (http://www.moodle.org)

At present, we are in the process of developing the first stage of the system. In order to provide voice based access to practice quizzes in the LMS, we have implemented a simple automated Moodle XML (MoodleXML, 2008) to the VoiceXML (VoiceXML, 2008) converter. Moodle XML (MoodleXML, 2008) is a XML based language which follows XML standards. The quizes of the Learning Management System could be exported as Moodle XML. Our converter simply converts the Moodle XML files to VoiceXML files. The converted VoiceXML files are intended to interpret through VoiceXML Interpreter (Carter, 2002).

In the second stage of our proposed project it is expected to build a voice site in parallel to the existing UCSC LMS. This would be fully automated system generated from web system. The voice site is intended to be updated automatically with respect to the web system. At the final stage of the project, we have proposed to build a voice module for the open source moodle project. This would be beneficial to the society, as the people are used to customize moodle for their learning and teaching purposes.

The main focus of our proposed system is to allow voice access to learning materials for the UCSC undergraduate, external and postgraduate students. The system can be sub divided into three main components.

1. Private Branch Exchange (Asterisk server and soft phone)
2. VoiceXML Transcoder
3. VoiceXML Interpreter

The Figure 1 depicts the overall architecture of the system and each of the above sub components will be discussed in sub sections.

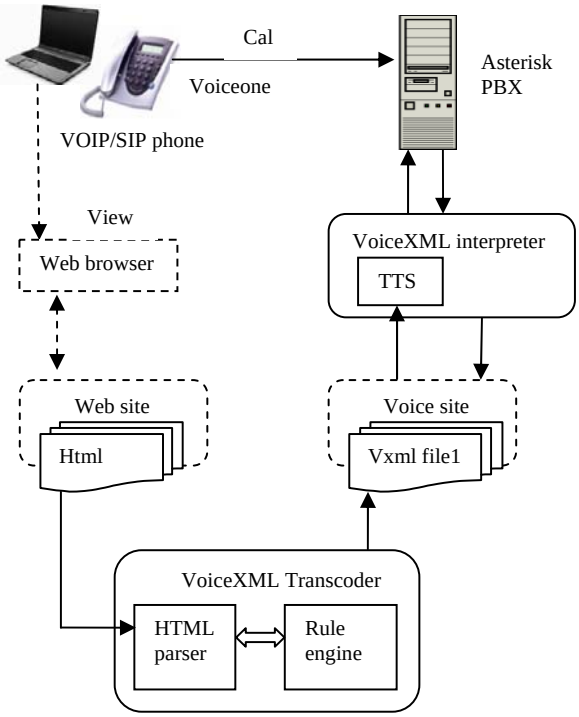

Figure 1: Overall architecture of the system.

3.1 Private Branch Exchange (PBX)

Private Branch Exchange is a telephone exchange, which serves a particular set of people. It could be located in a company, school, university etc. The cost of deploying a commercial PBX system is very high. Accordingly, we have used an open source PBX engine called Asterisk server (Asterisk, 2008) for our project.

Besides, one of the latest trends in PBX development is the Voice Over IP (VOIP) PBX, where internet protocols are used to communicate. The initial focus of the development is to configure a SIP phone to connect with the Asterisk server. For this purpose, we have used the freely available Ekiga (Ekiga, 2008) soft phone. A typical PBX set up is shown in Figure 2 below.

The asterisk server is basically capable to,

1. Get the user's input
2. Interactively provide voice response
3. Call forwarding to voice sites

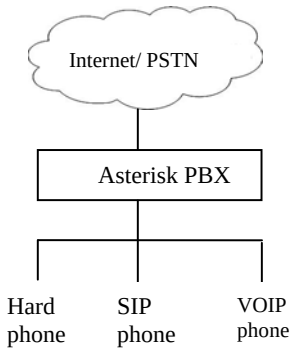

Figure 2: Overview of Private Branch Exchange.

3.2 VoiceXML Transcoder

It is a known fact that web pages are implemented using HTML. Likewise, voice pages have been built using a language called VoiceXML (VoiceXML, 2008). As the HTML pages are interpreted visually through web browsers, VoiceXML files are interpreted using voice browsers. For that the system should generate voice pages or convert existing web pages to voice pages.

The main objective of the system is to implement a voice site in parallel to the existing UCSC LMS web site. In order to do that, selected HTML web pages from the LMS site should be converted to voice pages. This process could be done through "HTML to VoiceXML Transcoder". As there are no any open source VoiceXML transcoders available, our system is expects to implement a VoiceXML transcoder from the scratch. Our proposed transcoder has 3 main components.

1. HTML parser
2. VoiceXML translator
3. Rule engine

The overview of the proposed transcoder is shown in Figure 3.

Firstly, the static HTML pages are analyzed through a HTML parser and a HTML node tree will be generated. Once the structure of HTML node tree is analyzed, the page is converted into a VoiceXML file internally by the system.

When applying the transcoding logic, our system makes use of grammar rules which have been defined by us. After validating the conversion with the rule engine, the syntactically correct VoiceXML file will be created.

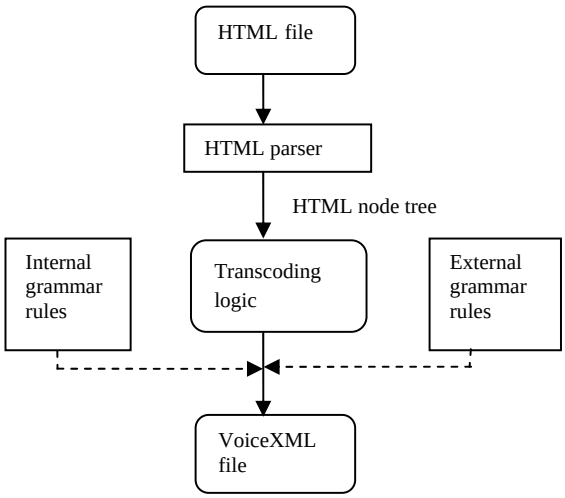

Figure 3: Overview of HTML to VoiceXML Transcoder.

A simple HTML file and it's corresponding VoiceXML file is shown in Figure 4 below.

```
<html>
<head>
<title>Welcome to University of Colombo School of
Computing</title>
</head>
<body>
<form next="method"
<INPUT type="radio" name="degree" value="computer
science">computer science<br>
<INPUT type="radio" name="degree"
value="ICT">ICT<br>
</form>
</body>
</html>
```

```
<?xml version="1.0">
<vxml version="2.0">
<form>
<prompt>Welcome to University of Colombo School of
Computing</prompt>
<field name="degree">
<prompt>Select your degree<enumerate/>
</prompt>
<option dtmf="1" VALUE="computer science">computer
science</option>
<option dtmf="2" VALUE="ICT">ICT</option>
</field>
</form>
</vxml>
```

Figure 4: Simple HTML and VoiceXML file.

3.3 VoiceXML Interpreter

XML based languages require an interpreter to interpret the markup commands. Accordingly, VoiceXML files should be interpreted automatically after the file is altered. OpenVXI (Carter, 2002) is one of the freely available VoiceXML interpreter used by majority of voice application builders.

Typical VoiceXML interpreter consists of 3 sub components.

1. Text-to-speech system (TTS)
2. Voice recognition system
3. User action handler

3.3.1 Text-to-Speech System (TTS)

Text-to-speech system is a way to present text output to the user through voice communication. In our system, we are using an open source TTS called FreeTTS (FreeTTS, 2008). It extracts the output from the VoiceXML file and presents it to the user through a soft phone.

3.3.2 Speech Recognition System

A typical voice-driven application has a component to recognize user's speaking context. In our proposed system, we have omitted this component and instead we are collecting user's input through Dual-Tone-Multi-Frequency (DTMF). The system prompts choices for the user and based on these choices, user has to select a number which can be entered through a telephone dial pad.

3.3.3 User Action Handler

This component is capable of collecting user's input and respond accordingly. For instance, if the user does not perform any action at his turn, the interpreter gives him a second chance to try the commands or inform him to end the call. Moreover, user action handler collects user inputs which are given by the dial pad. Likewise user action handler automatically performs several intermediate actions like a human being.

4 SYSTEM FUNCTIONALITIES

In this section, we describe the main functionalities of the system. The proposed approach is intended to be accessible via interactive telephone communication only. The user should make a call to the system in order to access the contents. The system is automated to provide services to the user regardless of other matters. The functionalities of the system can be categorized into 2 subsections as follows,

1. User-level functionalities
2. System-level functionalities

4.1 User-level Functionalities

In order to get the benefits from the distant learning project, the user should place a call to the system. This can be done through the dedicated telephone number which is assigned to the voice site. The user’s call would then automatically be handled by the Asterisk (Asterisk, 2008) server, where voiceone (VoiceOne, 2008) is the front end of the server.

The system identifies the call and redirects it to an appropriate voice site (At present, we have only one voice site in our system). The system prompts information to the user and gets their inputs through DTMF.

A sample user-system interaction is given below,

- User places a call to the system through the voice number given.
- System: Welcome to Learning Management System of University of Colombo School of Computing. Main Menu, For site news press 1, For undergraduate courses press 2, For Examinations press 3, For inquiries press 4, To exit from the system just Hang-up etc.
- User enters 3 through DTMF
- System: You have selected examinations. For Time table press 1, For exam results press 2. To go to the main menu press 0 etc.

The user can navigate through sub menus for his destination or simply can exit from any menu or sub menus. If the user fails to respond to the system within a given time frame, the menu (or sub menu) will be repeated once. If the user does not respond to the system further, the conversation will be disconnected automatically.

4.2 System-level Functionalities

At the system level, VoiceXML files will be generated and updated dynamically. This could be done by converting existing HTML files. The collection of VoiceXML files is integrated as Voicesites. The VoiceXML interpreter then interprets these VoiceXML files and presents them to the user through the TTS according to their requests. Before the voice prompts are presented to

the user, VoiceXML files will be validated through the system.

5 CONCLUSIONS

The V-learning project is proposed for the underprivileged users to provide access for learning resources through the voice communication. In our approach, we have explored the concept of World Wide Telecom Web that would be parallel to that of the World Wide Web. The motivation of our approach is to deliver the services for the benefit of the students in developing economies. Though it has several benefits such as low cost, it would not be as attractive as graphical user interfaces. We believe that the system would be a bridge between the IT-savvy and the non-IT-savvy population in the world.

ACKNOWLEDGEMENTS

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HOW GENDER ISSUES CAN INFLUENCE STUDYING COMPUTER SCIENCE

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Keywords: Gender, Success Rate, Professional Ambitions, Professional Satisfaction.

Abstract: This paper presents a gender related research conducted at Department of Mathematics and Informatics, Faculty of Science, University of Novi Sad; in order to explore the following points amongst female undergraduate students: (i) general success rate, (ii) professional confidence, interests and ambitions, (iii) level of satisfaction with the choice of studies, (iv) attitudes and beliefs towards the gender issue. The query resulted in indicative statistical data, providing basis for future work and discussion, as a contribution to narrowing of the gender gap within the field of Computer Science.

1 INTRODUCTION

Numerous researches shown a considerable lack of female students enrolled in Computer Science studies at universities worldwide. A lot of research analyzed different domains of ICT, involving different levels of education (Gunn, 2003), (Ilias, 2006), (Gharibyan, 2008), or related to new directions in education (Hughes, 2002), (Vekiri, 2008).

As stated in (Kilgore, 2006), in the USA, from 1995 to 2004, only 20% of BA degrees in CS were awarded to women, with the percentage continuously diminishing. Similar situation is in Australia (Miliszewska, 2006), or European countries: Germany (Vosseberg, 1999), Finland (Paloheimo, 2006), Holland (Prinsen, 2007), or Greece (Ilias, 2006). According to (Putnik, 2008), Serbia is also facing this global problem. The fact is that women who stay in the field discontinue their studies more often than their male colleagues – the phenomenon is known as "the shrinking pipeline": even though young girls are attracted by CS, the higher level of education, the smaller is the proportion of female students. Statistics show that only 22% of the employees in the science related fields are female, which does not match their share in the work force.

Some of the causes of this occurrence are following: (i) the intimidation with the male dominated nature of a field of CS, (ii) the absence of female role models (iii) the lack of respect towards female professionals, (iv) the lack of confidence in the abilities of female professionals, (v) social pressure not to study CS, (vi) fear of combination of work and family life in IT sector being problematic.

In addition, it has been reported that women are more attracted to applications that benefit society than in programming itself, and therefore, tend to lose interest when this aspiration is not satisfied, often because feeling restricted by somewhat abstract curriculum (Fisher, 2006).

On the other hand, historically observing, female researchers and programmers played a significant role in founding of CS. In the forties women formed a majority of the programmers. In the fifties and sixties female researchers contributed in the development of user interfaces (Ngambeki, 2006). A question poses: what have influenced a serious

Table 1: Number of female undergraduate students involved in the survey.

	1st year	2nd year	3rd year	4th year
Number of participants	36	38	24	18

Table 2: Average success rate.

June 2008 Year/Average mark	6.00-7.00	7.00-8.00	8.00-9.00	9.00-10.00	Unknown
1st year	11.11%	27.78%	33.33%	5.56%	22.22%
2nd year	-	-	68.42	31.58%	-
3rd year	-	64.29%	35.71%	-	-
4th year	-	33.33%	44.44%	22.22%	-

deepening of the gender gap over the past few decades?

Authors suggest that the key factor was the arrival of the home PCs: computers became a popular hobby for boys. This led to the situation where, the female students enter introductory CS classes with weaker programming skills and lack of computer related background. Also, according to (Paloheimo, 2006), social pressure is the obstructing factor: "The society does not actually prevent girls from accessing computers, but it has failed to introduce CS as a feasible option to them", and as a result, IT built a strong image as the men's playground.

What finally brings women to the table? The following was suggested: (i) the continuing presence of computers in a way that women can comprehend the versatility of computer use, (ii) support and encouragement by the female professionals in the field, (iii) help in understanding different career possibilities in IT, (iv) awakening of interest in math and science from the early age (Fisher, 2006).

The goal of this research was to explore gender influences on female undergraduate students at Department of Mathematics and Informatics, Faculty of Science, University of Novi Sad.

2 RELATED WORK

Beginning of the 21st century introduced a significant number of research and expert papers associated to gender politics. In (Paloheimo, 2006), authors state that "students perform far better if their comfort level is high". Students were divided into groups of female, male and mixed groups. The communication was observed, and surveyed. The study reveals that in CS classes "typical gender distribution (majority male) lowers the comfort level of all students in comparison to a case with even gender distribution", suggesting that both male and female students would benefit if more women studied CS.

In (Kilgore, 2006) no differences in abilities or ambitions between males and females are registered. Gender differences were shown in how students view the practical nature of engineering. "Men were more likely to discuss and be attracted to the hands-on possibilities: trying out ides in the real world", women were more likely to commit to "linking theory and practice: designing and creating".

In order to motivate and direct students in higher education, it is of great relevance to recognize life goals and attitudes towards profession (Ngambeki, 2006). Authors of the study analyzed personal and professional identity formation and attitudes towards learning amongst groups of female engineering and non-engineering students. Interviewers asked questions such as: "Where do you want to go in life and why? What have you learned in class that you feel really applies to your life? What impact does your field have on society? How and why did you choose your field?" They came to the conclusion that "students develop more sophisticated ideas about learning process and about their life goals as they progress through their undergraduate years, but that engineers have a clearer sense of professional identity than their non-engineering counterparts early and throughout their undergraduate careers".

Intriguing motives amongst female students for studying CS have been reported in (Gharibyan, 2008), providing completely different point of view. Author explored factors which attract women in Armenia to the field of CS. Namely, at some republics of former Soviet Union, female population is well represented in CS. Author explains that success with the following: "In Armenian culture there is no emphasis on having a job that one loves; there is a determination to have a profession that will guarantee a good living". Moreover: "Armenians consider themselves practical and reasonable, setting goals reachable within their talents, abilities and circumstances, and do not have glamorized expectations of life, therefore do not get disappointed easily and do not give up when things get difficult". As a result, CS is one of the most popular fields in Armenia.

Table 3: Expression of attitude towards curriculum.

Statement	Mean value	Standard Deviation
I am generally satisfied with my choice of studies.	4.27	0.86
I feel more comfortable with mathematical courses, rather than with CS courses.	2.87	1.59
Studies positively effected my intellectual development and interests.	4.29	0.95

Table 4: Interest in taken courses: the least preferred courses and the most preferred courses.

	1st year	2nd year	3rd year	4th year
The least preferred courses	Math. Logic and Algebra, Analysis, Financial Mathematics	Data Structures and Algorithms, Math. Logic, Analysis, Linear Algebra	Data Structures and Algorithms, Numerical Analysis	Differential Equations, Linear Algebra
The most preferred courses	Web design, Intro to E-business, Data Structures and Algorithms, Intro to Programming	Computer Organization, OO Programming, Data Structures and Algorithms, Web Design, Data Bases	Data Bases, Web Design, E-learning, Information systems	Data Bases, Information Systems, OO Programming

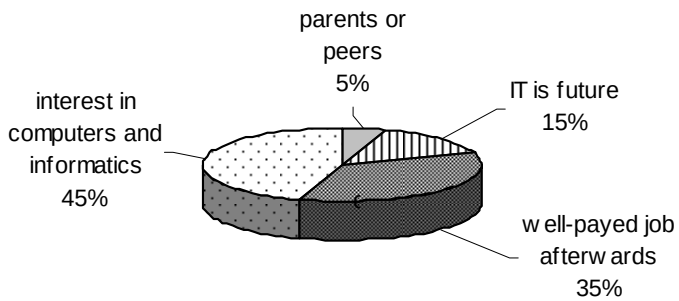

Figure 1: Results on question “What had the most influence on your choice of studies?”.

Gender related study was made at our Department (Putnik, 2008), comparing success rates and enrolment data of male and female students. Its findings reveal a surprising fact: when it comes to technically-oriented courses, “there is no significant difference gender wise”. When it comes to business-oriented courses, a difference in favour to women is noted. Yet, female students did show an inclination towards prejudices to some extent. Analysis of enrolment data in the same paper, reports that a constant number of females enrol into “Business Informatics” direction, while their number at “Theoretical Informatics” direction is steadily decreasing and there has not been a single female student enrolled into “Teacher of Informatics” direction in the past.

3 METHODOLOGY, SURVEY, COLLECTION OF DATA

The research presented here was conducted in June 2008, involving 116 female students of undergraduate studies of Computer Science at our Department (Table 1). The data was collected in the form of questionnaire, focusing on the following topics:

- General studies success rate
- Satisfaction with the choice of studies
- Professional confidence, interests, ambitions
- Attitudes and beliefs towards the gender issue

Survey was anonymous. Participants were asked to provide basic information: year of studies and average mark, and answer descriptive questions:

- How do you imagine your job position after the completion of your studies?
- On which job position do you see yourself in 10 years from now?

Participants were then asked to name the most liked and disliked courses they had. It was followed by three questions which required brief elaboration:

- What most influenced your choice of studies?
- Is IT a suitable field for women?
- Is it possible to have both successful career and family?

Finally, nine questions were given in the form of statements and participants responded on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree),

Table 5: Expression of personal ambitions regarding career.

Statement	Mean value	Standard Deviation
Marks during studies are important to me.	3.66	1.05
I believe I am about to have a successful career.	4.31	0.78
I am worried about further course of my career after I complete my studies.	2.44	1.26

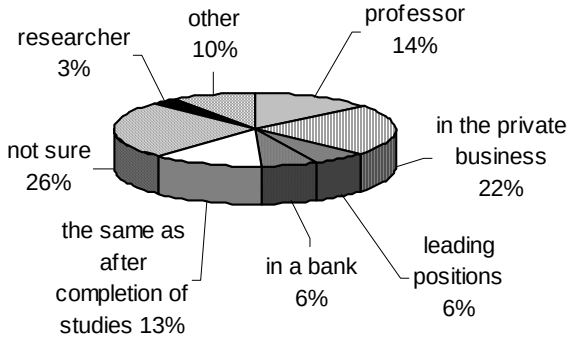

Figure 2: Results on question "On which job position do you see yourself 10 years from now?".

Table 6: Personal ambitions after completion of studies.

Typical answers	1st year	2nd year	3rd year	4th year
Working in education	4	12	-	-
Working in private business	2	4	2	2
Programmer, code writing	8	-	4	2
Working in a bank	4	2	10	4
Related to Data Bases	-	4	6	4
Related to Web programming	2	4	-	2
Manager	-	2	2	-
Researcher	-	2	-	2
Going abroad	-	4	-	-
Related to SE	-	-	-	2
Unknown	16	14	6	2

covering three key points of the research: expression of personal ambitions regarding career; attitude towards curriculum, and towards gender issue.

4 RESULTS AND DISCUSSION

This Section summarizes the results gathered by the survey:

4.1 General Success Rate

General success rate is given in Table 2. Grading system for higher education in Serbia is in a form of scale from 5 (failed) to 10 (outstanding excellence). Bologna education system, introduced in 2006, resulted in significantly higher passing rate and average success rate.

Notice that the 22.2% in the category Unknown for the 1st year students is due to the fact that research was conducted in June, before their first exam period. Those who provided data referred to the outcome of the winter semester.

4.2 Satisfaction with the Choice of Studies

Students responded on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree), to the statements presented in Table 3. We tried to determine the comfort level in studying and review effects of the studies on their intellectual development, and therefore our influence as an education institution. Results report it to be highly positive. Students have also shown satisfaction with the choice of studies. Answers on both of statements are with low standard deviation – even more encouraging.

Table 7: Expression of attitude towards the gender issue.

Statement	Mean value	Standard Deviation
Professionally, I feel completely equal to my male colleagues.	4.37	0.91
Concern regarding the lack of women in IT is justified.	2.62	1.33
Stereotypes regarding women in IT do not manifest in real life.	4.04	1.21

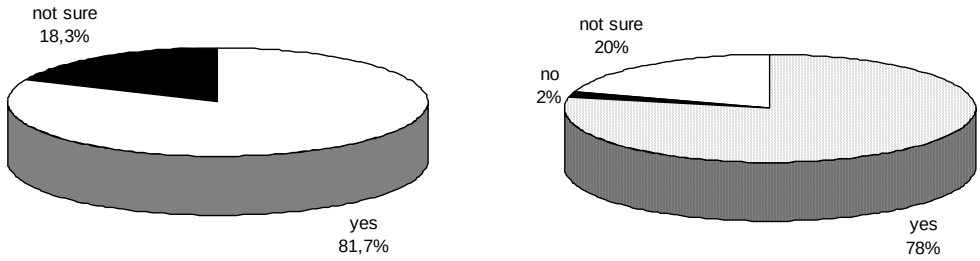

Figure 3: Results on question "Is it possible to combine IT career and family life?" and "Is IT a suitable field for women?".

Authors in (Fisher, 2006) suggested that girls are more inclined to mathematical than informatics related subjects. Obtained results indicate differently, but not strongly convincing – mean value is just about the middle (2.87), with high standard deviation (1.59). To support these claims, Table 4 illustrates expressed interest in taken courses, where mathematical courses often take place in the list of less popular. It can also be noticed that some of the courses go from category of "the most preferred" to the category "the least preferred" courses, as students advance through study years, as in case of "Data Structures and Algorithms".

Data about the motives for their choice of studies are given in Fig. 1. Compared to results of the study in Armenia, we can notice that well-paid job as a motive is as influential as in this former Soviet Union republic. We also detect lower significance paid to parents` or peers` influence.

In order to explore these ambitions in more detail, participants were asked to describe on which job position they see themselves after completion of studies (Table 6), and then, in comparison, where do they imagine themselves 10 years from now.

4.3 Professional Confidence, Interests and Ambitions

Insight into students` point of view regarding their professional future is given in Table 5. Marks seem to be lower priority than expected, consulting high general success rate. They also seem to be very confident in the realization of their career objectives and professional security and integrity.

Most popular options seem to be job in a bank and working with data bases. It seems that, as a consequence of rather conservative, male-oriented society in Serbia, only few participants in their answers mentioned terms such as "taking over leading positions", "multidisciplinary approach", "possibility of further education and professional growth". We also report very low interest in research. Reason for such attitudes could be a focus of some future work at our Department. Another interesting point is that surprising number of the participants in this research expressed a wish to work as a teacher, while none of them is enrolled in "Professor of Informatics" direction.

Teachers' positions, especially in elementary and secondary schools, are rather low-paid but on the other hand very secure and somehow protected in Serbia, as in most other countries. Also, it can be noticed that almost none of the girls in senior years used term "programmer" when describing their future goals. Also, term "software engineering" is only once mentioned. Group of answers classified in "Unknown" includes such as "it is too early to think that far". It is comforting that the share of such responses is decreasing with the year of studies.

How our students see themselves 10 years from now shows Fig. 2. Rather low number of students 12.7% gave answer "the same as after the completion of studies", supporting claim stated in (Gharibyan, 2008): by business owners, women are seen as more loyal, dedicated and less ambitious.

4.4 Attitudes towards the Gender Issue

Figure 3 shows that 81,7% of the participants believe that it is possible to combine IT career and family life, not a single one responding negatively. This is a little bit in contrary to previously obtained answers and non-ambitious for further advancement in professional life and continuation of education. When asked "Is IT a suitable field for women?", almost none gave negative answer (Fig. 4).

More surprising data comes from Table 7, where girls tend to diminish the presence of the gender issue, although the statistics very argumentative indicate opposite (Putnik, 2008). These numbers reveal remarkably high level of confidence, comfort and gender self-awareness related to professional skills amongst the participants.

5 CONCLUSIONS

This paper presented results that reflect the gender climate at the Department of Mathematics and Informatics, at Faculty of Science, University of Novi Sad, with the focus on (i) the comfort level, (ii) the confidence level, (iii) the success level; amongst undergraduate female students of all CS directions.

The research revealed that female CS students show surprisingly high level of gender self-awareness and confidence. Participants expressed serious and ambitious attitudes regarding their career objectives, feeling professionally equal to their male colleagues, with their marks to prove those claims. The comfort level considering their studies and future professional growth is also on a satisfactory level, even though the number of female students is dropping each year, those who manage to complete their studies, prove to be as competitive and skilful as their male colleagues.

This could partially be explained by the fact that technical skills are gender-blind, and as a consequence, CS as such "bears more promises for equity between genders in opportunities, positions and finally salary, than the other fields" (Putnik, 2008).

To conclude, our findings show that it is necessary to make an effort to improve education politics and attract more female students both at undergraduate level, and postgraduate level.

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ADJSCALES: DIFFERENTIATING BETWEEN SIMILAR ADJECTIVES FOR LANGUAGE LEARNERS

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Keywords: Adjective-scales, Patterns, Web-based, Second language learning, Gradation, Computational linguistics.

Abstract: In this study we introduce AdjScales, a method for scaling similar adjectives by their strength. It combines existing Web-based computational linguistic techniques in order to automatically differentiate similar adjectives that describe the same property by strength. Though this kind of information is rarely present in most of the lexical resources and dictionaries, it might be useful for language learners that try to distinguish between similar words and that want to capture the differences from a single structure. Additionally, AdjScales might be used by constructors of lexical resources in order to enrich them. The method is evaluated by comparison with annotation on a subset of adjectives from WordNet by four native English speakers. The collected annotation is an interesting resource by its own right. This work is a first step towards automatic differentiation of meaning between similar words for learners.

1 INTRODUCTION

In the process of building their vocabulary, language learners sometimes need to choose an appropriate word to use from a set of near-synonymous words. The subtle differences between words and the fact that the semantics of near-synonyms between the native language and the second language usually overlap only partially make it all more difficult. Consider for example the sentences, "This film is **good**", "This film is **great**", "This film is **superb**". All of these give a positive evaluation of a film, but in which one and under what circumstances will the film be perceived by a native speaker of English as the best? How is the learner to know?

A **Linguistic Scale** is a set of words of the same grammatical category, which can be ordered by their semantic strength or degree of informativeness (Levinson, 1983). Linguistic scales are lexicalized for various parts of speech. For instance, ⟨*surprise, startle, shock*⟩ is a verbal scale(Chklovski and Pantel, 2004).

Existing linguistic resources and dictionaries rarely contain information on adjectives being part of a scale, or being of a particular strength. Though, this information may be deduced in some cases from the word definition, such as "very small" for "tiny" in WordNet (Miller, 1995), it is not always so, and lacks the convenience of a single visual scale like *infinitesimal*→ *tiny*→*small*→*smallish*.

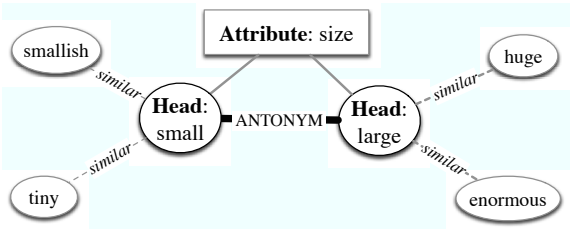

Figure 1: Descriptive adjectives encoding in WordNet.

Gradation is a related term describing variation of strength between adjectives. (Fellbaum et al., 1993) describes gradation as a semantic relation organizing lexical memory for adjectives and provides six examples of gradation for attributes SIZE, WHITENESS, AGE, VIRTUE, VALUE, and WARMTH. For instance, the example gradation for SIZE is ⟨*astronomical, huge,* ***large,*** *standard,* ***small,*** *tiny, infinitesimal*⟩. According to Fellbaum, gradation is rarely lexicalized in English, and thus it is not encoded in WordNet. Adverbial expressions like "slightly" or comparative expressions like "more" are usually preferred. While agreeing with this claim, we believe that having a method for grading adjectives that are lexicalized is important and beneficial for learners that struggle with similar adjectives. More-

over, using the Web as a corpus, this information may be extracted with less effort than before.

Descriptive adjectives describe a property and tend to be scalar. WordNet encodes them in clusters (**adjective-sets**). Two antonymous representative synsets (**head-words**) are linked to a noun they describe (**attribute**). Each *head* adjective is linked to **similar** adjectives. Relations between the *similar* adjectives and differences between the SIMILAR connections are not encoded. In the example encoding in Figure 1, there is a clear difference between "small-ish" that is slightly less small than "small", and "tiny" that is normally perceived to be *smaller* than "small". In this work, our objective is to identify such cases and to provide this kind of distinction.

The similar adjectives in each adjective-set in WordNet are not identical, and usually each synset provides a nuance of meaning that differentiates it from others. In addition to STRENGTH, there are others, such as INFORMAL-LANGUAGE-OF relation that holds between "teeny-weeny" and "small". Detecting these kinds of relations is also important in the context of lexical choice by learners. Gradation being very central in adjectives, other possible relations are left out of the scope of this work.

We introduce an automatic Web-based approach to extract strength information for adjectives, AdjScales, that incorporates recent advances in Natural Language Processing. In choosing the suitable methods for this task, our goal was simple and freely accessible methods that do not require any special corpora, parsing or tagging. The novelty of AdjScales is in its automatic construction of adjective-scales from several examples, in the language learner as the target user, and in its evaluation. This work can contribute to improving existing language resources, textbook authoring, and tools for learners.

2 PROPOSED METHOD: ADJSCALES

2.1 Pattern Extraction

Pattern extraction is a preparatory step for AdjScales. Similarly to (Davidov and Rappoport, 2008), we use **pattern-extraction-queries** of the form "a $*$ b" to find patterns where *a*, *b* are **seed words**, and "$*$" denotes a wildcard[1]. We extract binary patterns of the

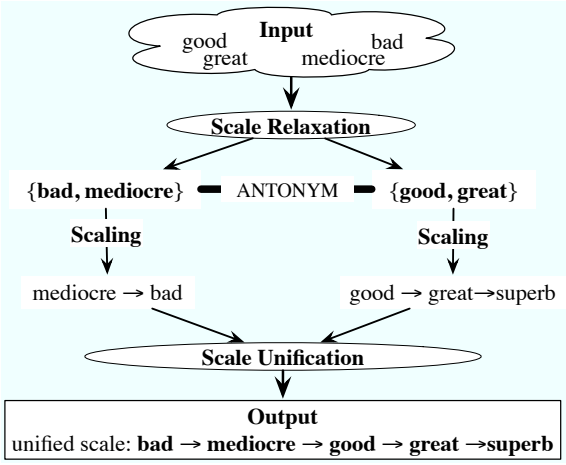

Figure 2: General Illustration of the Proposed Method.

form

$$p = [\text{prefix}_\text{p} \quad x \quad \text{infix}_\text{p} \quad y \quad \text{postfix}_\text{p}]$$

from the snippets of the query results returned by a search engine[2]. Snippets are a good source for patterns, because they contain the direct context of the query text[3]. A pattern p can be instantiated by a pair of words w_1, w_2 to result in a phrase

$p(w_1, w_2) =$ "$\text{prefix}_\text{p} \quad w_1 \quad \text{infix}_\text{p} \quad w_2 \quad \text{postfix}_\text{p}$",

or similarly it can be instantiated by a word w_1, and a wildcard to result in a phrase "$\text{prefix}_\text{p} \; w_1 \; \text{infix}_\text{p} \; * \; \text{postfix}_\text{p}$" to search for words cooccurring with the word w_1 in a pattern.

Let's consider an example pattern p_1 where $\text{prefix}_{\text{p}_1} = \phi$, $\text{infix}_{\text{p}_1} =$ "if not", and $\text{postfix}_{\text{p}_1} = \phi$, if we instantiate it with the pair of words (good, great) we will get a phrase $p_1(\text{good, great}) =$ "good if not great". Instantiating it with ($*$, good) will result in a phrase $p_1(*, \text{good}) =$ "$*$ if not good" that can be used to search for items appearing on the left side of the pattern p_1 with the word "good".

If $p(w_1, w_2)$ appears in snippets that are returned by a search engine for a pattern-extraction-query, we refer to it as p is **supported-by** (w_1, w_2).

Differently from (Davidov and Rappoport, 2008), we choose the seed word pairs in a supervised manner, so that $seed_2$ STRONGER-THAN $seed_1$. For the experimental settings described in this work we used 10 seed word pairs selected from the adjective scale examples in (Fellbaum et al., 1993). The relation STRONGER-THAN is asymmetric, therefore, we select only the **asymmetric patterns** that are extracted consistently so that the weaker word in each supporting

[1] $*$ denotes 0 or more terms that may appear in its place. In practice, search engines, usually use the notation of $*$ for a single-word, and we used the queries "a b", "a $*$ b", "a $*$ $*$ b" for each pattern-extraction-query.

[2] We use Yahoo search API (Yahoo Inc., 2008) throughout the experiments described in this paper.

[3] For the extraction purposes snippets are split into sentences and are cleaned from all kinds of punctuation.

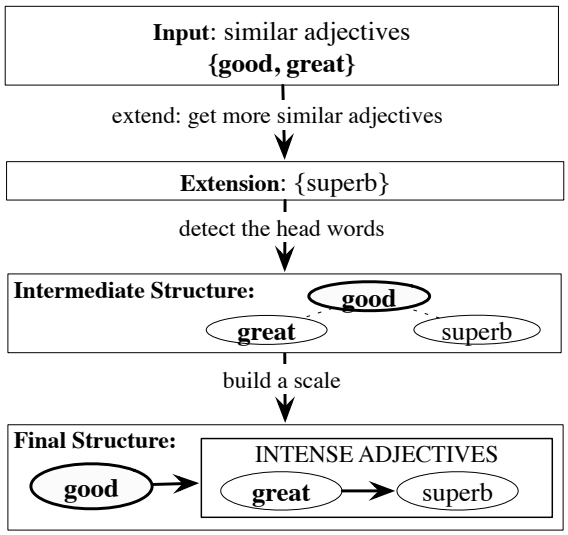

Figure 3: AdjScales Core.

pair is on the left side of the pattern (before the infix words) or so that the weaker word is on the right side of the pattern (after the infix words). If not all the supporting pairs of words share the same direction, the pattern is discarded. We define the former selected patterns as **intense**, and the latter as **mild**.

We select only the patterns supported by at least 3 seed pairs and we require a pattern instance by each supporting pair to repeat at least twice in the sentences extracted from the snippets to increase reliability. We also require the patterns to be supported by adjectives describing different properties. This constraint is important, because patterns that are supported by seeds that describe the same property tend to appear in very specific contexts and are not useful for other properties. For instance, [x even y amount] might be extracted while supported only by seeds describing the SIZE property, such as (huge, astronomical), (big, huge), (tiny, infinitesimal).

To exclude patterns that are too short and tend to be too generic, if pattern p is included in pattern q, and both of them match the other requirements, we select only the longer pattern, q.

2.2 Method Steps

AdjScales method, outlined in Figure 2, comprises several steps listed below with **Scaling** (Section 2.2.5) being its core. We divide the input adjectives into two subsets in a **Scale Relaxation** (Section 2.2.2) step. Then, the rest of the method is performed on each of the subsets separately until the results are unified in the final step of **Scale Unification** (Section 2.2.6) outputing an adjective scale.

2.2.1 Input

AdjScales expects at least 2 similar adjectives as the input. One adjective leaves the task of scaling open for too many interpretations, while two adjectives give a good clue on what scale is interesting for the user. Similar adjectives for our purposes are adjectives that describe the same property.

2.2.2 Scale Relaxation

According to (Hatzivassiloglou and McKeown, 1993), for adjectives, the total scale is commonly relaxed, so that elements of the scale can be partitioned into several subscales. Consider the adjective scale $\langle$*cold, lukewarm, warm, hot*$\rangle$. It is not clear what is the scale relationship between antonyms, such as "cold" and "hot". A total order by the relation of strength within the subscale $\langle$*lukewarm, warm, hot*$\rangle$ is, however, evident.

In the Scale Relaxation step, AdjScales divides the input into two antonymous subsets using antonymy and similarity information from WordNet. If the input words belong to the same adjective-set structure in WordNet they are divided by their similarity to the representative antonyms in the set. If the input words all belong to the same subset they will remain in the same set for the next steps. In other cases, if not all the words appear in WordNet, or they are not encoded in the same adjective-set structure, we currently assume that the input words belong to a single subscale.

2.2.3 Extension

AdjScales attempts to provide the user with further similar adjectives that do not appear in the input. Adjectives that are encoded as SIMILAR to the input adjectives in WordNet are added to the subset as an extension. For cases where WordNet is not applicable no extension is currently performed.

2.2.4 Intermediate Structure

WordNet encodes adjectives by selecting the head adjectives in each adjective-set and connecting the other adjectives to them with similarity links. The relation between the head adjectives is antonymous. We keep this type of encoding and call it an **Intermediate Structure**. For cases where the input adjectives do not appear in WordNet, we select the most frequent words sharing the same context as others as the head words. The Intermediate Structure allows us to reduce the pairwise computations in the Scaling step. It also allows the learner using the system to recognize the most basic words in the scale.

2.2.5 Scaling

The Scaling step depends only on availability of a search engine that estimates page counts. For this step, we refer to the set of patterns preselected by Pattern Extraction (Section 2.1) as P. For each pair (head-word, similar-word) from the Intermediate Structure, we instantiate each pattern p in P to obtain phrases $s_1 = p(\text{head-word, similar-word})$ and $s_2 = p(\text{similar-word, head-word})$. We estimate document frequency, $df(s_i)$, by using the estimated page count hits returned by the search engine. We run the resulting 2 phrases as 2 separate queries and check whether $df(s_1) > weight \times df(s_2)$ and whether $df(s_1) > threshold$. The higher the values are for the $threshold$ and $weight$ parameters, the more reliable are the results, and the fewer there are. If p is of the type *intense*, then a positive value is added to the similar-word, otherwise if p is of the type *mild* a negative value is added. When all the patterns are tested, similar-words with positive values are classified as *intense*, while the similar-words with negative values are classified as *mild*. Words that do not receive any points are classified as *unconfirmed*. For each pair of words in the each one of the subsets (*mild* and *intense*), the same procedure is repeated, creating further subsets of *mildest* words that have the most negative values within the *mild* subset, and *most intense* words for the words with the highest positive values within the *intense* subset. The information is recored in a **Final Structure** that can be visualized as a scale *mildest words* $\rightarrow \cdots \rightarrow$ *least mild words* $\rightarrow$ *head-words* $\rightarrow$ *least intense words* $\rightarrow \cdots \rightarrow$ *most intense words*.

To illustrate this process, consider the example shown in Figure 3. Assume that $P = \{p_1 = [x \text{ if not } y]\}$. The Intermediate Structure in the example contains head-words={good}, and similar-words={great, superb}. We instantiate $s_1 = p_1(\text{good, great})$ = "good if not great", $s_2 = p_1(\text{great, good})$. Choosing $weight = 3$ and $threshold = 100$ pages, we run the queries s_1, s_2. Google estimates $df(s_1)$ as $353,000$ and $df(s_2)$ as 108[4]. p_1 is a pattern of type *intense*, therefore a point will be added to the word "great". Similarly, $df(p_1(\text{good, superb}) > 3 \times df(p_1(\text{superb, good}))$, and $df(p_1(\text{great, superb}) > 3 \times df(p_1(\text{superb, great}))$. There are no *mild* or *unconfirmed* words in this example, resulting in the final structure:
{head-words={good},
intense words={great (-1) →superb (1)}}

[4]These figures are true for a search performed on 6th of December, 2008 and might change slightly depending on the date and the location of the search.

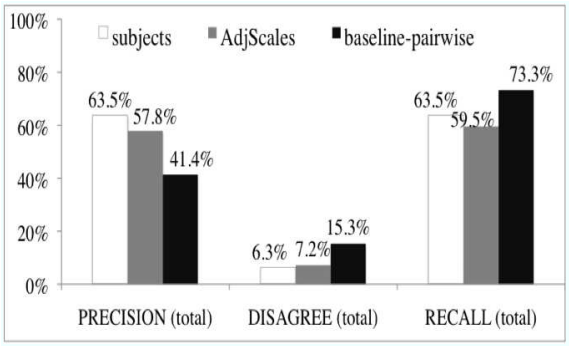

Figure 4: General pairwise agreement between AdjScales compared to human subjects.

or simply *good* $\rightarrow$ *great* $\rightarrow$ *superb*.

2.2.6 Scales Unification

Subscales may be unified into a single adjective scale simply by adding a link between the mildest words on both sides. The internal STRONGER-THAN links point from the mildest words towards the extremities. In fact, different properties are measured for each subscale. For instance, the words "good", "great", and "superb" in our running example measure GOODNESS, while their opponents "bad" and "mediocre" measure BADNESS. To present a unified scale of adjectives that describe the property VALUE we reverse the direction of links in one of the scales.

3 EVALUATION

For evaluation, we preselected 16 patterns (11 intense and 5 mild) in the manner described in Section 2.1.

3.1 WordNet-based Corpus

We extracted descriptive adjective-sets[5] from WordNet 3.0 as the input to our system for evaluation of the scaling step, and divided them into antonymous subsets. Four native English speakers (2 Americans and 2 British[6]), all male students from engineering departments scaled the adjective subsets.

Some subsets in WordNet are too big to be scaled by human subjects[7], and they need pruning. We downloaded snippets for queries of the type

[5]The extracted adjective-sets comprise 757 head words (645 distinct words) and 6,607 similar words (5,378 distinct words).

[6]We have observed no particular differences between British and American subjects in the evaluation

[7]The subset of "lean, thin" for attribute BODY WEIGHT comprises 51 similar words, for instance.

Table 1: Subjects selections for WordNet adjectives.

	#words mild	#words intense
$subject_1$	137	358
$subject_2$	99	301
$subject_3$	89	290
$subject_4$	141	313
All subjects	22	163

$p(\text{head-word}, *)$ and $p(*, \text{head-word})$ for each pattern p from the preselected patterns and for all the head-words resulting in 625MB of data. If a word in an adjective-set was not among the words appearing in the wildcard slots in the extracted snippets, it was pruned. The reasoning behind pruning is that currently our method cannot provide scaling decisions for words that do not appear in any patterns, so, to test this approach only the words that are potentially applicable are considered. The final dataset for evaluation contained 308 subsets with 763 similar words to be scaled.

Each subject scaled adjectives independently. For each subset in the dataset, the subject was presented with the head-words, attribute, and a set of similar words. The head-words were fixed as **neutral** and we asked the subjects to classify each similar word as one of 5 types, compared to the head-words and to the other words. When a word seemed stronger than the head-words it was to be classified as **intense** or **very intense**. When it seemed weaker than the head, it was classified as **mild** or **very mild**. Words of similar intensity to the head words were to be classified as *neutral*. When not sure about a certain word or thinking that it is not applicable for scaling, the subject classified it as **not sure** or **not applicable**, respectively.

We measure agreement between two subjects or between AdjScales and a subject as follows. First, **general agreement** is measured. If a word w in subset s is selected as *mild* or as *very mild* by subject A (or selected as *mild* by AdjScales), we will denote it as $w \in gen-mild_A$ (likewise for *intense*). Two subjects A and B agree if $w \in gen-mild_A \wedge w \in gen-mild_B$ or if $w \in gen-intense_A \wedge w \in gen-intense_B$. There are many words that were undetermined (*not sure, not applicable*, or *unconfirmed* for AdjScales), so it was important to also measure the **general disagreement** explicitly. For each two subjects A and B we measure

$$precision = \frac{|gen-mild_A \cap gen-mild_B|}{gen-mild_A},$$

$$disagreement = \frac{|gen-mild_A \cap gen-intense_B|}{gen-mild_A},$$

$$recall = \frac{|gen-mild_A \cap gen-mild_B|}{gen-mild_B}$$

Table 2: Additional adjective scales.

	precision	disagreement	recall
AdjScales	91.30%	8.70%	56.76%

for general agreement for words selected as *generally mild*. Same notation holds for *generally intense*. Table 1 shows the *generally mild* and the *generally intense* selections made by the subjects, and the number of selections all four of them agreed upon.

We averaged the pairwise agreement between the subjects, and we averaged pairwise agreement of AdjScales with each one of the subjects. Additionally, we ran a baseline method that selected the most frequently chosen classification, *intense* for all words, and compared it in a similar manner. The comparison between the subjects, AdjScales[8], and baseline is shown in the chart in Figure 4.

We also compared AdjScales to the answers that were generally agreed upon by all 4 subjects. AdjScales disagreed with the four subjects consensus for only one word. Additionally, to understand the finer agreement on ordering adjectives on a scale, we measure **order agreement**. Subjects A and B agree on order of a pair w_1, w_2 if A and B both classified w_1 and w_2 as generally mild or as neutral and if both A and B classified w_1 as milder than w_2. They disagree if A classified w_1 as milder than w_2 while B put them in the inverse order. The same is true for the intense side likewise. The subjects tend to agree on the order between words (for 86.11% of word pairs within the mild side, and for 88.74% of word pairs within the intense side). AdjScales scores 86.11% and 70.20% for order agreement for the mild and the intense sides respectively.

3.2 Additional Adjective Scales

In independent experimental settings we requested 2 native English speakers and 3 non-native English speakers to produce as many linguistic scales as possible. After the production step the subjects cross-verified the results, and only the scales agreed upon by all of them remained. We selected 9 of the scales that were adjective scales for our dataset. We ex-

[8]We used AdjScales parameters $weight = 15$, $threshold = 20$ set empirically. In order to reduce the search engine queries required for computation of each scale, we grouped the queries of patterns into 4 subgroups unifying m patterns instances in each subgroup by the operator *OR*:

$$\text{“}p_1(w_1,w_2)\text{”}\ OR\ \text{“}p_2(w_1,w_2)\text{”}\ OR\ \ldots\ OR\ \text{“}p_m(w_1,w_2)\text{”}$$

tended this dataset by adding several adjective scales from examples in the literature, such as 4 adjective scales from a teaching resource (Cadman, 2008). In the exercises in the suggested resource, several verb and adjective scales are provided, where the students are requested to order them by strength. The dataset of this kind is less confusing than adjective-sets in WordNet that are not organized as scalable-sets to begin with.

We relaxed each of the scales in our dataset manually into 2 antonymous subsets, where there were two antonymous components and performed scaling, resulting in 21 subsets. We compared the scaling results by AdjScales with the same parameters as in section 3.1 to the expected scales as shown in Table 2.

4 RELATED WORK

A major work in differentiation between near-synonyms in computational linguistics by (Inkpen and Hirst, 2006) provides a list of types of nuances of meaning that need to be differentiated, such as stylistic, attitudinal etc. Using automatic methods to differentiate between near-synonyms is the objective of our research, and in this sense this work is relevant to ours. Language learners have difficulty in perceiving the differences among near-synonyms and adding distinctions on these subtleties to existing language resources is needed. Currently, we focus only on differentiation of similar adjectives by strength. Adding further types of differentiation is a much needed extension of our work in the future. Differently from Inkpen and Hirst that use a collection of machine readable dictionaries, we use the Web as a corpus.

(Hatzivassiloglou and McKeown, 1993) established the first step towards automatic identification of adjective scales. They provide an excellent background on adjectives and a general plan to identify adjective scales, though, they focus only on clustering of similar adjectives.

Using patterns extracted from large corpora in order to learn semantic relations between words is a common approach in computational linguistics. The pioneering work (Hearst, 1992) extracted hyponym (IS-A) and meronym (PART-OF) relations. Further studies (Chklovski and Pantel, 2004; Davidov and Rappoport, 2008; Turney, 2008) intensively extend this methodology, further relations are explored, supervised and unsupervised methods are introduced. Our work belongs to this school of relation extraction.

VerbOcean (Chklovski and Pantel, 2004), explores fine-grained relations between verbs, STRONGER-THAN being one of them. Their work is very similar to ours in using lexico-syntactic patterns extracted from the Web. Their selection of patterns is manual, and it is based on training on 50 verb pairs, with a total of 8 patterns selected for the STRONGER-THAN relation. We utilize the asymmetry of the STRONGER-THAN relation in a similar manner to VerbOcean. We differ in our focus on adjectives and in our evaluation procedure. VerbOcean, providing differentiation between similar verbs, should be considered in the context of language learners.

A large body of research (Turney and Littman, 2003; Popescu and Etzioni, 2005) has been conducted in the field of **opinion mining**. An important distinction for opinion mining is **semantic orientation** (**positive, negative**, or **neutral**) of words and utterances. In this work we do not distinguish between the positive or the negative senses of adjectives, but rather make a more general distinction of the extent of adjectival descriptive strength. We also have a different objective to provide linguistic distinction between synonymous adjectives for learners, while the research in opinion mining concentrates on strength of subjectivity and sentiment of words, and texts.

One of the main approaches in opinion mining is extraction of semantic information from the Web, and typically adjectives play a central role in understanding opinion from texts. In these aspects, this field is related to our work. According to (Turney and Littman, 2003) semantic orientation of a word, in addition to its direction also comprises intensity, **mild** or **strong**. They compute intensity in a combined computation of the direction, using statistical association with a set of positive and negative paradigm words. OPINE (Popescu and Etzioni, 2005), a system for product reviews mining ranks opinion words by their strength as one of its subtasks. Both of these works focus on detection of semantic orientation of words and report on a very limited evaluation of ranking by strength.

No previous work that we are aware of proposes an automatic method to identify adjective-scales for language learners.

5 DISCUSSION

We have presented AdjScales, a method to build adjective scales from several examples of similar adjectives using a state-of-the-art methodology of extracting relations using patterns over the Web. It is simple, and the only required resource (for Scaling step, which is the main focus of this work) is access to a search engine. Overall, as can be seen from the evaluation, AdjScales scales similar adjectives only

slightly less well than human subjects and much better than the baseline[9]. It also performs quite well on examples that seem more relevant in the context of a language learner, although quite a few words still remain unconfirmed by the system (recall of only 56% for the additional examples). There is only one disagreement of the system with answers that all human subjects agree upon, suggesting that in cases where a scale is clear and thus suitable for learning, AdjScales will be more accurate. The usefulness of the system for learners is in the area of differentiation between similar words using a simple structure (scale) to visualize it.

A surprising observation from our experiments is an unexpected asymmetry between the adjectives on the mild side and the intense side of the head words in WordNet. Subjects and AdjScales consistently selected less words as mild, and also performed less well for their mild selection. It may suggest that WordNet structure or even language structure itself, is such that there are many more words to intensify the common head-words rather than weaken them. We have also observed from analysis of the results that some patterns perform better for mild words while others do better in identification of intense words. This direction will be further explored in the future.

Similar adjectives in general and adjectives in the same adjective-set in WordNet differ in more than one way. In many cases the subjects faced a difficulty in scaling similar words that were presented to them, because they were different in several aspects. This suggests that the similar adjectives in adjective-sets in WordNet are not necessarily in the same **scalable-adjectives** set. We plan to study how to detect adjectives that are on the same scale.

Some adjectives are much more intense than others, while others are only slightly so. Estimating the distances between the links on a scale seems to be an interesting task that may be a useful visualization for learners.

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[9]Recall is substantially higher for the baseline due to its nature of classifying all the words as intense.

A LARGE AMOUNT OF FINAL PROJECTS EFFECTIVELY PROCESSED WITH MINIMAL SOFWARE REQUIREMENTS

Open Source and Platform Independent Solution: A Case Study

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Keywords: Final project Grading, XML, XSLT, HTML.

Abstract: In this paper, we present a case study based on our two-years experience with a processing of a large amount of final projects (1200 students) in a basic course on database systems (Databases 101). Each student is required to present his/her own project documentation with a relatively well-defined structure and content. The present paper offers a solution to the following bias: each student has his/her own preferred/disfavored editor and, at the same time, the teacher needs to see all the final projects in a unitary format to make the results controlable. Furthermore, we address the issue of automated (or semi-automated) processing of some parts of the controling process. Importantly, the whole process involves exclusively standardized technologies implemented in many (also open-source) tools, XML and XSLT standardized by W3C in particular.

1 INTRODUCTION AND MOTIVATIONS

There are many sophisticated tools for teaching support, however, these tools often offer only proprietary solutions (moreover, usually to problems one is not concerned with at the moment). In this paper, we show how to use very common and basic tools to achieve a relatively easy control (and feedback options) for the teacher on one hand and a relatively non-constrained requirement on the students. Hence, a win-win solution with minimal technology requirements.

The problem we deal with is this: there is about 600 students per semester at the basic Database systems course (Databases 101). Each of the students has to present a final project. This project has a form of a paper that has to be processed and controlled by a teacher. Hence, the challenge is to make it both possible for the teacher to control the papers relatively easily on one hand and, on the other, not to impose a system on a student (in particular a system he or she is not used to work with).

There is a plenty of systems available for such purposes (we have some experience with moodle on CTU).
Starting with open-source solutions, we are usually faced with a poor documentation. Moreover, we have to invest a lot of effort to install (and maintain) these tools. Adding furthermore long and expensive training period both for the teacher and the student, we want something simpler for our purposes.

Additionally, it is very often the case that these systems are equipped with too many functions that are usually unnecessary for both the teacher and the student.

So, it seems that we want to balance the overwhelming power of these systems with our real needs of efficient and relatively easy control of the final projects.

In this paper, then, we present the initial problem (a large amount of final projects that need to be controlled; the requirements will be defined below) and our solution to this problem based on the following technologies - http, webdav, xml and xslt. The solution has gone through a two year cycle, hence, about 1200 students participated in the course Databases 101.

The main theses of this case study are:

- basic course of DBS (Databases 101),
- several hundreds of students per semester,
- individual projects,
- certain requirements for both the structure and the final format,
- crucial impossibility to impose one or few editors on the students,

- further advantage: possible automated processing of (at least) some parts of the final projects.

The rest of the paper is organized as follows: firsts, we give a detailed description of the requirements on the final projects from DBS (Databases 101) in the section 2. Advantages of the implementation of our solution with respect to the technologies used and their compatibility as well as students' point of view is presented in the section 3. In the section 4, we present our experience after two semesters[1]. We consider two groups of students here – students familiar with XML/XSLT technologies vs. those without such experience. To conclude, in the section 5, we summarize our findings with respect to the above specified statements. Also, we shortly discuss the future work and potential extensions here.

2 FINAL PROJECT REQUIREMENTS

Our aim is to provide a structure for the students' final projects. This structure must be flexible enough to reflect the needs of the descriptive parts of the document. On the other hand, it must be rather strict, as it defines the names and the order of the required parts of the document. The requirements for the final project structure are not so strict to allow fully automated processing as it is usual in programming courses, see (Cheang et al., 2003) and (Helmick, 2007) for example.

XML (Extended Markup Language) seems to be an ideal format for these purposes. So, the final project is ought to be presented as an *XML document*. There are some basic rules on syntax of a XML document. A document which satisfies such rules is called *well-formed*. See W3C pages for detail (`http://www.w3c.org`).

However, a well-formed XML document still does not meet our expectation on the final project structure. We need to strictly specify the names of individual final project parts (*element*s in XML terminology), the order of these elements, and their cardinality (the number of their occurrences in certain context).

For example, an element `description` which represents one part of the final project document, consists of exactly one element `title` followed by at least one (but potentially more) paragraphs. Each paragraph consists of an element `para` optionally followed by an element `comment`. In DTD formalism (see bellow), this requirement looks as follows:

```
description (title, (para, comment?)+)
```

[1]Databases 101 runs only in the Fall semester.

For these purposes, a *document type description* can be specified. A document is then checked against this structural description. If it satisfies all the requirements on the document type description, it is marked as *valid*.

There are three notations/languages used for a document type definition – DTD, XML Scheme, and RelaxNG. We choose DTD, since it is the simplest one, yet, it is powerful enough for our purposes. Each DTD specification can be automatically translated into XML Scheme as well as RelaxNG specification. These facts, in turn, are important for XML document editing. Some editors do not support DTD, but require XML Scheme, for example.

A complete DTD specification for a DBS final project is included in Appendix A.

2.1 Final Project Parts

Let us shortly describe the main parts of the final project. We will refer to them in chapter 3.

2.1.1 Domain Description

First, students are required to specify their own database for an implementation. They have to describe the context they are going to model on a conceptual level and, subsequently, they have to implement it in SQL server[2]. This part consists of minimally one, typically several paragraphs.

2.1.2 Conceptual Model

As a second step, students formalize their domain in ER (Entity Relationship) notation. They use a special tool for ER modeling in this stage of the work. They are required to include a figure of their ER model and an URL link to the source code of this model into their final project documentation.

This part also requires at least one additional paragraph, in which the students discuss the potential problems of loops that might arise in their model and they also formulate additional integrity constraints (such that can't be described in ER notation).

2.1.3 Relational Database Implementation

This stage of the final project consists of several individual parts. We'll describe each of them in the following paragraphs.

[2]As a rule, Oracle is used for all the courses.

SQL Script for Database Creation. It can be created automatically from the tool used for the ER model creation. Students can edit and comment on this script. The SQL script is then included as a URL link into the final project documentation.

SQL Script for Database Initialization. Students are required to create a set of INSERT statements in order to fill their database. It is necessary for further SQL statements development. It is included as a URL link in the final project documentation.

SQL Statements. Students have to design at least 25 SQL statements of various complexity over their database. Various types of SQL statements are described in a table, which is then included in this part of the final project documentation. Students have to cover each column of the table by at least one SQL statement. Each SQL statement consists of a description, SQL code and potentially a formulation of a query in relational algebra notation (students have to provide a relational algebra notation for at least 10 queries).

SQL Script with SQL Statements. In order to control for a correctness of their SQL code, students are required to attach a sql script consisting of only SQL statements. This script can be created automatically from the final project documentation using another XSLT transformation; see section 3 and figure 1 for details. The script is included as a URL link in the final project documentation.

SQL Statements Report. In order to show that their SQL statements really work, students have to include a report with SQL server responses to their SQL statements. Again, this document can be created automatically running previous sql script in SQL server. See figure 1 for details. As before, this report is included as a URL link in the final project documentation.

2.1.4 Conclusion

This section serves exclusively for the students' review of their experience. It thus has at least one paragraph in the Final project documentation.

2.2 Comments

We decided to add (optional) comments to most parts of the final project docementation structure. It is meant as a place for discussion or comments on a particular solution both for the students and the teacher. It is implemented using a button with java script functionality which allows to shows or hide all comments in the final work in its web presentation. See chapter 3 for details.

3 IMPLEMENTATION

3.1 Technical Description

Figure 1 provides a brief description of the technologies used in the final project and of the final project document processing. Let us describe the processes in detail here. We will refer to the labels of arrows in figure during our explanation.

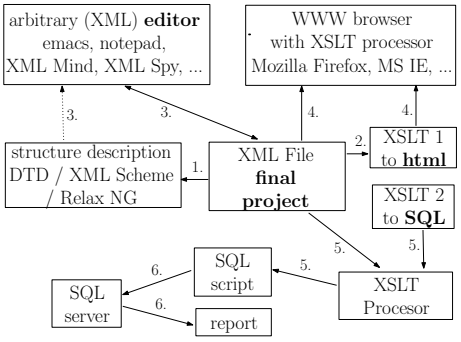

Figure 1: Tools envolved in the final work processing.

1. Final project document points to a related DTD in a meta-element `<!DOCTYPE>`. Hence, each tool which is used for a final project document can access and use a DTD specification to validate the document.
2. In another meta-element – `<?xml-stylesheet>`, the final project document points to a XSLT1 transformation program (by URL). It transforms the final project document into html. Visual formatting of output html document is done through CSS (Cascade Style Sheet) which is included in the head of the output html document by standard html tag `<link>`.
3. Editing of the final project document. This is the main task in the whole process. A document can be edited either by a student (most often), potentially by a teacher (especially comment elements). Editing can be done either locally on students'/teachers' PC, or directly on a server (if it is supported by the access protocol). Practically, we are using WebDAV protocol which allows remote file editing. Related DTD of the document can be used by the editor (dotted arrow), but a document can be (and it often is) edited by an arbitrary (non-XML specialized) editor.

4. This arrows represents the main benefit of our solutions. The final document is placed on a web server into a folder accessible through http protocol. If a user uses WWW browser with XSLT processor (actually, this feature is implemented in many browsers: Mozilla, Firefox, Opera, Safari, Microsoft IE), then the XML document is automatically transformed via related XSLT (see label 2. above) and displayed as html page. Unfortunately, the relation to XSLT transformation inside XML document (although it is standardized!) is not implemented in a standard way (always – i.e. in MS IE). Hence, if one sustains on using MS IE for his/her final project, it is necessary to (slightly) modify XSLT 1.
5. This processing is optional. Another XSLT template (XSLT 2 in figure) can be applied to the final project document. It extract only a part related to SQL statements and it creates a SQL srcipt which can be directly run in a SQL server.
6. Actually, our XSLT 2 transformation is built for optimal use with Oracle SQL server. It includes settings for sqlplus command tool and in this way it generates a html report with responses to SQL statements. It is also a required part of the final project (see 2 for details).

3.2 Users' Point of View

In this subsection, we're going to describe the whole process of the creation of the final project from the point of view of a user – i.e. a student as a creator and a teacher as a reviewer. We'll do it in a way of "use cases".

Suppose now that the final project files are placed on a server, which provides http and WebDAV (possibly ftp or scp) access to files. Both the student and the teacher know URL (Unified Resource Locator) which points to a particular final project documentation.

3.2.1 Student

Edit Final Project. The student can edit the final project document using an arbitrary editor. As before, it can be done locally by transferring the document, editing it locally and then posting it back to the server. And again, it can be done by a special feature of a remote editing as well.

View Final Project. In a web browser with XSLT support (Firefox is recommended) type URL of XML document. It is displayed with a proper formatting. Use embedded push button to hide/show comments in the document.

Deliver Required File to the Server. An arbitrary file can be posted to the project folder on the server and then linked from the final project document via URL. The delivery is done via server supported technology (WebDAV in our case). An arbitrary tool can be used. WebDAV protocol is also supported in tools like Konqerror in Linux KDE environment or Explorer in MS Windows.

Deliver Figure to the Server. A figure of conceptual model is required as a part of the final project. It can be delivered in the same way as another files. See the paragraph above.

Create Script with SQL Statements. Use any xslt procesor and apply XSLT2 template to the final project document. There are free as well as payed xslt prcoessors (Xerces, xsltproc, or xalan for example). Moreover, XSLT2 template can be downloaded from the project server.

Run SQL Script and Obtain Report. In sqplus run sqlscript which is the output of XSLT2 transformation. It creates the report automatically.

3.2.2 Teacher

View Final Project. In a web browser with XSLT support (Firefox is recommended) type URL of XML document. It is displayed with a proper formatting. Use embedded push button to hide/show comments in the document.

Comment on a Part of the Final Project. Using an arbitrary editor, edit a chosen comment element (it can also be added according to DTD specification). It can be done locally by transferring the document, editing it locally and then posting it back to the server, or, as before, by using a special feature of remote editing.

3.2.3 Recommended Editor

Let us note that any kind of an editor (either XML or non-XML one) can be used, but there is also a recommended (i.e. supported) one.
We choose *XMLMind* editor. It is implemented in java language, so it is a platform independent. A community edition is free of charge. On the other hand, a payed version has the posibility to edit files directly on a remote server via WebDAV protocol (which has proven as beneficial in our case).
The editor works in WYSIWYG (What You See Is

What You Get) mode. We spent some effort to provide formatting identical to the final presentation via html (see figure 1 and description of label 4., as discussed in chapter 3).

A support of our final project document processing is implemented as a standard XMLMind plugin. So, its installation and configuration is trivial and user-friendly.

4 OUR EXPERIENCE

The students in the DBS course (Databases 101) are not a homogenous group of students. In particular, there are students who have already passed a course on XML Technologies (hence, they are familiar with XSLT transformations). On the other hand, there are students without a prior knowledge of the XML technologies. Nevertheless, it turned out that the prior knowledge of the XML technologies is not a special advantage, as we might have suspected from the beginning, for the Databases 101 course. That is, all the students are capable to successfully submit their final projects and, moreover, the students found the process described here very helpful and useful. In particular, they are thrilled by the fact that the rigid structure of the documentation (via its *validity*) contains all the required parts and they do not have to concentrate on the formatting side of the final project. Interestingly, vast majority of the students used the simplest possible editor (Notepad) for editing the XML. However, it seems that the possibility to write comments (as described in chapter 2) is not widely used neither by the students, nor by the teacher.

5 CONCLUSIONS AND FUTURE WORK

Two years after having implemented the proposed solution we can summarize that the project was very successful and useful not only for the students, but – importantly – also for the teacher responsible for the control of the final projects. The proposed solution meets the requirements we diagnosed in the first chapter: it is simple, it is not dependent on a proprietary solution, it is not time consuming, it is based on an open source and standardized technologies.

In the future, we would like to extend the automatic SQL control of the final projects. Once a script with SQL questions is automated, it will be possible to run it on SQL server and automatically analyze the report. However, the possibility of further automated control of such final projects is directly proportional on the structure and requirements of the final project. Still, leaving aside these potential extension, we found the proposed way very prosperous and worth further exploration.

The overview of the proposed solution can be found at
`http://service.felk.cvut.cz/courses/XE36DBS/xml/test/test.xml`
for now only in Czech. However, for the camera ready paper, the English version should be available, including instructions the student were given and the comments on the technologies used. Mozilla or Firefox are recommended.

ACKNOWLEDGEMENTS

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APPENDIX A

Complete DTD for Final Work From DBS

Explanation:

`#PCDATA`	stands for an arbitrary string (text)
`comment?`	zero or one occurence of element `comment`
`comment+`	one or many occurences of element `comment`
`comment*`	zero, one or many occurences of element `comment`

DTD specification link (URL) can be included in each XML document, so validating software can find and access it.

```
<!ELEMENT sproject (course, author, content)>
<!ELEMENT course (cname, code, semester,
      seminar)>
<!ELEMENT author (aname, uname, email)>
<!ELEMENT content (declaration, title,
      description, data_model, queries,
      scripts, conclussions,  references)>
<!ELEMENT cname (#PCDATA)>
<!ELEMENT code (#PCDATA)>
<!ELEMENT semester (#PCDATA)>
<!ELEMENT seminar (#PCDATA)>
<!ELEMENT aname (#PCDATA)>
<!ELEMENT uname (#PCDATA)>
<!ELEMENT email (#PCDATA)>
<!ELEMENT title (#PCDATA)>
<!ELEMENT declaration (#PCDATA)>
<!ELEMENT description (title, (para, comment?)+)>
<!ELEMENT data_model (title, dm_picture, comment?,
      dm_discussion)>
<!ELEMENT scripts (title, (para, comment?)+)>
<!ELEMENT queries (title, dotazy, comment?,
      pokryti_dotazu, comment?)>
<!ELEMENT conclussions (title, (para, comment?)+)>
<!ELEMENT references (title, (para, comment?)+)>

<!-- paragraph -->
<!ELEMENT para (#PCDATA | link)*>

<!-- comment -->
<!ELEMENT comment (para)*>

<!-- dm_picture -->
<!ELEMENT dm_picture (mediaobject)>

<!-- dm_discussion -->
<!ELEMENT dm_discussion (para, comment?)+>

<!-- table -->
<!ELEMENT pokryti_dotazu (kategorie_dotazu+)>

<!-- kategorie dotazu / query category-->
<!ELEMENT kategorie_dotazu (entry+)>

<!-- entry -->
<!ELEMENT entry (#PCDATA )>

<!-- link -->
<!ELEMENT link (#PCDATA)>
<!ATTLIST link
      url CDATA #REQUIRED
      >

<!-- dotazy / queries -->
<!ELEMENT dotazy (dotaz)+>

<!-- dotaz / query -->
<!ELEMENT dotaz (popis_dotazu, comment?,
      relacni_algebra?, comment?,
      (sql, comment?)+)>

<!-- popis dotazu / query description-->
<!ELEMENT popis_dotazu (para)+>

<!-- rel. algebra / relational algebra -->
<!ELEMENT relacni_algebra (#PCDATA)>

<!-- sql -->
<!ELEMENT sql (#PCDATA)>

<!-- mediaobject -->
<!ELEMENT mediaobject (imageobject)>

<!-- imageobject -->
<!ELEMENT imageobject (imagedata)>

<!-- imagedata -->
<!ELEMENT imagedata EMPTY>
<!ATTLIST imagedata
  fileref  CDATA   #REQUIRED>
```

GIS DAY ACTIVITIES AND THE ConTIG PROJECT
Using Geographical Information Technologies in Middle and High School

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Keywords: ConTIG, GIS Day, Geographical Information Technologies (GIT), Learning experiences.

Abstract: In November 2008, ISEGI-UNL (Instituto Superior de Estatística e Gestão de Informação – Universidade Nova de Lisboa) hosted a GIS Day inviting seven secondary schools to use and experience Geographical Information Systems (GIS) and Global Positioning System (GPS) technology. Sixteen teachers and about one hundred and twenty students from 7th to 12th grades were able to try and learn about Geographical Information Technologies (GIT). This event is one of the activities that are being developed by ISEGI-UNL in a partnership with ESRI Portugal and two Portuguese high schools since 2007. During the 2007/2008 school year, ISEGI-UNL had a grant from the Portuguese program "Ciência Viva" (from the National Agency for the Scientific and Technological Culture) to develop several learning experiences with the aim of promoting a learning process centred on experience, in which the focus is given by the use of geographic information technologies (the ConTIG project). During the current year (2008/2009), the project continues, but open to any school that wants to try the learning experiences (that are available online) and also share their own experiences. GIS Day is one of the ConTIG events. Other activities will also include courses for teachers to learn how to use the technologies and practical activities with students in their schools.

1 INTRODUCTION

Since 2007, the Instituto Superior de Estatística e Gestão de Informação from the New University of Lisbon, (ISEGI-UNL) is coordinating a Project (named ConTIG) that aims to promote experimental teaching in basic and secondary education through the use of Geographical Information Technologies (GIT). The project's general goals are the following:

- Awareness to the importance of geographic information in daily life,
- Develop spatial analysis skills in students,
- Develop research and group work skills,
- Develop critical sense about spatial planning,
- Create maps for various purposes,
- Share these learning experiences and all the materials,
- Disclose the project results and some of the students work in seminars and in teachers meetings.

Among the different activities of the ConTIG project are the GIS Day events. These were held in ISEGI-UNL's campus in order to get teachers and students of non university levels in contact with GIT and with people that use them daily. It is also important to show how GIT have real-world applications and how important they are to our every-day activities.

Other activities of the ConTIG project are teachers training, production of educational materials to use in the classroom, preparing field trips with the aid of GPS and ArcPad®, supporting teachers in different activities in and outside the classroom.

2 THE *ConTIG* PROJECT

The ConTIG project, supported by the National Agency for Scientific and Technological Culture ("Ciência Viva" program) until 2008, was carried out by ISEGI-UNL and three partners: ESRI-Portugal and two schools in the Lisbon area (Escola Secundária com 3ºCiclo do Ensino Básico de Pinhal Novo and Escola Secundária Maria Amália Vaz de Carvalho, in Lisbon). Two other schools (Escola Secundária de Palmela and Escola Profissional de

Ciências Cartográficas in Lisbon) also participated in some activities, developing exercises in the classroom, using Geographical Information Systems (GIS) to create maps and carrying out other assignments for different classes.

One of the goals of the ConTIG project is to help teachers organize the *curricula* according to the guiding principles of the Portuguese standards and national *curricula* that, among other things, state that one must use a diversity of methods, activities and strategies in education, especially using information and communication technologies, to promote skill development in a lifelong learning perspective (MINISTÉRIO DA EDUCAÇÃO, 2001).

The ConTIG activities involved students from different levels and teachers from different subjects: Geography, Biology, Geology, Physics, Chemistry, Economics, Philosophy, Computers, Project and specific subjects from professional courses in Gardening and Tourist Technician. About 120 students from the 7th to the 12th grades were involved in the project, during 2007/2008.

The ConTIG project also created a web page (http://ubu.isegi.unl.pt/labnt-projects/contig) that provides free access to all the materials produced, such as the learning experiences with the geographical data, teacher and student's guidelines and also the results (such as maps and reports) produced by the students (Figure 1).

Figure 1: The ConTIG web page.

In this web page it is also possible to read all the news about the activities, the seminars on which the project is being presented and a web-GIS platform in which some of the learning experiences can be carried out. The learning experiences can include classroom activities, field trips planning, reports, simple research tasks, among others.

By the end of the "Ciência Viva" program in July 2008, the balance was very:

- Two workshops for teachers were completed;
- Several teachers created learning experiences and tried them with their students successfully. These learning experiences are available at the ConTIG's web page with free access to all the materials (including geographical data, tutorials etc.).
- The web page works as a tool to help teachers and students use the technology (ISEGI-UNL was responsible for producing tutorials) and also as a dialog platform, where registered users can publish news and materials to share;
- Some equipment (including PDA, GPS and GIS software) were acquired for both schools that were partners on the project;
- The project was presented in several GIS and education meetings, in Portugal and in the USA.

In 2008-2009, although there is no longer funding from the "Ciência Viva" program, the ConTIG project continues to carry out its activities with the support of a high school teacher on a sabbatical license. The sabbatical allows this teacher to be fully dedicated to the project, maintaining the information on the portal up to date, organizing the activities, producing materials and data to be used in classes, following up the activities in different schools, supporting and training teachers, etc. This work, supported by ISEGI-UNL (who is still coordinating the ConTIG project), is very important to keep teachers from different schools in contact with each other and to maintain their involvement in the ConTIG activities, by supporting them when needed.

2.1 GIS Day (2007 and 2008)

ISEGI-UNL has experience in organizing GIS Days since 1999 and the high school teacher responsible for the project is also organizing these events since 2005.

GIS Day is a world wide event that is integrated in the Geography Awareness Week, sponsored by the National Geographic Society. This week aims to promote "geographic literacy in schools, communities and organizations, with focus on the education of children. GIS Day is held on the Wednesday during Geography Awareness Week" (ESRI, 2008). GIS Day is sponsored by several organizations (including ESRI, Association of American Geographers, the United States Geological Survey, the Library of Congress, Hewlett

Packard, etc.), and provides an international forum for GIS users. GIS Day is important to demonstrate real-world applications of these technologies.

According to the GIS Day sponsors (ESRI, 2008), participating in a GIS Day will benefit students in different ways:

- Exposing students to cutting edge technology;
- Helping students understand real-world problems using data analysis;
- Developing appropriate curriculum that will keep students' interest;
- Preparing and point students toward GIS jobs and career options;
- Sharing information across multiple disciplines and promoting a holistic approach to learning;
- Building alliances with other schools and organizations.

One of the first activities of the ConTIG project was the celebration of GIS Day in the ISEGI-UNL campus in November 14th 2007, showing how GIT works and some of its possibilities. Students and teachers from both partner schools were present to meet each other and got to do a hands-on activity with GPS and GIS technologies. The activity consisted on a *Geopaper* on the ISEGI-UNL campus. The students had to find clues with the help of a GPS receiver and ESRI's *ArcPad*® technology (Figure 2 and Figure 3).

Figure 2: *Geopaper* activity during GIS Day2007.

Figure 3: Learning to use *ArcPAD*® during GIS Day2007.

This event is an opportunity to help expose students to GIT (including GIS and GPS), educate other teachers and also build alliances between schools and organizations. Students benefit from GIS Day because they have the opportunity to contact directly with the technology and with instructors and professionals that can help them.

In November 19th 2008, ISEGI-UNL organized a similar activity. This year, 123 students and 16 teachers from seven different schools attended the event (Table 1):

Table 1 – GIS Day 2008 participants at ISEGI-UNL.

School	Teachers present	Participating students
Centro de Educação e Desenvolvimento de Maria Pia (from Lisbon's Casa Pia)	4	21 (7th grade)
Escola Secundária/3 Seomara da Costa Primo	3	21 (8th grade)
Escola EB2,3 com Secundário de Santo António (Barreiro)	2	19 (9th grade)
Escola EB Cidade de Castelo Branco	3	20 (9th grade)
Escola Secundária da Amadora	1	14 (10th grade)
Escola Secundária Maria Amália Vaz de Carvalho (Lisbon)	1	20 (11th grade)
Escola Secundária com 3º Ciclo do Ensino Básico de Pinhal Novo	2	8 (12th grade)

During the day, teachers and other ISEGI-UNL's collaborators were available to help the students. But there was no helping on finding the locations. Almost everyone was able to successfully finish the assignments. But it was also noticeable that some students still have problems with orientation and finding their way on the map. It was also noticed that there is some confusion between Latitude and Longitude. The most common error was North and South Longitudes and East and West Latitudes. One of the teachers said the experience was useful for her to realize she needs to do more practical activities to consolidate certain basic spatial skills.

The activities, similar to the ones in the previous year, were carried out in four shifts: 10H, 12H, 14H

and 16H. In each shift, there were seven teams of four or five students that received some information about GIS, GPS and how to use the ArcPad® (Figure 4).

Figure 4: *ArcPAD®* with the information for the GIS Day2008 *Geopaper.*

Then, each team had to search for places and answer a geographical question in each place (Figure 5 and Figure 6).

Figure 5: *ArcPAD®* and question sheet for the GIS Day2008 *Geopaper.*

Figure 6: Using *ArcPAD®* on GIS Day2008.

The activity consisted on examining a map placed on the GPS receiver equipped with *ArcPad®*. The map represented ISEGI-UNL's campus and had three points indicating the locations to search. Each group had three different points. The students had to use their orientation abilities and also their map reading skills to get to the points. At each location they had to determine the geographical coordinates and answer a simple question. These questions appealed to their orientation skills and were also useful to determine if they were at the right place. It could be a question about something written on a sign or a specific orientation of landmarks.

Coming back, as quickly as possible with the right answers, there was a winning team in each shift. After presenting the results and giving out the prizes and some gifts to all, there was time for a snack. Figure 7 shows the sequence of the activities of each shift.

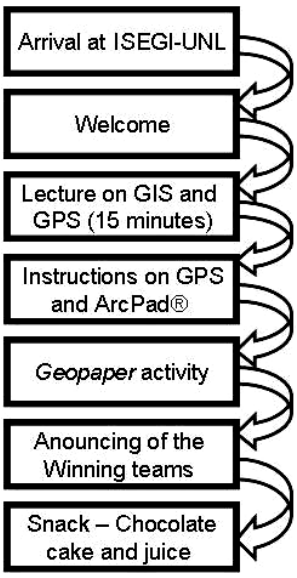

Figure 7: GIS Day 2008 activities.

A few weeks after GIS Day, a simple opinion questionnaire was made to the participants. Teachers and students representing grades 9th to 12th answered. The results show that most students and teachers enjoyed the activity and would like to repeat it or even have a similar one at their schools. Students had the perception that the activity was useful for learning new things like using new technology (on a scale of 1 to 4, the average answer was 3) and they also think the activity contributed to understand better Geography subjects (on a scale of 1 to 4, the average answer was 2,7). As for teachers, they all responded that they would like to organize more activities of this kind and said that GIS-Day was an important way of detecting missing skills in students, giving them an indication of what subjects need to be enhanced in the classroom.

These results showed us that it is important to pursue investigating in this field to identify the real impacts that practical orientation activities using GPS and GIS technologies have in learning. We can certainly conclude that these are motivating activities.

2.2 Teachers Training

"Geographic information systems (GIS) technology and methods have transformed decision-making in society--in government, academia, and industry. Some educators consider GIS to be one of the most promising means for implementing educational reform" (KERSKI, 2003). In 2004, Steven Palladino stated that the use of GIS in secondary levels is not that important to create new knowledge, but it "should allow for a more sophisticated form of enquiry in secondary school geography (and in other subjects). This enhanced ability to stimulate critical thinking and problem solving is one of the great promotions for the use of GIS in the secondary schools" (PALLADINO, 2004).

Teachers can use technology in the classroom as a way of getting the students to develop better spatial skills. GIS software can help educators and students answer community and global questions. GIT can be a good tool to help understand the world around us. It promotes critical thinking and solving problem skills in students. It has been pointed by the report from the American National Research Council (NATIONAL RESEARCH COUNCIL, 2006) that it is important to install spatial thinking skills across subjects and into the lives of learners of all ages. GIS can help doing this because not only it can help develop spatial skills, but also can promote interdisciplinary teaching. It's possible to create learning experiences with GIS that involve different subjects. GIS can manage a great deal of information and link together different maps and data.

To get students to use GIT, it's important that the teachers can use them well. So, one of the priorities of the ConTIG project is to train teachers not only on how to operate the computer programs, but also on showing them how they can develop activities for the classroom. Workshops and courses were prepared in order to achieve these goals. Some of the teachers involved never worked with GIS before so it is important to begin training by the fundamentals of GIS knowledge. Most of the teachers that attend these trainings are Geography teachers and some already use online resources like Web GIS and programs like Google Earth in their classroom. These training sessions were important to lead to the production of educational materials that are online at the ConTIG web page.

After the two workshops that occurred in 2007/2008, the ConTIG team is preparing some specific training in GIS. This will be held in the first trimester of 2009 to prepare teachers to better use the GIS technology. This training will be officially credited by the Scientific and Pedagogic Council for Continuous Training (official organism that credit Portuguese teachers for their life long training) and by the Portuguese Association of Geography Teachers through the Professor Orlando Ribeiro Training Center. Geographic inquiry consists on five steps which are (MALONE *et al*. 2002):

1- Ask geographic questions
2- Acquire geographic resources
3- Explore geographic data
4- Analyze geographic information
5- Act upon geographic knowledge.

This mode of thinking allows students to think spatially and investigate with the same methods as professionals in different areas.
We hope that this training will not only get teachers to have a better domain of the software, but also promote ways of teaching in an inquiry based learning (MOTA, 2005).

2.3 Support Teaching Activities in Schools

The "Learning to Think Spatially" report (NATIONAL RESEARCH COUNCIL, 2006) states that it's important to have support systems including *curriculum* and teacher training. The ConTIG project is committed to help teachers with their training but also within the classroom. Some high school classes were given with more than one teacher at the time, so that the students can have a better support of teachers while using the GIS programs. These classes are supported by the ConTIG project, that provides someone available to prepare materials (theoretical and also data sets and GIS projects) and exercises for the students. The results of these actions are being positive because when students use the software for the first time, it's important to have more than one teacher to solve small problems if they occur. The 90 minutes of a regular class in Portugal, can be better managed and the students can profit better from having two teachers there. It's also important when teachers are not so at-ease in a computer room and this can occur if they are not yet very comfortable with the software (if they are still in training themselves).

The ConTIG team is also available to give lectures in different schools (to teachers and/or students) to promote the project, and trying to get more teachers to participate.

It is also part of the activities planned for 2008/2009, to work with elementary schools. Of course, in this case, the lessons will be prepared with

much simpler software, but the "thinking spatially" philosophy will still apply. We are eager to try and see the results.

3 CONCLUSIONS

Due to the advantages (demonstrated through out the bibliography) of using GIT in the classroom, we believe the ConTIG project can alter the way people are teaching Geography and other subjects, bringing benefits to student's spatial analysis skills. Different phenomena, with a common spatial scenario can be analyzed and explored together. It's possible to find patterns and it's easier to observe relationships between them. The use of Communication and Information Technologies (computers in general) is frequently a motivating factor for students in middle school and high school levels.

Activities such as GIS Day are fun but are also important to alert to the importance of Geographical Information in different contexts. They are a starting point to get teachers to use Geographic Technologies (GT) as tools for teaching experimental sciences. From the questionnaire made to the GIS-Day participants we conclude that organizing such an event is not enough to get teachers involved in using GT in the classroom, but it certainly can be a stating point. It seems to be an activity that gets teachers aware of the possibility of doing these kinds of practical activities and detecting missing skills.

We believe that the technology is not necessary to acquire orientation skills. However, it can be a much more appealing way of reaching youngsters interests. It's also a good way of getting student's attention to the fact that Geography can be helpful and useful. From the student's opinions, we learned that they liked to participate and that they believe they understand better some Geography subjects.

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C PORTAL
Online Educational Framework for C and C++ Languages

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Keywords: C programming language, C++ programming language, Educational portal, Moodle framework, GRE security, Chroot, Resource limitation.

Abstract: This paper introduces the C portal educational framework, which helps teachers to assign C and C++ programming language problems to students and automatically compile and test the received solutions in a secured environment. The paper evaluates how the compiled untrusted binary can be executed with minimal security risk with focus on privilege escalation and uncontrolled resource usage. The paper also proposes how the system can be integrated in the existing systems intended for programming education like Moodle or dokeos.

1 INTRODUCTION

For more than a thousand year papers, letters or books were the main medium for delivering thoughts, ideas and theories between people. This has changed a lot with the spread of interconnected and telecommunication systems. These technologies make it possible to receive, send and share huge amount of information within a fraction of a second. The effects of these developments are estimated to be as big as the first industrial revolution.

These changes affect all aspects of the everyday life, which includes the educational system too. Our goal was to create an on-line interactive e-learning system for the C and C++ programming languages. There are several e-learning systems, but most of them can only handle tests or essay-like exams and hardly any supports the teaching of programming languages. The tools of this type mainly deal with interpreted languages like Prolog, ASP, PHP, Lisp, etc. or languages which can be easily tested in a secured container like Java or ran on the client side.

The C language is something completely different. It is a compiled language usually used for system programming, which means that it is hard to safely execute a C based program either by previous parsing of the source code or limit the capabilities of the binary executable by the operating system.

The goal of our system is to provide an environment in which solutions to C based e-problems can be safely tested. This environment consists of two parts: 1) a plugabble user interface described in the 2.1 section, 2) a batch system described in sections 2.3 and 2.4. The batch system is responsible for handling, executing and testing the submitted solutions. The last section of the paper covers the security risks and implications of the presented system.

2 THE INFRASTRUCTURE

The structure of the system consists of four logical components, which are illustrated on figure 1. The first is the *user interface* which handles the interaction with students and teachers. The *interoperability interface* stores all input and output data in a relational databases and shares it between the different components of the system. The third component is the *workload manager*, which is responsible for global job scheduling and separating the database from the unsafe running jobs, the last component is the *execution system*, which executes, tests and separates jobs from eachother. This last component can be composed of multiple physical computers. The last two components are called the batch system.

2.1 User Interfaces

The platform where certain users can interact with the system are the user interfaces. These are dynamic web pages, accessed via SSL using certificates,

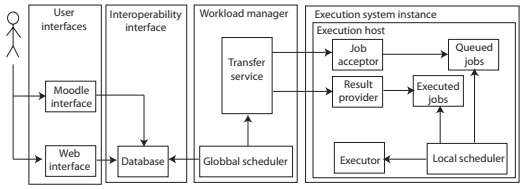

Figure 1: The structure of the system.

where the user has to authenticate with a username and password. The web pages are implemented using PHP, a widespread script language for developing dynamic web pages and applications (McArthur, 2008; Adam Trachtenberg, 2006). The user interface on development level is separated to two distinct layers: the data processing layer and the presentation layer.

The data processing layer collects all the input generated by the user (via submitting a form, or just clicking on a hyperlink), and executes the script for the actual target object. After the processing is finished, including verifications, validations and database transactions, the presentation layer is called by the appropriate parameters describing the structure of the page to be displayed and the generated content.

The presentation layer is a collection of self written and Smarty template engine (Sweat, 2005) templates. The Smarty template engine is also implemented in PHP, and gives a very simplified but enhanced way of generating web pages from predefined templates by providing an object oriented api for passing content.

All input generated by the user is being verified and validated to prevent malicious code to be inserted and executed, to prevent cross-side scripting and sql injections. The input types are classified in order to how the content is to be verified and validated. There are input types for what the user can only choose a value, but there are free input fields which have input scope boundaries. These inputs are supervised by regular expressions and built in methods.

Apart from php and database security the most threat comes from the user written C and C++ codes which are too difficult (impossible) to filter. Therefore we rely on the strength of the *execution system* defense mechanism.

There are two completed user interfaces ready and in use: the administrative and the student interfaces. The integration with the Moodle e-learning content management system is already started.

2.2 Interoperability Interfaces

The interoperability interface has two functionalities: First to provide asynchronous communication between the global scheduler and the user interfaces.

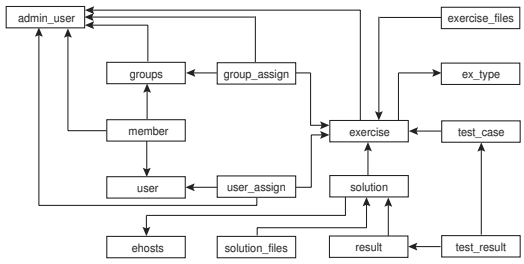

Figure 2: The schema of the database structure.

Secondly to act as a data storage for the neighboring components. The best choice for both tasks was an SQL database (Kofler, 2005; Dubois, 2007). The complex structure of the database used by these modules is shown on Fig. 2. This structure was chosen to provide maximal modularity and scalability for the system.

As this interface is used by more than one component, it has to provide granular data to each subsystem without the ability to identify the component which is doing the query. Tables have been divided to ensure flexibility, and to provide a simple way of accessing data independent from the type or content, while keeping the existing connections among the objects. As of security concerns, each component were granted different access privileges to the database - select, insert, update and delete rights -, keeping the number of these rights at the minimum, but still sufficient to ensure the expected functionality to be presented by each component. This is done by defining roles - collection of privileges -, and associating them to the appropriate subsystem.

Further concern was to enable the integration and cooperation of this system with existing, e-learning projects, such as Moodle (Cole and Foster, 2007; Korte, 2007). As being a complex e-learning content management system, Moodle already has a well documented, distributed database infrastructure with more than two hundred tables. It includes the storage of a wide variety of educational data templates, such as tests, quizzes, discussion boards, etc.

As the redesign of the database schema of Moodle is impossible we had to add new fields and tables to our database to ensure the functionality of the new Moodle module, while keeping the connections and data structure provided by Moodle untouched.

2.3 The Workload Manager

The workload manager runs the global scheduler, which implements two functionalities: the information collector for the execution system and the global resource broker. The information collector gathers all

metrics (queued jobs, running jobs, available slots) of the execution system instances, these are needed for global load balancing. The global resource broker uses this information to track and schedule the jobs.

The job scheduling covers three tasks: 1) query of the interoperability interface for new jobs, 2) selection of an executor instance for job locations and 3) transfer of the results of the solutions from the executor instance to the database through the interoperability interface.

The workload manager also contains the transfer service, which moves the data between the execution system instances and the workload manager. This is implemented as an SSH client, which holds the private keys of the job acceptor and the result provider users of each execution system instance. This operates in a push/pull mode, which means that it pushes a job to the execution system instance, and periodically queries the result provider for available results. The pull mode on one side has a slight overhead, but on the other side it allows a much clearer separation between the two systems.

2.4 The Execution System

The execution system consists of several execution hosts. Each host runs four services. These are job acceptor, result provider, execution and local scheduler services. These services are explained in the following sections.

Execution system hosts are physically separated from the Internet by sitting in a private network which is connected to the workload manager over a switch but not to Internet. This separation prevents all computers except the workload manager to communicate with the executor hosts.

2.4.1 The Job Acceptor

The job acceptor accepts jobs *pushed* from the workload manager. Currently it is implemented as a simple SSH server, which only accepts connections from the workload manager and a unique user which can write to one single directory, which is the execution queue.

2.4.2 The Result Provider

The result provider is a *pullable service*, which allows the transfer service to move the produced result of the pushed solution back to the workload manager. In our system it is implemented as a simple SSH server, which allows a single user of the transfer service to handle the results queue:

- count the number of entries in a single directory, which represents the results queue

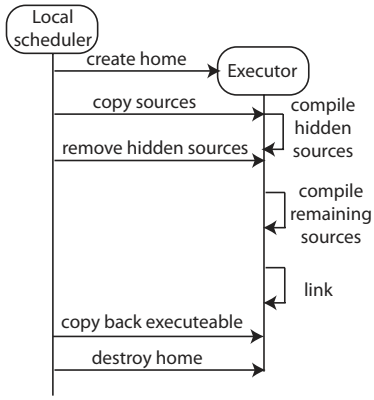

Figure 3: The comilation process.

- retrieve and remove elements from this queue

2.4.3 The Local Scheduler

The local scheduler is responsible for two tasks. 1) measure the metrics related to the execution hosts. These metrics are the load and the number of running and queried jobs. 2) drive the execution service, namely to decide which task should be executed from the received jobs. In the current implementation this is a shell script running in the background.

2.4.4 The Execution Service

The execution service driven by the local scheduler provides the safe container for running and testing solutions. The execution environment is a read only image, which contains a minimal operating system with pool users used for compiling and executing solutions. If the scheduler notices that a solution needs to be tested from the local queue it selects a pool user(PU) and compiles the user supplied and hidden source files as illustrated on figure 3.

The home of the user is a separate memory based temporary image created on demand and mounted inside the read only environment. After the home is mounted the sources are copied. First the hidden source files are compiled, than they are deleted and only the compiled object files are available in the further steps. After this the user supplied and non-hidden files are compiled. If all compilation was successful the objects are linked, and the final executable is copied outside of the read-only environment. Before the complete home is destroyed the log file is transported and parsed outside of the sandbox environment by the local scheduler.

If everything regarding the compilation process succeeded according to the settings defined by the in-

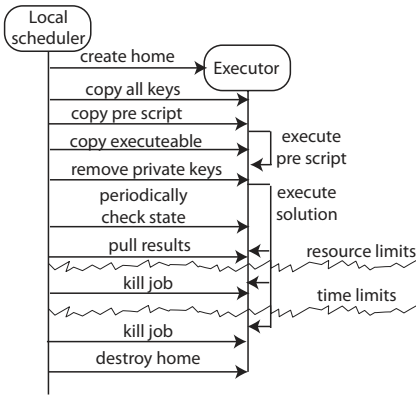

Figure 4: The execution process.

teroperability interface the testing phase begins. In this phase each test case is executed separately. The process of a test case execution is illustrated on figure 4. This process also starts with a temporary home creation and all keys, the executable and the *pre scripts* are copied there. After this step the system executes the pre script, which can create user specific input or data for the executable. After the pre script finished the compiled executable is started.

The local scheduler chroots(Joy,) to the scratchbox and executes the wrapper of the job, which is binary that closes the standard input and outputs (stdin, stdout, stderr) of the wrapper and reopens them: The file called INPUT is used as standard input and the STD.OUT and STD.ERR files are opened for standard output and standard error respectively. If the streams are opened successfully the wrapper calls the exec system call for the compiled binary.

The following limitations are set for the solution execution:

1. The shell of the PU is the compiled executable
2. The PU can write only in its home
3. The PU can have only one process (it can not fork)
4. The PU can use maximum 32 MB memory
5. The PU can not use the network
6. The PU can not use more then 60 sec CPU time
7. The PU can not use more then 300 sec real time
8. The PU can not access device files
9. The PU can not access the sys or proc file system

The pool user is prevented from breaching 5, 8 and 9 limitations on kernel level, while the UNIX standard *limits* utility is used to enforce limitations 3, 4 and 6. The rule 2 is enforced by using a file system for the operating system which lacks write operations and ismounted as read-only. The home of the user is a memory file system. The 1 limit is hard coded into

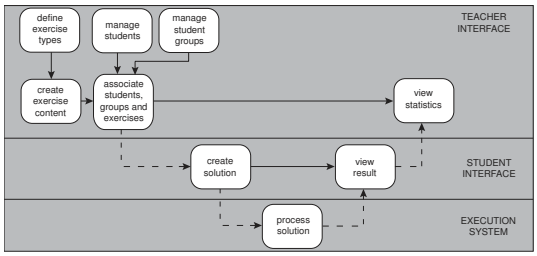

Figure 5: The usecase worrkflow of the user interfaces.

the read only image. The limitation 7 is enforced by the local scheduler, which terminates the running process if the consumed amount of real time is more than allowed.

If none of these limitations are breached and the test case process exits normally, then the *post* script is executed. which processes the output and decides whether the test case is accepted or not. This post script is a simple shell script, which has access to the all keys of the test case. If the post script exists normally it creates a *done* flag, which is checked by the local scheduler which moves all data to the results queue.

2.5 The Workflow

The workflow is centralized to the lifecycle of an exercise, shown on Figure 5. The account of the main administrator is automatically generated, and by authenticating with this account, the administrator has full management and administrative access to every object in the system. The main administrator has to initialize the database by inserting the available exercise types, and generating the student database. The admin has full access to the user management module, so it is possible to add users when the system operates.

As the user upload module accesses the interoperability interface, five pairs of public and private keys are generated automatically and associated to each student user, thus enabling the modules of the execution system to ensure privacy by accommodating encryption algorithms without querying the database for personal data.

The main admin may also generate sub-admin accounts in the same way as students (for the assistant lecturers for example). Sub-admins can create student groups conformly with the labor or seminar groups.

The next step is the creation of an exercise. This is a complex task for the teacher user, because all the required information have to be inputted. These parameters describe the method of giving the exercises to the students, and specify the parameters of how the solutions are to be verified, validated and evaluated.

Header file contents can be added to provide distinctive api to the students, as well as hidden files needed only for the compiler while building and testing the program from the source code handed in. When setting the specification of the exercise, the teacher may add student specific parameters automatically generated by the system at runtime. This can be done by explicitly the teacher: the body of the parameter generating script can be entered manually for each exercise, so as the students receive the exercise specification, the parameters are generated by the input function body as a static part of the specification, so the student acquire these parameters transparently. Any number of test cases can be assigned to the exercise.

At the point when the execution system successfully compiles the solution source code, it runs a series of tests defined by the creator by input and output. Prescripts and postscript can be also defined to each test case, enabling the configuration of the execution system to react and function in a unique way, while processing the solutions and evaluating each test case for each exercise. The creator has full access to manage and modify the settings of the exercise while it is not associated and distributed to the student users. Other teacher users have read privilege to exercises of other creators, and can easily create new ones with using similar settings or header files.

When an exercise is successfully entered into the system, every teacher user may assign it independently from the identity of the creator of the exercise to single student users. Exercises can also be assigned to groups of students (even if it is already assigned to individual student users), but with the limitation that the teacher user may only assign it to groups created by their own. The procedure of removing associations is similar.

As a student user authenticates on the student web interface, the assigned and completed exercises are prompted. In this page a student may hand in solutions to the associated exercises - the number of possible tries, the content length and the maximum number of uploadable file content are all defined by teacher users -, and is also able to view the results of each previously handed in solution. When a solution is submitted, it is passed to the interoperability interface, from where the execution service takes all the parameters of the actual exercise, and the contents of the solution. After the evaluation is completed, and result data is written back into the database, the status of the solution changes to evaluated, thus enabling the web page for the student to view the results of the provided solution and maybe create a newer one based on the evaluated solution.

3 SECURITY CONSIDERATIONS

During the development of the framework the two most important principles used were to keep the system simple, stupid and use only well proven, out of the box technologies. Since no system can provide 100 percent protection against all local exploits, one of the best choices is to keep the used technologies as updated as possible and use the strongest enforced privilege and service separation and prevent the spreading of the compromisation.(Bishop, 2003)

In an order to secure the infrastructure we run each functionality from 1-4 on separate nodes, and deploy firewalls between them.(Rash, 2007) These firewalls should allow only the absolutely necessary network communication between the services. The physically separated part of the infrastructure are the execution instances, the most easily breachable part of the system. They are only connected to the workload manager, which drops every incoming network packets and only allows the SSH client of the transportation service to reach the executor instances. This makes it impossible for the executor instance to reach the rest of the infrastructure. Even if the execution system is compromised, the rest of the system stays protected from internal attacks.

The workload manager runs the global scheduler as a non root user, which on one hand writes to the execution system through SSH and to the interoperability interface through PHP and MySQL. It accepts incoming connections only from the user interface while anything else is dropped. It is difficult to bypass this node as the rest of the system is connected only to this and there is no direct transfer of any network traffic.

The hardest part is the protection of the executor system. This not only includes the privilege protection, but the ensuring that the running test do not jeopardize the system, by creating dead locks, starvation or high load, which renders the system unusable. These problems are further explained in the (Daniel J. Barrett, 2003) and (Bishop, 2003) books.

The privilege protection is achieved by the technologies explained in the limitation enumeration, but the rest has to be achieved by the created architecture. The too extensive I/O usage limiting is achieved by using a read only scratch box and a temporary 2 MB size tmpfs created in the memory acting as the home of the pool user. This creates a maximal disk quota and converts disk usage to memory access, which is indirectly the already limited CPU usage.

The pool user is prevented from network usage by GRE security. This is required to protect the network from flooding. (Simson Garfinkel, 2003; Vacca, 2007)

The UNIX based systems normally can not handle more then 65536 processes, so the pool users must be prevented from flooding the system with huge amount of processes, so the maximal number of processes for a single pool user is limited to one.

The pool users are separated from each other by the standard UNIX UID/GID structure to prevent unwanted interference.

Above these limitations the solutions of the students are fairly queued, which means that the system tries to allocate the same amount of resources to each student. This prevents a single user to flood the system with jobs, which wait in the queue and delay the solutions of other users for a longer amount of time.

On the interoperability interface the backups of the databases must be periodically stored on a separate node. There are several tools to backup a database, so secured backups are out of the scope of this paper.

We can draw the following conclusion on the security side: This system is an educational supporting framework and not a mission critical banking system or airplane control unit and should not be treated as such. If an incident happens, the main goal is to protect the database, notice the event and identify the student who submitted the dangerous code.

If only the executor instance is compromised, it can be easily reinstalled, since it holds no states. The lost jobs, which are not transported back to the workload manager can be rerun.

4 CONCLUSIONS

As the implementation of the necessary core functionality of the system has been finished, our goal was to construct an environment consisting of distributed elements capable of compiling and testing C based problem solutions. Private and public testing proved that the modules of the system are well constructed and stable, and its usage did not produce any unexpected event.

Due to its distributed structure, the vulnerability of singular components does not affect the stability of the whole system, thus it provides a stable solution for a distributed system to be applied in an educational institute. As the system is already being used by more than half a year by more than two hundred students without severe errors or malfunctions, we can state that our security assumptions were correct. As usage increased many software ergonomical problems were resolved and interfaces were made more user-friendly.

There are lots of e-learning platform and portal implementations used by major institutions, and as our framework was designed to be compact but modularly structured, it is a bearable and sustainable development to integrate our system as a module to these bigger platforms. The integration into the Moodle e-learning content management system is almost finished.

ACKNOWLEDGMENTS

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INTEGRATING KNOWLEDGE FROM VIRTUAL REALITY ENVIRONMENTS TO LEARNING SCENARIO MODELS
A Meta-modeling Approach

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Keywords: Learning scenario, VRLE, IMS-LD, Meta-modeling.

Abstract: This paper focuses on learning scenario modeling for Virtual Reality Learning Environments (VRLE). Learning scenario models used in computer-supported learning environments are usually not able to describe educational activities implying interaction of learners with a virtual environment. In this paper, we propose an IMS-LD extension making it possible to describe executable educational activities taking place in virtual worlds. Moreover, the model described in this paper is generic in the sense that it can create scenarios regardless of the nature of virtual environments or application domain.

1 INTRODUCTION

A learning scenario describes educational activities taking place during a training session, and is usually written by the trainer. This paper focuses on learning scenarios modeling for sessions where some learning activities use virtual reality learning environments (VRLE). A VRLE is a computer-supported learning environment (CSLE) that uses virtual reality (VR) technology in order to immerse learners in a virtual environment. In the context of learning scenarios modeling, the specificity of VRLE in comparison to classic CSLE is related to the nature of activities that take place in the scenario, that imply actions of actors in a virtual environment.

Educational modeling languages that describe learning scenarios usually define five types of information (Koper, 2001):

- Prerequisites: prerequisites describe knowledge or skills the learner should have in order to take advantage of the learning scenario.
- Learning objectives: learning objectives are knowledge or skills to be gained by learners that achieve the learning scenario.
- Activities: it consists in the description of activities that can be performed in the environment by the different actors, learners or teachers, and their scheduling.
- Roles: they describe the involvement of the users in the learning scenario, and activities they have to perform.
- Environments: an environment describes the context of execution of educational activities. It contains necessary resources to the execution of activities.

Existing learning scenario models in the domain of CSLE (Koper et al., 2003; Rodríguez-Artacho and Verdejo Maíllo, 2004), generally consider educational activities as “black boxes”, described by a textual description. Activities are considered atomic, in the way that their execution is not described in the scenario. Only their inputs (resources) and outputs (outcomes) are taken into account.

On the other side, most VRLE include an authoring tool that allows the description of learning activities execution in a virtual environment (Munro, 2003; Gerbaud et al., 2008). Learning scenario models included in these authoring tools usually have two problems. 1) They don’t describe the integration of the activity in virtual environment into a more global educational process. 2) They are generally not reusable because of their specificity in relation to a particular

domain, like maths (Koedinger et al., 2004), to a particular task, like assembly operations (Brough et al., 2007), or to a particular pedagogical strategy, like discovery learning (Van Joolingen and de Jong, 2003).

Our learning scenario model proposition is grounded on the observation made by (Guéraud and Cagnat, 2006) that learning scenarios describing situations in which learners interact strongly with interactive educational tools (like virtual environments in our context) must provide information on the internal progression of educational activities. However, (Burgos et al., 2007) pointed out the difficulties encountered when trying to integrate simulations or games in an executable learning scenario. A full integration of the simulation in the learning flow should make it possible to receive information from the learning scenario (initial configuration, environment modification...) and to send information generated during its execution (actions performed, state of the world...). The constraint it brings is that a specific wrapper, linking the simulation and the learning scenario, should be created for each simulation. Then, even if the learning scenario model is as generic as classical CSLE models, we encounter the same problem as with VRLE authoring tools because the integration of the virtual environment requires specific development.

There is a need to provide models and tools allowing trainers to create learning scenarios integrating activities in virtual environment, regardless of the nature of those environments, and directly executable on a virtual reality platform. The learning scenario model we propose is based upon IMS-LD (Koper et al., 2003), a specification that has been normalized and widely accepted in the field of CSLE. IMS-LD allows to write scenarios describing the five types of information presented in introduction (prerequisites, learning objectives, activities, roles and environments).

In order to fully integrate a virtual environment in the learning flow, a both-way communication is necessary so that: 1) the virtual environment can be adapted to the profile of learners and activities they previously performed and 2) the learning flow can be modified based on what happens in the virtual environment in real time. It is thus necessary to extend IMS-LD so that the learning flow can take into account learners activity in the virtual environment. In section 2 we present the abstraction level of the model, and more precisely the virtual environment meta-model that it uses. In section 3 we show how IMS-LD can be extended to integrate activities in virtual environments in learning scenarios.

2 MODEL'S ABSTRACTION LEVEL

As previously said, the integration of a virtual environment in the learning flow requires a both-way communication between the learning flow and the virtual environment. To enable this communication, the learning scenario must be able to reference concepts used in the virtual environment. To do so, an approach consists in describing all those concepts in a domain-specific model of the application. This domain-specific model gathers information about types of entities that can be found in the environment, their properties, behaviors, *etc.* Thus, a learning scenario linked to such a model can express properties about the environment using domain-specific concepts. At this point, two abstraction levels can be identified: the virtual environment (level 0) and the model of this environment (level 1). In order for the learning scenario model not to be specific to one domain, the concepts of this domain (level 1) must be considered as interchangeable input data of the learning scenario model. For the learning scenario model to be able to handle these data, it uses a meta-model (level 2) that describes concepts used in domain-specific model.

To sum up, a learning scenario takes place in a virtual environment (level 0) and references the model of this environment (level 1). The scenario is expressed using a learning scenario model that uses the virtual environment meta-model (level 2). Figure 1 shows the links between learning scenarios, learning scenario model and the different virtual environments modeling level.

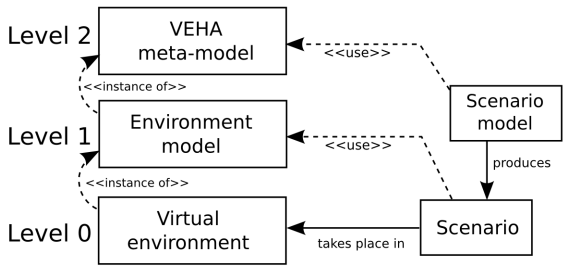

Figure 1: Representation of links between learning scenarios, learning scenario model and the different virtual environments modeling level.

This meta-modeling approach can be compared with the content layer of the PALO model (Rodríguez-Artacho and Verdejo Maíllo, 2004). Unfortunately, the meta-model they use contains only two concepts (entity and relationship), and is not expressive enough to describe complex virtual environments. For exam-

ple, it cannot describe the dynamic behavior of entities, or actions that can be performed by users in a virtual environment.

The MASCARET (Buche et al., 2004) (Multi-Agent System for Collaborative, Adaptive and Realistic Environment for Training) project is intended to design realistic VRLEs. MASCARET contains several models that describes different parts of VRLE. In this paper, we describe two models that are used by the learning scenario model: the virtual environment meta-model and the organisational model.

Virtual Environment Meta-model: VEHA

VEHA (Marion et al., 2007) is a meta-model designed to define virtual environments, providing a semantics allowing artificial or human agents to build a representation of it.VEHA meta-model is based upon UML 2.1[1]. Figure 2 presents a overview of VEHA.

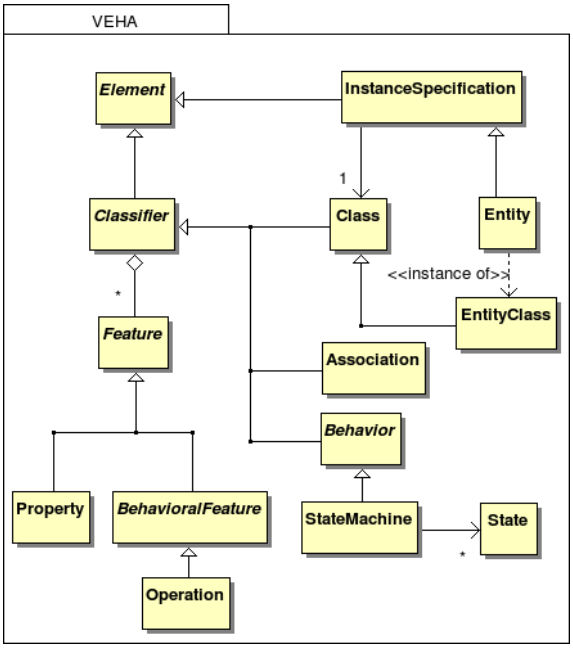

Figure 2: A part of VEHA meta-model.

Concepts of domain-specific models are represented by instances of the `Class` class. The structural (`Property`) and Behavioral (`BehavioralFeature`) properties of classes are associated with `Class` *via* the `Feature` class. Instances of these classes (entities actually evolving in the environment) are defined by the `InstanceSpecification` class.

To explicit knowledge about virtual reality, VEHA extends UML meta-model adding classes making it possible to model objects that are geometrically represented in the virtual environment, and which are therefore controllable by the user. A VEHA environment is a set of objects with graphical representations. The `Entity` class can represent such objects. Entities are instances of a particular class: `EntityClass`. It owns not only `Features`, but also information related to the shape, geometry, positioning, *etc.*(not represented on the figure).

VEHA provides an informed virtual environment meta-model that explicits characteristics of environments and entities that compose them. In addition, it allows the introspection of the domain-specific model (level 1), as well as the virtual environment (level 0). This meta-model can be used by a learning scenario model to express a learning scenario that references concepts of the domain. Thus, the scenario can describe properties of the environment that have to be observed by the learning flow during learners activity, as well as modifications to bring to the environment, based on the progress of the learning flow execution.

MASCARET's Organisational Model

MASCARET allows the creation of virtual environments in which humans and virtual agents can interact by playing roles within organisations. This is done *via* an Agent–Role–Organisation structure, described in (Buche et al., 2004). It is important for the learning scenario to reference organisational entities that exist in a virtual environment, in order to make it possible for users of the learning scenario to play specific roles in the virtual environment. The learning scenario model proposed in this article uses MASCARET, more precisely its virtual environment meta-model (VEHA) and its organisational model. The scenario model allows to create scenarios describing learning activities in virtual environments, as long as those virtual environments are described in MASCARET. MASCARET has already been used to create virtual environments for learning like GASPAR (Marion et al., 2007), SÉCURÉVI (Querrec et al., 2003) and a physics lab work (Baudouin et al., 2008).

3 LEARNING SCENARIO MODEL

In this section, we present how IMS-LD can be extended to integrate activities taking place in virtual environments. This section contains three parts, describing three aspects of learning scenarios that need to be extended to integrate activities in virtual environments: the pedagogical organisation model (3.1), the property model (3.2) and the environment model (3.3).

[1]Unified Modeling Language 2.1: http://www.omg.org/docs/formal/07-11-01.pdf

3.1 Pedagogical Organisation Model

This part focuses on the organisation of the different roles that perform activities in the scenario. In IMS-LD, every information of the scenario is contained in the `learning design`. A learning design contains a set of roles. Two types of role exist: learner roles and staff roles. In the scenario, roles are associated to activities that represent activities that users playing that role have to perform. Proposed model adds the notion of pedagogical organisation. This notions is based on MASCARET'S organisational model. Figure 3 presents the pedagogical organisation model we propose, as well as the part of MASCARET on which it is based.

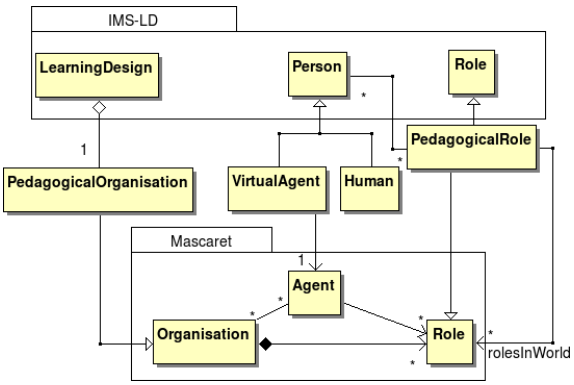

Figure 3: Pedagogical organisation class model.

Every `LearningDesign` contains one pedagogical organisation. Pedagogical organisations, are defined using the notion of organisation described in MASCARET. A pedagogical organisation is composed of pedagogical roles. In comparison to a MASCARET role, a pedagogical role adds two information:

- a link to one or many roles of the virtual environment (`rolesInWorld`). This linked can be used by the trainer to specify that a user will play one or several roles of the virtual environment (in addition to his pedagogical roles) in order to perform a collaborative activity.
- a link to one or several instances of the `Person` class, that represent the users of the scenario that will play this role at run-time, and perform associated activities. These persons can be humans or virtual agents.

This extension of IMS-LD organisational model allows the learning scenario to take into account the organisational structure of the virtual environment. The trainer can associate a pedagogical role to one or several roles in the virtual environment so that users playing that pedagogical role are automatically associated to the corresponding role in the virtual environment for a specific activity. an trainer or an intelligent tutoring sustem (ITS).

3.2 Properties Model

The principle of properties is that the trainer can describe variables on which tests can be done, and describe the progress of the scenario based on the results of those tests. This mechanism adds flexibility for the trainer to describe the scheduling of the scenario.

In IMS-LD specification, a property represents a variable that can have a type and a value. Properties defined by IMS-LD can have different scopes: local (same value for all users in a scenario), global (same value for every user in every scenario), personal (different value for every user) or role (same value for every user playing the same role).

In order to make it possible for the trainer to take into account the virtual environment in the learning scenario, it is necessary to extend the definition of property made by IMS-LD. In the learning scenario model, a property can not only represent a variable as in IMS-LD, but also an entity's property, an entity's state-machine or the fact that an action has been performed in the virtual environment. The properties model is based on UML's properties model, already implemented in VEHA. Figure 4 represents the class diagram of properties model.

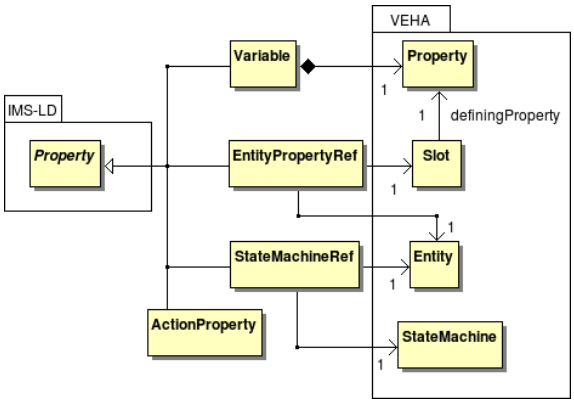

Figure 4: Properties model of proposed learning scenario model.

This figure shows four types of property:

- Properties as defined by IMS-LD are represented by the `Variable` class. A variable contains a VEHA `Property`, that defines the data type and initial value of the variable. During run-time, one or many slots (property instances) are instantiated

for each variable (depending on the type of the variable; for example, for a personal value will be instantiated one slot by user).

- An `EntityPropertyRef` represents a link to a property of an entity in a virtual environment. The difference with a `Variable` is that an `EntityPropertyRef` references an existing slot, that belongs to an instantiated entity of the virtual environment.
- A `StateMachineRef` represents a link to a state-machine of an entity in a virtual environment. The value of such a property is the current state of the referenced state machine.
- An `ActionProperty` allows to know if a specific action has been performed in the virtual environment. `Actions` are defined in the domain-specific model and describe the set of actions that can be performed by actors (human or virtual) in the virtual environment. `ActionProperty` model is not detailed in this paper.

Those four types of property behave the same way in that that we can retrieve their value or modify their value, with the exception of `ActionProperties` from which we can only retrieve the value.

The properties defined by the trainer are used to define conditions in the scenario. These conditions associate an expression (defined by a set of properties and their values combined with boolean operators) and a pedagogical action.During run time, conditions are tested by the platform, and pedagogical actions associated with true conditions are triggered. As in IMS-LD, pedagogical actions can be: change the value of a property, send a notification or change the visibility of a component of the scenario (make available or unavailable activities, environment, resources, ...). In addition, we added a new action called `VRAction`. The `VRAction` class represents a set of pedagogical actions that can be applied to a virtual environment, given a certain context. The various actions are based on the list of pedagogical assistances defined by (Lourdeaux et al., 2002).
Properties, expressions, conditions and pedagogical actions make it possible for the trainer to add run time individualization to the scenario based on learners' actions. Our proposition adds three new types of property that allow the description of learners' expected activity in virtual environments, and pedagogical actions to perform.

3.3 Environment's Model

Every activity takes place in an environment. Figure 5 represents corresponding class model.

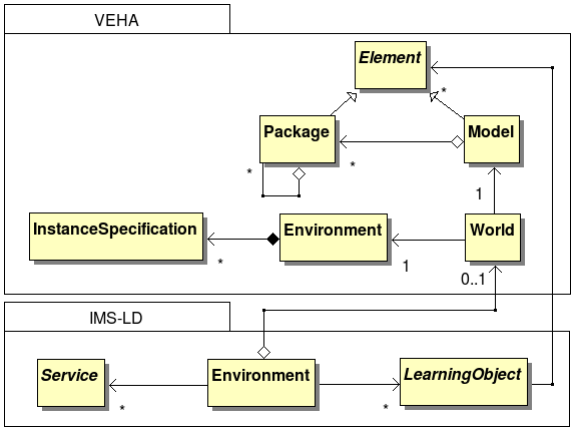

Figure 5: Environment's class model.

In IMS-LD, an environment contains learning objects and services. In the context of VRLE, the notion of environment is a bit different. In addition to learning objects and services, an environment contains a virtual world in which learners are immersed and act. To take this specificity into account, proposed model adds a virtual world to the environment *via* the `World` class defined in VEHA. A world represents an informed virtual environment created with VEHA and contains two main information:

- A domain-specific model for the application (`Model`, level 1). This model contains all the concepts described by a domain expert (as classes, associations, *etc.*), types of entities composing the environment, their properties, *etc.* the whole being gathered into packages.
- A virtual environment (`Environment`, level 0). This environment describes an actual instantiation of the domain-specific model and contains `InstanceSpecification` objects (*cf.* section 2).

Every information about the virtual environment can be referenced by the scenario and properties about entities of this environment can be defined (*cf.* 3.2). Proposed model adds a link between a learning object and VEHA elements. This association makes it possible to express links that can exist between virtual environment entities and learning objects outside the virtual world. For example, it can describe the association between a virtual tool and its instructions of use in PDF format. Then, this link can be used during simulation by an trainer or a pedagogical agent to provide struggling learners an appropriate resource.

4 CONCLUSIONS AND PROSPECTS

This paper describes a learning scenario model able to integrate VRLE in the learning process. The main advantage of this model, based on a meta-modeling approach is that it is generic, in that virtual environments can be integrated, regardless of their nature or domain. This model extends IMS-LD on several aspects. First, it makes it possible to take into account the organisational aspect of virtual environments. Then, three types of properties have been added (`EntityPropertyRef`, `StateMachineRef` and `ActionProperty`) so that conditions about virtual environments' state can be written. Finally, the model integrates virtual worlds in IMS-LD environments, and thus makes it possible to create links between learning objects and elements of the virtual environment. The learning scenario model described in this paper has been used to create a learning scenario for SÉCURÉVI (Querrec et al., 2003), a MASCARET-based virtual reality application designed to train firefighters. The main prospects of this work focus on the evaluation of this model by didactics expert of different domains. The goal of this evaluation is to check that the scenario model is flexible enough to take into account characteristics specific to different domains as well as characteristics specific to different pedagogical strategies.

ACKNOWLEDGEMENTS

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QGM – A SYSTEM TO IMPROVE MATHS e-LEARNING

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Keywords: Learning Objects, LOM, MathML, XML.

Abstract: The main goal of Projecto Matemática Ensino (Mathematics Teaching Project) – PmatE – is to promote the learning of mathematics. To achieve that, PmatE has been developing since 1990 an internet project especially designed to increase the interest of students in the discipline. The core of the Project anchors on the so-called "Questions Generator Model" (from the Portuguese "Modelo Gerador de Questões"). Each "model" is a tool based on parameterized expressions, which usually allows thousands of different questions to be generated (different formulations of the same "model") formally equivalent in terms of pedagogic content. The scope of this paper is to redesign the former "model" using the IEEE LOM's structure to define the learning object and redefine the model structure itself to allow for independence of the technological platform used to support the Project.

1 INTRODUCTION

The Mathematics Department of Aveiro University (Portugal) has been developing a project named *Projecto Matemática Ensino* (Mathematics Teaching Project) – P**mat**E since 1990 which aims at promoting the learning of mathematics using new information technologies. The central focus of this project is a structure called *modelo gerador de questões* (questions generator model) (Vieira, Carvalho et al., 2004).

Each *questions generator model* (QGM) is a piece of software that generates questions about a predefined theme, based upon scientific and learning objectives. These questions are randomly generated with parameterized expressions; the parameters depend on the age and educational level of their users. For each question, there are at least four possible answers, again randomly chosen among a set of possible answers.

Matching a question to an answer a true or false statement is obtained. All questions may be true or false. The user's task is to answer correctly to each statement. The QGM's may be organized in "competition mode" or in "evaluation and learning mode". In the competition mode, a collaborative competition is suggested. In the learning and evaluation mode, the cooperation among schoolmates and teacher is an intrinsic aspect of the process (Isidro, Pinto et al., 2005). Whatever the mode, the evaluations to be performed by the students will use, approximately, 20 models.

The randomness of the QGM's is the key of this project. In fact, for the same QGM thousands of different formulations with the same pedagogical and scientific value can be formulated. This feature enables two computers running side-by-side to have different questions and a different set of possible answers while using the same QGM. Combining the previous statement with the fact that the time to perform the evaluation is restricted, makes almost impossible for two students to practise any form of plagiarism (Pinto, Oliveira et al., 2007).

To materialise this project, P**mat**E has continuously developed an information system that offers a set of contents related with the several disciplines of Mathematics. Portuguese and Biology QGM's are also available recently. These learning materials are, however, prisoners of the technology used in their creation. They are all coded in Visual Basic 6.0 and stored in ActiveX dynamic link libraries (dll's). The content of these libraries are used to generate the questions that will be presented in a browser, using the ASP technology (Isidro, Fernandes et al., 2003). Such technological

dependency implies that sharing or reusing QGM's is very difficult, if not impossible.

The next two pictures show the system look and feel. They represent two distinct formulations of the QGM with ID 76.

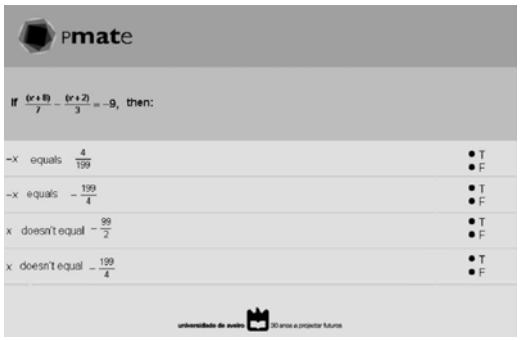

Figure 1: Using QGM number 76 (Pinto, Oliveira et al., 2007).

Figure 2: Another formulation of QGM number 76 (Pinto, Oliveira et al., 2007).

The pictures above show the power of the QGM's. To make it possible for the QGM's to be shared throughout Portuguese and international networks of Learning Objects, P**mat**E is promoting their adaptation. To do that, we are dealing with two distinct concerns: the QGM's must become independent from the technological platform and must comply with the international standards used to describe Learning Objects.

In this article, a description is given of the efforts made to transform the QGM's. First, we present the QGM LOM structure and the arrangements made to adapt it. Then we present the new QGM structure and syntax and finally we present the efforts done to test it.

2 LEARNING OBJECTS

There is no consensus on the definition of Learning Objects (LO) (Daniel and Mohan, 2004). Therefore, we will use the IEEE definition: "a learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training" (IEEE, 2002).

According to that definition, we can consider that the QGM's defined and built by P**mat**E are suitable to be viewed as *learning objects*.

2.1 Learning Objects Metadata (LOM)

Before we start, just a few introductory questions: What is a Learning Object? In a simple way, a Learning Object is the conjunction of metadata about a learning object and the learning object itself. What is metadata? Metadata is knowledge about knowledge (Taylor, 2003)) or information about information. Why is metadata so important? The major reason is that with such information we are able to understand the usefulness of a learning object.

In 15 July 2002, the IEEE published the final "Draft Standard About Learning Objects Metadata" (IEEE, 2002). This was the end of a long journey that started in 1997 with the efforts of the IMS Project, a non-profit consortium of US institutions of higher education (Consortium, 2006). They aimed to develop a specification for learning content metadata and an open market-based standard for online learning. One year later, IMS and ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe) proposed together to the IEEE, a new proposal of the Learning Objects Metadata. After four years of development, the final release was published (IEEE, 2002). This final release proposed a structure to represent the metadata about an LO. This strongly hierarchical XML-based structure has nine sessions:

- *General* – describes the general information of the LO;
- *Lifecycle* – specifies the actual state of the LO and its evolution;
- *Meta-Metadata* – specifies the knowledge about the LOM, not about the LO;
- *Technical* – describes the technical requirements and technical characteristics of LO;
- *Educational* – describes the pedagogical and educational characteristics of the LO;

- *Rights* – describes the copyrights and terms of use of the LO;
- *Relation* – describes the kind of links that this LO could have with other LOs;
- *Annotation* – in this session comments on the educational use of the LO can be provided;
- *Classification* – specifies the classification system of the LO, if any.

Together they form the *LOMv1.0 Base Schema*.

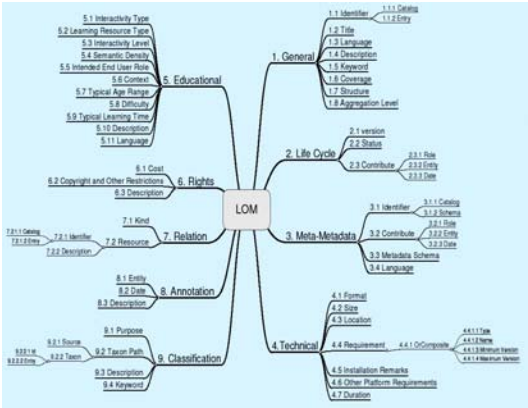

Figure 3: The LOM structure (Barker 2005).

Every element has sub-elements, and several of them have, again, new sub-elements. All the elements have their predefined data type. There are two kinds of data types: aggregate data elements and simple data elements. Simple data elements have individual values, defined by scope and data type. For aggregate data elements, *LOM v1.0 Base Schema* does not define individual values.

Whenever possible, the *LOM v1.0 Base Schem*a restricts the values a user can choose to a predefined list. This is useful to increase the interoperability of the LOM within several systems.

For IEEE, LOM can be defined as *strictly conforming* if it complies with all the rules and has no extended elements or, as *conforming*, if it has extended elements. Extended elements should have their own *namespace*, instead of using the LOM's *namespace*.

2.2 The LOM Models

As mentioned above, the QGMs are captive of the technological solution that had made them grow. Bearing that in mind, P**mat**E started to redefine the structure of the QGMs. This new model follows the Learning Object architecture: the *QGM* has two distinct sections:

- the metadata about the QGM, described using the LOM structure;

and

- the QGM itself.

The metadata section will contain the necessary to process information to allow compliance with the LOM's structure. Almost every LOM elements will be used.

The QGM internal structure will be completely rebuilt. The new structure is one of the scopes of this article and will be further discussed in Session 5.

2.3 The <bibliography> Element

Besides the LOM architecture, it accomplishes almost everything. However, during the process of QGMs implementation in LOM, we faced a problem: where to place the bibliographic references necessary to produce and support scientifically a QGM?

Our first attempt was to describe the bibliographic issues in the `<annotation>` element of the LOM's structure. Nevertheless, that solution conflicts with the nature of the LOMs – the interoperability between several metadata systems.

Therefore, we decided to create a new element (the 10th) in the LOM's proposed structure – the `<bibliography>` element. Our goal is to define the `<bibliography>` element accordingly to leading software in this area that represents the bibliography. This procedure will allow to export/import bibliographic information to/from LOM's structure.

This new element follows the Portuguese standard for bibliographic references. We also studied other formats used to describe bibliographic references, in XML: EndNote (EndNote, 2007) and BibTex (Patashnik and Feder, 2006; Gundersen and Hendrikse, 2007).

2.3.1 The <bibliography> Structure – 1

The `<bibliography>` element has one sub-element `<item>` that could be used once or several times. Each `<item>` element represents one bibliographic reference. This element has one attribute named *id*, which is mandatory. The attribute aims to identify uniquely each `<item>` element.

This element is then divided into 9 (nine) sub-elements: *type, authors, titles, publisher, edition Number, updatedDate, normalizedNumber, accessed URL, comment.* All elements can be used only once. The `<type>`, `<authors>` and `<titles>` elements are mandatory. The others are optional.

The `<type>` element identifies the class of bibliographic item and has a list of predetermined options. Those options are almost every types defined by (EndNote, 2007): *Ancient Text, Audiovisual Material, Book, Book Section, Chart or Table, Computer Program, Conference Paper, Conference Proceedings, Dictionary, Encyclopedia, Figure, Journal Article, Magazine Article, Manuscript, Newspaper Article, Online Multimedia, Personal Communication, Report, Thesis, Unpublished Work, Web Page*. To allow other types not specified in that set, we have the option *Other Type*.

The `<authors>` element represents the bibliographic reference authors. The `<authors>` section has, at least, one sub-element, named `<author>`. If the bibliographic reference has more than one author, one `<author>` element must be filled by author. The order of the `<author>` element in the `<authors>` section follows the order used in the source. We consider that the first author is the most important.

The `<titles>` element stores the title of the bibliographic item. It has four sub-elements: *title, chapter, pages and language*. As the name suggests, `<title>` represents the title of the bibliographic item. This element is mandatory. <chapter> and <pages> represent the sections of the book that is important to be noted. If the bibliography is something written, it should be important to express the `<language>`. The data type of this element is *LangString*.

The `<publisher>` element represents the editor's name of the bibliography. It has three sub-elements: *editorName*, *editionYear* and *local*. The `<editorName>` element expresses the editor's name of the bibliography. If `<publisher>` element is used, this sub-element is mandatory. `<editionYear>` and `<local>` represents the date and local where the bibliographic item was published. The data type for `<editionYear>` is *DateTime*.

`<editionNumber>` expresses the edition's number of the bibliographic item.

`<updateDate>` records the date of last update of the bibliographic item. Its data type is *DateTime*.

The `<normalizedNumber>` element is the place to represent the kind of standard number that is used to identify the bibliography. This element has an attribute named *type*. This attribute uses a list of predetermined options corresponding to six different standards: *ISBN*, *ISSN*, *LCCN*, *PCN*, *CIP* and *DOI*.

If the bibliography was accessed in the Internet, the element `<accessedURL>` expresses that url. This element has two sub-elements: *url* and *visitedDate*. If `<accessedURL>` is used, the two sub-elements are mandatory. As their names suggest, *url* represents the URL of the bibliography, and *visitedDate* represents the date when the reference was visited. For this last sub element, the data type is *DateTime*.

The last element, `<comment>`, allows the possible recording of comments about the bibliographic item. Its data type is *LangString*.

The default data type is *text*.

2.3.2 The <bibliography> Structure – 2

The next code presents the <bibliography> structure:

```
<bibliography>
  <item id="unique identifier">
    <type>type of bibliography</type>

    <authors>
      <author>Name of first
           Author</author>
      <author>Name of
           Author</author>
    </authors>

    <titles>
      <title>Book's title</title>
      <chapter>Chapter's name</chapter>
      <pages>consulted pages</pages>
      <language>Book's language</language>
    </titles>

    <publisher>
      <editorName>Editor's name</editorName>
      <editionYear>
         <dateTime>2008</dateTime>
      </editionYear>
      <local>Edition place</local>
    </publisher>

    <editionNumber>Edition number</editionNumber>

    <updatedDate>
       <dateTime>2008-12-20</dateTime>
    </updatedDate>

    <normalizedNumber type="ISBN">ISBN Number
    </normalizedNumber>

    <accessedURL>
      <url>URL</url>
      <visitedDate>
        <dateTime>2008-12-20</dateTime>
      </visitedDate>
    </accessedURL>

    <comment>
      <string language="en">possible comment about
         this bibliographic item</string>
    </comment>
  </item>
</bibliography>
```

Figure 4: The <bibliography> structure definition.

2.3.3 <bibliography> Example

Here is an example of the use of this new element:

```
<bibliography>
  <item id="01">
    <type>Web Page</type>

    <authors>
      <author>Duval, Erik</author>
      <author>Wason, Tom</author>
      <author>Hodgins, Wayne</author>
      <author>and others</author>
    </authors>

    <titles>
      <title>Draft Standard for
             Learning Object Metadata
      </title>
      <language>en</language>
    </titles>

    <publisher>
      <editorName>IEEE</editorName>
      <editionYear>
        <dateTime>2002</dateTime>
      </editionYear>
    </publisher>

    <editionNumber>IEEE 1484.12.1-2002
    </editionNumber>

    <updatedDate>
      <dateTime>2002-07-15</dateTime>
    </updatedDate>

    <accessedURL>
      <url>http://ltsc.ieee.org/wg12/
           files/LOM_1484_12_1_v1_Final
           _Draft.pdf
      </url>
      <visitedDate>
       <dateTime>2008-12-06</dateTime>
      </visitedDate>
    </accessedURL>
  </item>
</bibliography>
```

Figure 5: A <bibliography> example.

2.3.4 The <bibliography> Validation

Since this is an element that was added to the LOM's structure, to allow the validation of such element it was necessary to write a new Schema and integrate it with the Schema provided by IEEE (IEEE, 2005). With that integration, we are now able to perform a total validation of the new LOM's structure.

To support this extension, we defined a new namespace: *http://PmatE.ua.pt/lomExtended.xsd*.

4 MATHML

MathML is the acronym for *Mathematical Markup Language*. This markup language is especially suitable for representing mathematical notation. It can represent the structure and capture the content of a mathematical expression (Ausbrooks, Bos et al., 2007). MathML, like other markup languages, is an XML file. It is possible to write MathML documents with two distinct notations: presentation and content. *Presentation markup* is a more pleasant way to write but this version only encodes the notational structure. If it is necessary to encode the functional structure of an expression, the *content markup* is the best option. Nevertheless, this version is very hard to code. When both presentation and content markup are required, MathML allows the mix of the two markups.

The QGMs started to be mathematical learning objects, so the use of the MathML occurred naturally. With the new version of the QGMs, MathML gained a new importance. As will be explained in the next section, MathML will be used to represent mathematical expressions and to represent the validation expressions of the QGMs. Here the representation is necessary, but the knowledge about what is represented is crucial. That was the reason why we use the MathML *content markup* version.

5 A QGM AS LEARNING OBJECT

The new QGM uses the XML as a description language. With that, we intend to create a structure that is suitable to be represented by a browser or perhaps used in another system. By writing their learning materials in XML, P**mat**E promotes the content exchange with several platforms of Learning Objects. At this moment, P**mat**E is making an effort to diversify the subjects of their QGMs. The majority of them are about mathematics, but the number of QGMs in physics, biology and Portuguese are increasing. This structure is independent of the QGM subject.

A QGM has three sections:

- parameters (`<dominioParametros>`),
- text (`<texto>`), and
- answers (`<respostas>`).

```
<modelo>
  <dominioParametros>
  ...
  </dominioParametros>
  <texto>
  ...
  </texto>
  <respostas>
  ...
  </respostas >
</modelo>
```

Figure 6: A QGM structure.

The `<dominioParametros>` element has several sub-elements. Each one describes the set of possible

values to each variables and the options that are required to use the QGM. All values are represented in MathML.

All elements have several attributes, needed to format the values they represent. We use the `<![CDATA[` element to isolate the MathML code and avoid inconsistencies with the Schema.

```
<operador id="op2_aberto" nOpcoes="1">
  <opcao varDependente="false"
         calcular="true">
     <![CDATA[<math>
        <cn>1</cn>
     </math>]]>
  </opcao>
  <opcao varDependente="false"
         calcular="true">
     <![CDATA[<math>
        <cn>-1</cn>
     </math>]]>
  </opcao>
</operador>
```

Figure 7: Example of a <operador> element.

The `<texto>` element contains the text used to be presented as *question* in the normal usage of the QGM. If the *question* has options, they are represented also in MathML.

The last section, `<respostas>` contains the set of possible *answers* that can be presented to the user when a QGM is instantiated. Since each question always has four possible answers, this set must have at least four answers. The necessary information to each answer is stored in three sub-elements: answer text (`<textoResposta>`), validation (`<validacao>`) and additional objectives (`<objAdicional>`). The `<textoResposta>` and `<validacao>` sub-elements use MathML. In `<textoResposta>` the MathML is used to prepare the information that will be presented to the user. In `<validacao>` the MathML is used to implement the validation expression that will determine whether the response of the user is valid or not.

6 THE QGM PARSER

The entire system required has three modules:

- the LOM's editor;
- the QGM editor;
- and the QGM parser.

So far, only the first version of the QGM parser is available.

The parser has the following architecture:

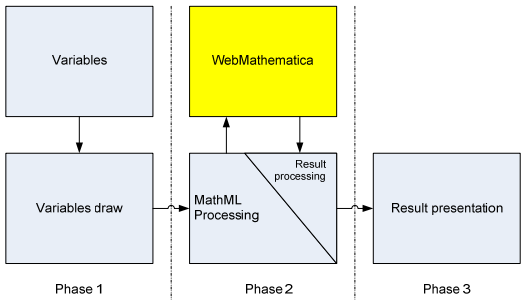

Figure 8: Parser architecture.

As referred, a QGM Learning Object uses XML as description language, and has a set of possible answers. In order to instantiate a new question and present it to a user, a parser is required. Such parser will select the possible answers and the difficulty level according to some parameters such as the user age.

Figure 9 shows the instantiation of the QGM number 290. It is possible to see the MathML code required to produce the answers that a user has to choose. Figure 10 shows the instantiation of the QGM number 1594 about the Portuguese language.

Figure 9: Parser result of math QGM.

Figure 10: A Portuguese language QGM.

The parser uses an XML Schema to validate the QGM and XSLT files to extract the information.

A QGM is a very complex document, with many options that the parser has to choose. Most of these options are coded in MathML. However, MathML is a complex language too and making a good parser for it would be very difficult. So, we decided to extend our own parser with WebMathematica. This leading software in the math's domain would be accessed through a *web service* and would be responsible for validating the choices made by the parser. The code produced in step 1 of the parser is complete but step 2 was impossible to test so far due to the high cost of WebMathematica's license. To test phase 3 we were able to solve the MathML manually.

7 CONCLUSIONS

At the beginning of this work we were confronted with two problems: How to pass on our long-term experience to Portuguese and international networks of Learning Objects? How to make our Learning Objects independent from the technological structure?

Although the P**mat**E project was older than the LOM proposal, the QGM metadata have evolved due to the efforts of its staff. Therefore, the adjustment of QGM's metadata to the LOM structure occurred straight. The only problem found was the lack of bibliography references in the LOM reference model. That limitation was overcome by adding the `<bibliography>` element.

The definition of the QGM structure through XML makes it freely available for other uses. In fact, now with a XSLT file it is possible to extract information from them rapidly. That was not possible with the older structure.

Another major advantage of this new architecture is the speed of development. Actually, due to the volume of material to be developed, it took us two to three months to be able to generate questions with a QGM. With the QGM editor, it will be possible to reduce that time by 90%, because we do not have to code and we can try it immediately.

In the whole work we had a remarkable setback: the inability to test our parser with the WebMathematica. Despite this setback, we believe that our new structure will be the future and it will work.

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TOWARDS DEVELOPING AN INTEGRATED MULTIMEDIA FRAMEWORK FOR ENHANCED e-LEARNING

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Keywords: Learning Management system, LMS, *ume*LMS, Multimedia streaming, Mobile learning, Lecture recording.

Abstract: In recent years, information and communication technology and multimedia technology have increasingly altered the landscape of the educational field particularly in higher education. In that, e-learning in its broad sense makes use of network and computing resources for bringing general education to the potential benefits of distant education and face to face classroom education. The amount of multimedia support facilitated by the e-learning systems has given significant consideration in order to make distance education as effective as classroom education and make the blended leaning experience more effective. While the technology is moving toward a multimedia rich learning management system, its practical deployments is still far away, due to many unsolved technical and pedagogical problems. In this paper we discuss the design and implementation of a prototype system *umeLMS* which features an integrated framework that interacts with a rich set of hypermedia contents and provides ubiquitous access. The main focus of this design is threefold: first *input integration* by which multimedia can be incorporated into the LMS in various ways. Second, *content Integration* by which different forms of hypermedia is linked to the course contents. Third, *access integration* by which a wide array of mobile devices are supported for multimedia content browsing which creates a real u-learning environment by enabling active participation in the learning/teaching process.

1 INTRODUCTION

In recent years, information and communication technology and multimedia technology have increasingly altered the landscape of the educational field particularly in higher education. Ritsumeikan Asia Pacific University (APU) in Japan, whose mission is to create world leaders in Science, Management and Economics through a bilingual curriculum, has increasingly been using many computer supported learning and teaching modalities to promote its educational delivery, since its establishment in 2000. The authors have involved in developing a prototype system (Nishantha, 2008) that extends APU's e-learning platform with interactive multimedia.

Computer modalities and software systems, which are used to achieve the blended learning objectives together with the support to administrate and monitor educational courses are generally termed **Learning Management Systems** (LMS) (Bersin, 2008). Choosing an LMS platform, however, is a critical decision which can have a significant impact on the academic institutions' ability to help students and lecturers meet their educational objectives.

Use of multimedia in learning content has been identified as an important element (Chris, 2007). According to United States Department of Defense data (Oblinger, 1991), we have short-term retention of approximately 20% of what we hear, 40% of what we see and hear, and 75% of what we see, hear, and do. The WebCT/Blackboard system (BlackBoard inc., 2009), heavily used commercial LMS today, has integrated virtual classroom/collaboration functionality in its latest (Windows Vista compatible) version. Moodle, a heavily used open source LMS, has also integrated a multimedia plug-in, named *DimDim*, to facilitate primitive video conferencing capability. Many academic institutions

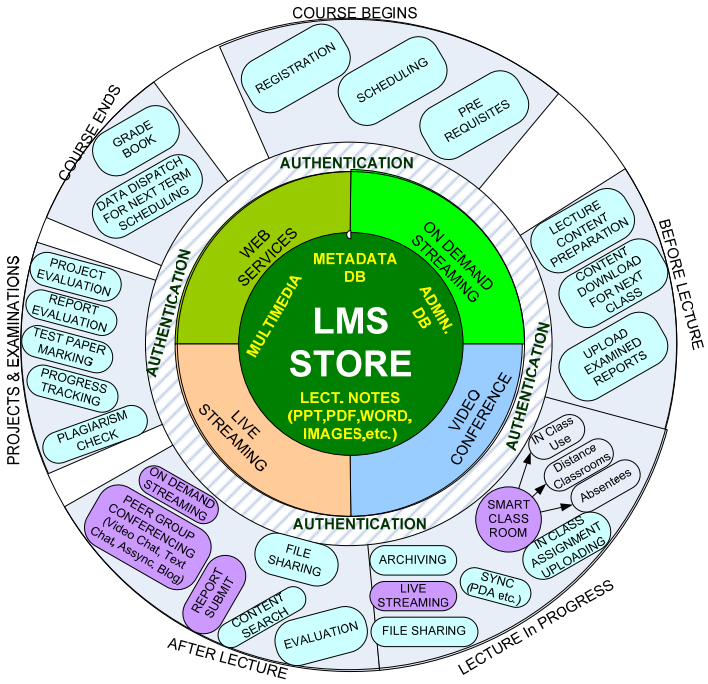

Figure 1: Activities throughout a course life cycle in a fully integrated LMS.

reportedly have added an array of custom multimedia functionalities either as an integrated tool to the LMS or as an independent tool to quickly cater the demanding needs for multimedia functionalities. While the technology is moving toward a multimedia rich learning management system, its practical deployments is still far away, due to many unsolved technical and pedagogical problems. Therefore, in Asia Pacific University in Japan, we have started developing a *Ubiquitous Multimedia Enhanced Learning Management System* (**umeLMS**) to enhance its education quality while reducing the user burden. The term *ume* (ゆめ : pronounced as Yume) in Japanese Language means dream: hence we envision an ideal LMS (dream LMS) to enhance the quality of education.

In this paper, we present our three fold contribution to enhance LMS. Firstly, **input integration** by which multimedia can be ingested into the LMS in many ways. Second, **content Integration** by which different forms of multimedia interact with the course contents. Thirdly, **access integration** by which a real u-learning environment is made possible by allowing an array of mobile devices to participate actively in the learning/teaching process.

The rest of this paper is organized as follows. In Section 2, we present the design rationale of the proposes system. Section 3 presents implementation and deployment of webELS prototype. Conclusions appear in section 4.

2 DESIGN RATIONALE

In devising a prototype for a Multimedia Enhanced Ubiquitous Learning Management System, considerations should be given to all stake holders of the system to be provided with facilities to (a) reduce cost and time consumption (b) reduce workload (c) enhance educational quality (d) enhance the accessibility and (e) enhance usability. In achieving some of these objectives rich use of multimedia plays a significant role. Figure 1 illustrates the activities and interaction of a fully integrated LMS over a generic course life cycle indicating the interaction of all stakeholders (i.e. administrators, teachers & lectures with the contents stored in LMS store and the interfaces provided). Multimedia is used in this model with close integration with the lecture content for supporting students to understand the course content, report back to the lecturer as well as group discussions. Further, multimedia is an integral component to realize smart classrooms that serves outside audiences.

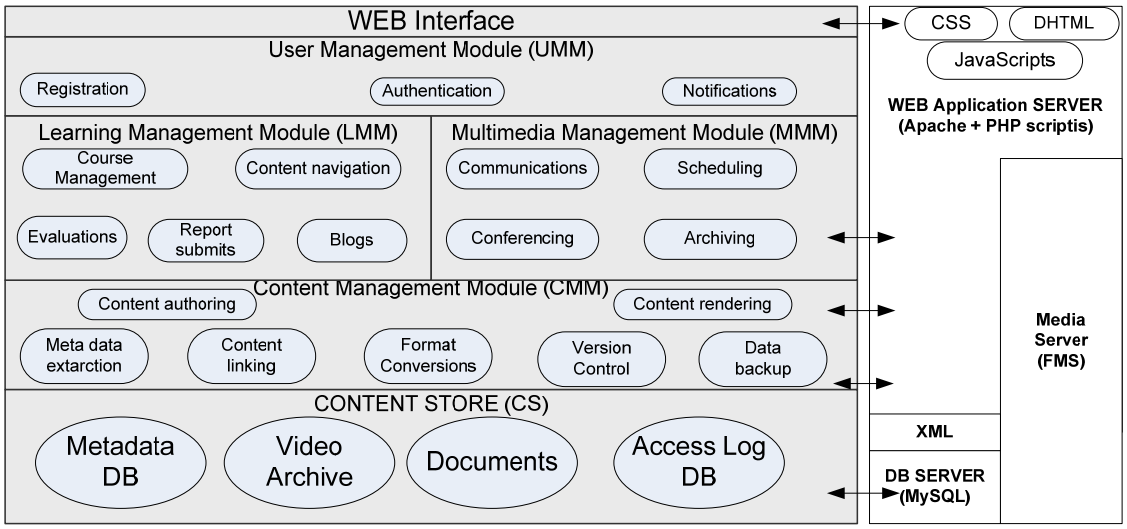

Figure 2: Modular architecture of umeLMS.

2.1 Design Architecture

Despite the availability of many famous open source learning management systems, we have opted to implement a novel system to cater for the special needs of the system that we envision.

The access interface identifies the client side devices and performs custom rendering to the device's screen resolution. Personal computer (PC) and mobile devices like third generation mobile phone and PDA (Personal Digital Assistant) could access the system through mobile connections like 3G or through wireless LAN connections.

The target learning system essentially consists of four functional modules as shown in Figure 2 namely: *user management module* (UMM), learning management module (LMM), internship management module (IMM), and *content management module* (CMM). UMM manages users as well as user groups and provides access authorization to the system resources through the functional modules LMM and MMM. LMM manages the learning and teaching where students teachers and administrators interacts with didactic and administrative material. Multimedia Management Module (MMM) houses the functionality to handle multimedia. This modular design enables networking with the other functional modules developed by the authors (e.g. projects management module in (Long, 2008) as well as exiting third party modules.

2.2 Content Integration

Three types of integration methods are incorporated in webLMS, namely: *input integration*, *content integration* and *access integration*.

2.2.1 Input Integration

Input integration refers to capturing various multimedia inputs to enhance the richness of lecture contents. Following multimedia input methods are of major concern for maximizing multimedia effects in teaching as well as learning.

- **Lecture recording:**

Lecture recording has become more and more popular in every university nowadays. However, in most cases it is used as a single stream audio video recording and often not integrated to the LMS. In this paper we propose a cost efficient methodology that uses a single dedicated PC per classroom to process inputs and form a composite stream for recording as illustrated in Figure 3. Three video inputs are captured from three IP cameras pointing to the lecturer's desk, whiteboard and the students and combined at the dedicated PC and then archived at the Flash Media Server (FMS) (Adobe Inc., 2008).

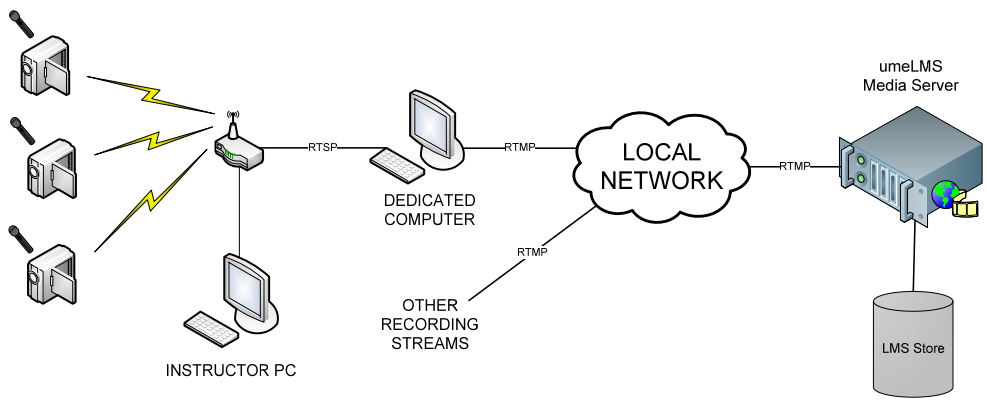

Figure 3: Lecture recording architecture.

- **User side recording:**

The users should be facilitated with an interface to upload live audio/video recordings which allows them to submit their reports/suggestions/comments using rich multimedia formats. This enables enhanced interaction among students and teachers by providing an interface to answer or issue queries without wasting time, without the need to be active to respond, and without the need to be familiar with multimedia processing knowledge.

- **Live conferencing:**

Live conferencing features are considered as a very strong tool used in many areas like business, medical, and government. In education, live conferencing is strongly supported by commercial LMS. Open source LMS have less built-in-features than the commercial ones but they are open source and easier to be developed to extend the features. umeLMS with FMS server can provide high quality and flexible synchronous media streaming which can be used for live conferencing integration.

2.2.2 Content Integration

Having built up the content store with a mixture of related hypermedia elements (i.e. lecture contents, lecture recording, report submissions and client side multimedia) it is required to relate different elements for enhanced accessibility. We adopt a metadata model to implement a semantic linking mechanism as presented in (Hiromitsu, 2005) to relate different elements in the LMS store.

- **SCO content model**

We propose a Sharable Content Model (SCO) that can be easily modified, shared and reused to store multimedia contents. We adopt this model, similar to SCORM (Gord, 2004); to facilitate a high-level and well defined content structure while keeping the content development burden as painless a manner as possible to the university lectures. However, in order to keep this SCO methodology less complex, we keep away from the Standard SCO models such as SCORM-2004 (Victor, 2008) but using a simple custom tool for content authoring.

- **Content Authoring**

Figure 4 (left side) shows the formation of SCO script in *manifest.xml*. The SCO publisher in takes different type of hypermedia inputs as shown in (I) and generates manifest.xml file (II). Hypermedia input in (I) is saved in the proper service location (ie. Data Server, Web Server or Media Server). Metadata for generating the SCO object is captured from user behaviour, user input, and scanning the input contents by the system. Input files which do not generate any metadata description will all be stored as linked *assets* of the course contents. In this approach, contents corresponding to one course are packaged in to one container with a *manifest* file.

- **Content rendering**

When a client request to access an object from Web Server (1) , the web Server will check from data server and get the info of that object (SCO compliant) (2,3). After receiving the requested information from data server (objects permission, file info, etc) (4), web server will render the html output, with embedded objects or hyperlinks to contents. In case of media streaming, the web server will pass the required information for the client to communicate directly with the media server (6,9) and instructs the media server to service the client (7,8).

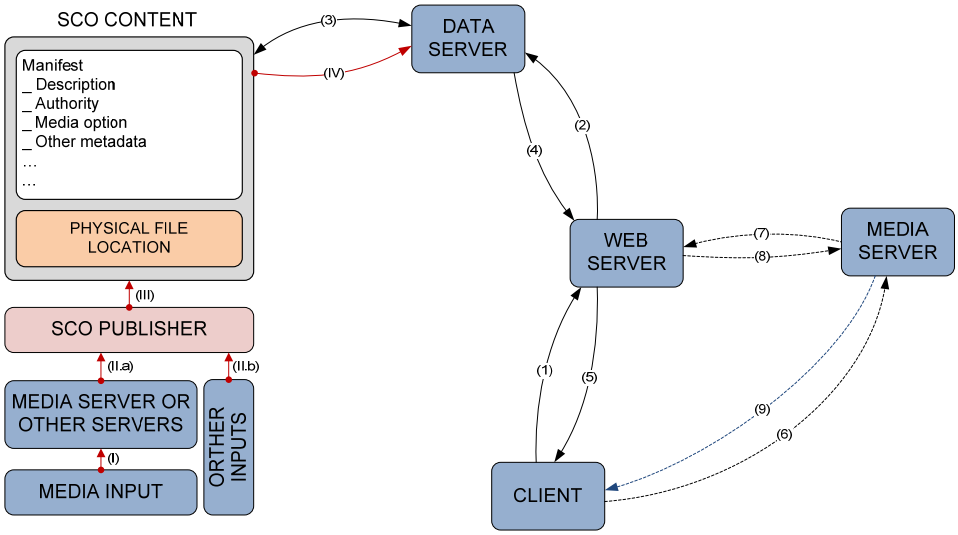

Figure 4: SCO content integration.

2.2.3 Access Integration

Access integration is one of major goals of the development of umeLMS by which the LMS systems is open to ubiquitous access through desktops as well as mobile devices. This is made possible by using Flash Streaming Technology (adobe, 2009) which is supported by almost all internet browsers and installed virtually in all computers irrespective of the operating system.

The Media Streaming System we use is multimedia framework using Flash Media Interactive Server provides the ability to stream live videos or video on demand contents as show in Figure 5. Nearly every device which can access the Internet has the built-in Flash supported browser for rich Internet contents, like PSP, iPod Touch, and other PMP (portable music player) devices. With Flash being widely supported by many devices, umeLMS will gain a fully fledged ubiquitous connectivity.

3 SYSTEM IMPLEMENTATION

3.1 Working environment

umeLMS Web Server is built upon a L(W)AMP stack (which stands for Linux (or Windows), Apache, MySQL and PHP). umeLMS Media Server (with is powered by Flash Media Interactive Server) is using another dedicated Linux or Windows server. A dedicated Database server is optional, it can be used in case of large-scale organization, in this development stage, we use one computer to act as both Web server and Database server for easy control and cost efficiency.

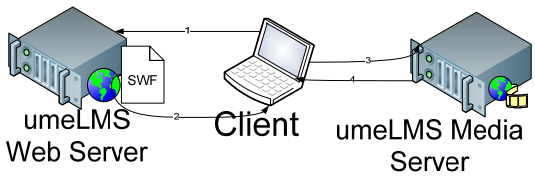

Figure 5: Media streaming in umeLMS.

3.2 Implementation

umeLMS Web Server and *umeLMS* Media server communicate with each other through a low-level API system. When Media Server wants to connect to the web server, it will use the web service (written in PHP) and make an XML-RPC (Remote Procedure Call) to request the user authenticating data. On the other hand, when Web Server wants to make a Live Conference through Media Server, it will request Media Server to open live streaming service. The client (desktops or handheld device) only need a Flash supported browser to access Web Server, everything will be taken care in server-side.

To maximize system efficiency as well as compatibility for other LMS integration, we have developed a set of APIs for umeLMS web server which implements the modular architecture we explained in Figure 2. Figure 6 illustrates a snap shot of umeLMS umeLMS showing video playback and student's personal notes. By this way, each student can maintain his/her own study profile.

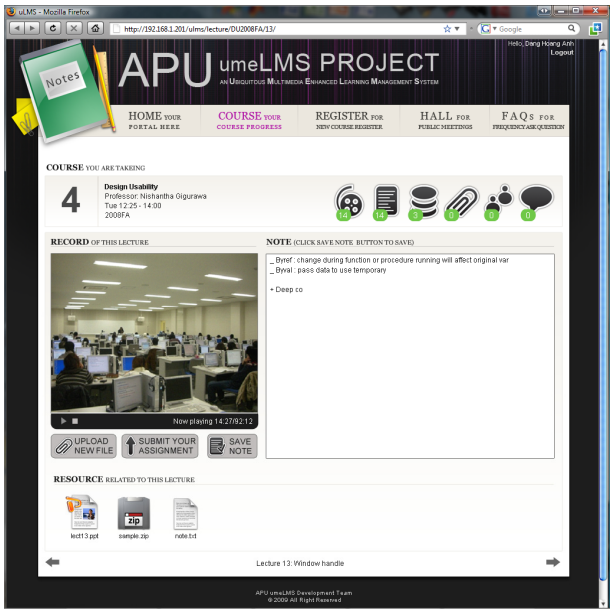

Figure 6: A snapshot of umeLMS showing video playback and student's personal notes.

4 CONCLUSIONS

In this paper we presented a framework for implementing a ubiquitous multimedia enhanced enhanced learning management system (umeLMS). To implement this we propose SCO based content model and a flash based multimedia framework, with which content captured from various sources is integrated. Due to the dominant use of multimedia in our system, we believe 3G devices will find these very attractive thus enabling students to actively engage in the learning process from anywhere and at any time. We hope our pilot run in Asia Pacific University will be an example for other universities to revise their learning systems.

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PROCCESS OF DEFINITION OF LEARNERS STEREOTYPES TO INTELLIGENT TUTOR SYSTEM BASED ON STRUCTURAL COMMUNICATION EXERCISES

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Keywords: Learners Stereotypes, Structural Communication, Intelligent Tutor System.

Abstract: The subject of this paper is the forgotten instructional technique called Structural Communication and how learners stereotypes could be defined to a generic Intelligent Tutor System based on Structural Communication Exercise. This instructional technique stemmed from teacher's practice of analysing a learner's problem solution to an ill-structured problem. The solution described in this paper is based on some ideas of convergent and divergent cognitive learner styles. These cognitive learner styles were used to define a set of twelve basic learner stereotypes. These ideas of learners stereotypes stemmed from the observation of how learners could employ some domain's concepts or ideas in a convergence and divergence way to solve a set of ill-structured problems. This set of learner's stereotypes is represented by three independent dimensions or layers and define a Learner Model of a generic ITS based on Structural Exercise.

1 INTRODUCTION

Hannafin et al. (1999) and Jonassen (2004), among other researchers, emphasized the lack, necessity and importance of models or instructional techniques that could help the Intelligent Tutor System - ITS developer to represents some instructional activities based on ill-structured problems.

To attain this desirable representation, the ITS developer faces two basic requirements: the specification of ITS architecture and the selection of instrucional techniques. This type of challenge motivates some researches such as those performed by Arruarte et al, (2003) as well as Heffernan and Koedinger, (2002) to join instructional techniques to ITS or Authoring Tools.

In a typical ITS Architecture, the Learner Model has an important role (Murray, 2003). This Learner Model could represent several facets and information about learners. In this context, the ITS developer could typically define a set of learners's stereotypes. For example, Milik et al, (2008) used two learner's stereotypes based on spatial ability into ERM-Tutor. Other example, Parvez and Blank (2008) defines a set of learner stereotypes based on Felder-Silverman learning style model (Felder and Silverman; 1988).

This basic and important ITS requirement was also researched by Bahar (1999). Bahar identified some convergence and divergence features in learners solving ill-structured problems using Structural Communication – SC (Egan, 1976). SC is na instructional technique stemmed from the teacher's practice of analysing a learner's problem solution to a set of ill-structured problems. The result of this analytical process helps the teacher select a correct feedback message.

Despite of this, the current state of art of SC doesn't report any development of ITS based on this technique neither how learner stereotypes could be represented in a computer environment.

This paper describes how Bahar's convergent and divergent cognitive learner styles could be used to define some learner stereotypes to a Learner Model of a generic ITS based on Structural Communication exercises.

This paper contains 5 sections. Structural Communication is summarized in Section 2. Section 3 presents and describes a Learner Model to an ITS based on Structural Communication execises. Section 4 analyses the model. Finally, Section 5 presents the conclusion and future works.

2 WHAT IS STRUCTURAL COMMUNICATION?

Structural Communication is an instructional technique that individualizes learning, provides controls for the process by which the learner moves through the lessons, faces him with challenges to construct his own multifaceted responses to complex open-ended problems and ill-structured problems, analyses these responses and firmly provides complex, multifaceted, feedback on all relevant issues revealed by his answer (Egan, 1976).

The Structural Communication technique involves the development of special units of domain study. Each learning unit should be structured in such a way that the learner spends approximately an hour of study to complete the activities foreseen by the author. However, the work of the learner is somewhat analogous to the research of the content and planning of the structure of an essay or term-paper type of response - a task that typically takes many (sometimes many dozens) hours. Thus, the learner has the opportunity to engage in a much larger number of creative knowledge-construction exercises during the time available for study on a given course. A SC learning unit usually contains the following sections:

- **Intention** - This section defines what should be learned and to what level or intensity. It supplies a general vision of the objectives and context for the unit of study.
- **Presentation** - This section supplies descriptive information on the subject, possibly practical exercises or case studies. It can be composed of text materials, videos, simulations, computer-based training systems, hypermedia courses, adaptive hypermedia systems, electronic games, and site visits, among other forms.
- **Investigation** - This section presents a group of usually 3 or 4 interrelated, challenging and generally open-ended questions on the subject of the Presentation. They constitute the challenge for the learner who responds by selecting elements from the Response Matrix presented next.
- **Response Matrix** - It is a response-generating instrument formed by a large number of elements, typically 20, from the domain under study; they can be sentences that summarize an idea, key words, concepts or principles contained in the Presentation. The learner constructs a response by selecting those elements that are considered part of a complete response to the complex question that is being addressed.
- **Discussion** - This section is composed of two parts: a group of " if - then - else " rules and a series of feedback comments elaborated by the author, each one associated with one of the rules. The comments have a constructive purpose and they discuss in depth the reasoning used by the learner when selecting or omitting certain items or subsets of items from the Response Matrix. They seldom classify a response as incorrect and never supply a "correct" response, but rather encourage the learner to think again and to think deeper and wider around the issues being addressed.
- **Points of View** - This last section is used by a SC exercise's author to present other interpretations or conflicting points of view and to revise some aspects presented earlier. This section finishes the interaction between the learner and author, which mimics a virtual dialogue between them.

One may ask why the potential of researched methodologies such as Structural Communication has not been realized by ITS's developers. One possible reason for this lack of computer applications of a theoretically "good idea" is the gap of Models to represent an SC Unit and SC Domain Knowledge in a computer environment.

3 LEARNER MODEL TO STRUCTURAL COMMUNICATION EXERCISE

The learner stereotypes are defined in this work using three layers and they are based on the learner's last solution to a problem and recorded solution history. The last learner solution is analysed in the first layer and clustered based on domain concept convergence. This solution can be classified in Convergent (C) or Divergent (D). The Second Layer analyses the history of solutions and classifies the learner in Convergent (C), Mixed (M) or Divergent

(D). Finally, the Third Layer analyses the history of solutions and looks for a hidden convergence in all recorded solutions. The learner is classified as having presented a Convergent Concept Path (C) or a Divergent Concept Path (D) if this third layer finds some convergence in all solutions recorded in the learner's solution history.

In this context, an example of a hypothetical learner "A" is represented in a three dimensional space in Figure 1. This space can represent any learner stereotype or learner behaviour. Learner "A" has a **C**onvergent Solution, a **M**ixed History of Solutions and a **D**ivergent Concept Path.

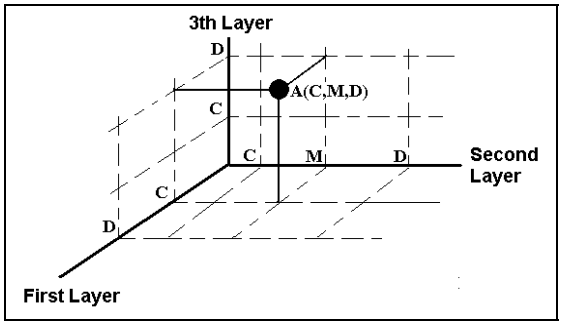

Figure 1: Representation of Learner Stereotypes in Three Dimension Space.

This current paper section is composed of 4 subsections. Section 3.1 describes how Response Matrix Elements selected by a learner could be represented in a symbolic expression to be used by a computer system. This expression records the presence and absence of some domain concepts in the Selected Response Matrix Element. Sections 3.2, 3.3 and 3.4 describe a computer algorithm to analyse this expression. The result of this analisys is a more precise and refined learner classification.

In this example, a symbolic Response Matrix with 20 elements is considered. These Response Matrix Elements are sequential abstract elements labeled as { $F_1, F_2, F_3, \ldots, F_{18}, F_{19}, F_{20}$ }.

The same example also considered that Concept Graphs could be associated with all Response Matrix elements F_n. These Concept Graphs are very similar to Novak's Conceptual Maps. (Novak, 1998). Figure 2 illustrates this idea. In this figure, the following Response Matrix Elements {F_1 , F_2 , F_{11} , F_{12}, F_{13} and F_{18} } were associated with some important concepts or ideas detached from domain by the SC exercise author (Noronha, 2005). These concepts or ideas are labeled as Knowledge Keyword - KWK in this context (Noronha, 2005).

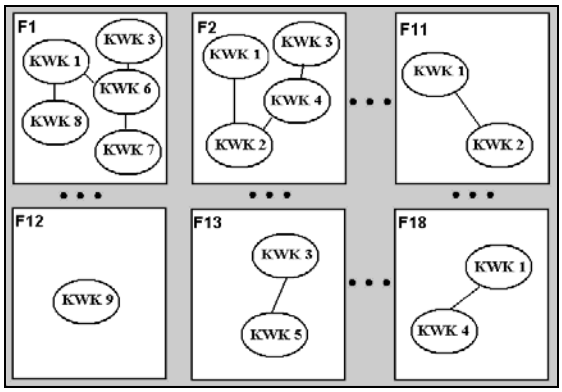

Figure 2: Graph Representation of some Response Matrix Elements.

How can these important concepts or ideas be represented in a symbolic expression? The next sections define expression of concepts and show how learners can be classified in three layer-based learner stereotype model.

3.1 Expression of Concepts - S_F

The Expression of Concepts - S_F represents the presence of each KWK in each Response Matrix element selected by a learner to compose a solution. The index "1" is used to indicate the presence of each KWK inside the Matrix Response elements.

For example, the following expressions S_{F1} and S_{F2} represent the elements F_1 and F_2, in Figure 2. The set composed by elements KWK1, KWK3, KWK6, KWK7 and KWK8 corresponds to element F_1 and another set composed by KWK1, KWK2, KWK3 and KWK4 corresponds to element F_2.

S_{F1} = 1.KWK1 + 1.KWK3 + 1.KWK6 + 1.KWK7 + 1.KWK8

S_{F2} = 1.KWK1 + 1.KWK2 + 1.KWK3 + 1.KWK4

All Matrix Response elements can be represented by a similar expression to those described in this example.

3.2 First Layer: Classification of Learners Based on Individual Analysis of Learners Solution

In this first layer, the problem solution dispatched by learner must be analysed in an isolated way. Any solution by the learner could be composed by some or all Response Matriz elements *Fn.* For example, a learner could select the following Response Matrix elements { F_{11}, F_{18}} to compose his/her solution to

a challenge or problem defined in SC Intention Section. These elements are illustrated in Figure 2. Another learner could select other Response Matrix elements such as { F_{11}, F_{13}}.

This example is illustrated in the following Figures: 4 a) e b). The solutions are labeled *Sa* and *Sb,* in these figures. The elements F_{11} and F_{18} compose the solution *Sa,* whereas the elements F_{11} and F_{13} compose the solution *Sb*.

Figure 3a) illustrates a solution composed of Response Matrix elements F_{11} and F_{18} represented as Venn diagramas. These matrix elements share the element KWK1. This is represented in Figure 3a) by means of an overlapping region. In this case, the solution is classified as Convergent to KWK1.

In contrast, Figure 3b) doesn't show an overlapping region. In this sample case, the solution is classified as Divergent to KWK1, KWK2, KWK3 and KWK5.

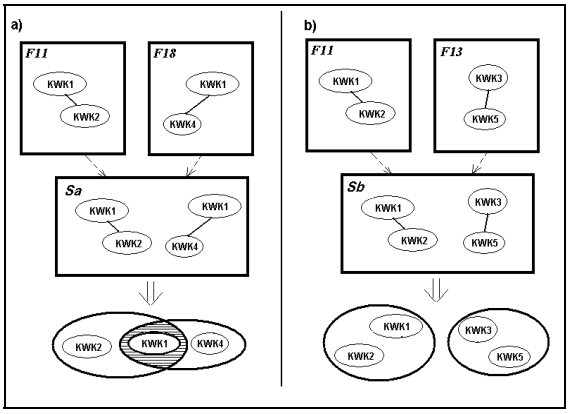

Figure 3: Example of Problem's Solution Analysis.

These analyses could also be conducted using the Expression of Concepts described in section 3.1. Each solution expression is created by separately adding the corresponding index for each KWK. For example, the solution illustrated in Figure 3a) can be represented by the following expression of concepts:

$$S_{F11} = 1.KWK1 + 1.KWK2$$

$$S_{F18} = 1.KWK1 + 1.KWK4$$

$$S_a = S_{F18} \wedge S_{F11} = 2.KWK1 + 1.KWK2 + 1.KWK4$$

The KWK1 has a "2" index because it appears two times, in F_{11} and in F_{18} . The index analysis of the concept expression identifies which KWKs have superior index values. These KWKs indicate a convergence of ideas or concepts. KWK1 has a superior index value, in this case. Because of this, the solution is classified as Convergent because it converges to KWK1.

The expression of concepts to solution illustrated in Figure 3b) is represented by :

$$S_b = S_{F_{11}} \wedge S_{F_{13}}$$

$$S_b = 1.KWK1 + 1.KWK2 + 1.KWK3 + 1.KWK5$$

The index analysis of expression S_b does not identify index values above "1". This means that the solution is not converging on any idea or concept previously defined by the author. So, this solution is classified as Divergent to KWK1, KWK2, KWK3 and KWK5.

To summarize, if the concept expression of solutions had an index value higher than "1", this solution is classified as Convergent to KWKs with a superior index value. If the concept expression did not have an index higher than "1", this solution is classified as Divergent to KWKs with a "1" index.

3.3 Second Layer: Classification of Learners Based on History of Problem Solutions

This layer classifies the learner as Convergent, Divergent and Mixed History of Solutions. If all solutions recorded in learner's solutions history were classed as Convergent, then he/she is clustered as Learner with Convergent History (C). If all solutions recorded in learner's solutions history were classed as Divergent, then he/she is clustered as Learner with Divergent History (D). If the learner's solutions history has solutions classed both Convergent as Divergent, then he/she is clustered as Learner with Mixed History (M).

Although this basic learner classification uses only three clusters, these clusters can be detailed by the SC author. For example, a learner clustered as a Learner with Mixed History could be divided into smaller categories namely:

- More Convergent, when the amount of Convergent solutions has higher value than the amount of Divergent solutions.
- More Divergent, when the amount of Divergent solutions has higher value than the amount of Convergent solutions.
- Homogeneity, when the amount of Divergent solutions is exactly the same as those of classed as Convergent.

3.4 Third Layer: Classification of Learners Based on Problem Solution History Path

In this Third Layer, the learner model looks for some hidden convergence in learner's solutions history. For instance, if one learner is classified in Second Layer as Learner with Mixed History, and he sequentially presented the following solutions exemplified in Table 1, is it possible for the Learner Model to automatically identify some hidden convergent ideas?

Table 1: Example of Learner with Mixed History record.

S	Solution classification	Expression of Concepts
S0	Convergent to KWK1	S_0 = 2.*KWK1* +1.*KWK2* + 1.***KWK4***
S1	Divergent	S_1 = 1.*KWK1* + 1.*KWK3* + 1.***KWK4*** + 1.*KWK5*
S2	Convergent to KWK2	S_2 = 2.*KWK2* + 1.***KWK4*** + 1.KWK8
S3	Divergent	S_3 = 1.*KWK1*+1.*KWK3* +1.***KWK4***

The analysis of the set of solutions presented by learner exemplified in Table 1 indicates one hidden convergence. ***KWK4*** is present in all learner's solutions. In this symbolic example, even though no solution had been classified as Convergent to KWK4, this hypothetical learner used the KWK4 element in most or all solutions. This learner is classed in third layer as a Convergent Concept Path.

To summarize, the analysis of the history of the learner's solutions represented in Table 1 gives the following information:

- The learner's clustering in the First Layer used the last solution, S_3 . This solution is classed as Divergent.
- The Second Layer clustered this hypothetical learner as a Learner with Mixed History. This hypothetical learner oscilated among all types of solutions. Sometimes he/she presents Convergent Solutions, sometimes he/she presents Divergent Solutions.
- Finally, the Third Layer identified a hidden convergence. This hypothetical learner used the ***KWK4*** in all solutions presented. This KWK during the entire solution process may indicate a possible learner belief.

4 CLASSIFICATION ANALYSIS

The independence of classification i) of individual solution, ii) from history solution and iii) from Concept Solution Path allows the specification of layers that can be used to cluster learners based on a set of stereotypes including the three layers. These stereotypes were also defined based on the way the analytical process can be conducted. The ways are summarized as follows:

- **Individual Solution** – The learners can be classed as Convergent or Divergent. This type of classification is called "Individual Solution".
- **Individual Solution History** – The learners can be classed as Learner with Convergent History Solutions, Learner with Divergent History Solutions or Learner with Mixed History Solutions. This type of classification is called "History Solution".
- **Collective Solution History** – The learners can be classed based on Convergent and Divergent ongoing ideas inside the learner solution history. This type of classification is called "Solution Concept Path".

The combination of these three layers defined in this paper, allows the identification of 12 basic learner stereotypes that can be found in an SC exercise. These stereotypes are presented in Table 2.

Table 2: Basic Stereotypes of Learner Model's.

Layer of Classification			Learner's Cluster
First	**Second**	**Third**	
Divergent	Divergent	Divergent	**DDD**
Divergent	Divergent	Convergent	**DDC**
Divergent	Convergent	Divergent	**DCD**
Divergent	Convergent	Convergent	**DCC**
Divergent	Mixed	Divergent	**DMD**
Divergent	Mixed	Convergent	**DMC**
Convergent	Divergent	Divergent	**CDD**
Convergent	Divergent	Convergent	**CDC**
Convergent	Convergent	Divergent	**CCD**
Convergent	Convergent	Convergent	**CCC**
Convergent	Mixed	Divergent	**CMD**
Convergent	Mixed	Convergent	**CMC**

Why these stereotypes showed in Table 2 is important? Because, the learner stereotypes can be used as guide to formation of feedback message (Noronha, 2007; Parves and Blank, 2008).

If an ITS running a SC exercise has only one stereotype then all learners must match with this stereotype. On the other hand, if there is a high quantity of stereotypes, then there is more clusters in this ITS that the each learner could be suitable

match.

This ability was not defined by creators of SC, despite it was described by Egan (1976). The feedback messages could be also adapted based on learner's model. For example, a feedback message could be composed by some "real samples", "study of cases", tables or charts. This message could be presented to learner clustered as CMC and CCC. A similar message could be formed by definitions, explanations and desmonstrations of some domain concepts. This message could be presented to learner clustered as DDD or DMD. Clearing some fuzzy aspects of domain is the purpose of both feedback messages previously exemplified, but the messages use distinct ways to accomplish it. The learner's stereotypes were used to envelop the feedback message.

5 CONCLUSIONS

This paper described a model of learner's stereotypes definition based on three independent layers.

These layers were defined based on convergence and divergence characteristics of learners. These ideas of learners stereotypes were derived from the observation of how learners could employ some domain's concepts or ideas in a convergence and divergence way to solve a ill-structured problem. These main ideas or domain's concepts are named KWK and typically they are defined by the author of SC exercise.

This paper expand some SC characteristics adding the possibility of employ a Learner Model during the excecution of SC exercise. In this new context, feedback message can also be selected and defined based on learner stereotypes.

The contributions of this paper are the definition of learner stereotype and a generic learner model that can be used in Intelligent Tutor Systems based on SC Exercise. Future work includes some research questions such as how to define models of feedback messages based on each of the 12 stereotypes described in this paper.

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COMPUTER-BASED SIMULATOR TRAINING IN THE HOSPITAL

A Structured Program for Surgical Residents

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Keywords: Computer-based simulator training, Surgical skills, Surgical resident education.

Abstract: Rapid developments in techniques and new skills requirements have increased the need for surgical training outside the operating room (OR). Simulator training is often seen as a vital part of the surgical resident's education. This paper presents a simulator training program aimed at providing surgical skills training for residents in a hospital. The theoretical background on the subject is considered and initial findings discussed. The results highlight the need to organize the training systematically. Simulator training prior to entering the OR should be mandatory for all residents, even though the study showed the motivation for voluntary participation to be high. The role of the specialist surgeon emerged as an essential element in the simulator training, both as an evaluator and as an instructor.

1 INTRODUCTION

During their university studies, physicians are provided with the basic knowledge and skills of medicine. After graduation, those aiming to become surgical residents have to work in hospitals for another period of 5-6 years to achieve the level of a specialist. The basic university teaching is thoroughly planned, but the six years of learning for specialization may well include no detailed learning or teaching program, and tends to be dependent on local circumstances. In many medical specialities self-study via books or the Internet can compensate for possible defects caused by inadequate training programs. However, surgical skills cannot be achieved by reading. Learning comes from experience in the operating room (OR) or from a simulated learning environment. At least in Finland, hospitals are mainly organized to take care of patients; the training of personnel is a secondary task.

Video-assisted surgery has changed traditional surgery and new skills are needed in the OR. Laparoscopy refers to a surgical technique performed in the abdominal cavity in which the operation is conducted through small incisions, with the surgeon viewing the operating area from a video-screen. Laparoscopic operations have proved to be more difficult than traditional open surgery, for both experienced and novice surgeons (Madan et al., 2004; Soper et al., 1994). Rapid developments in equipment have increased the time needed to learn surgical procedures. There is thus a need to construct teaching protocols (Reznick and McRae, 2006) that are not only more effective in themselves, but also capable of being embedded within fluent, economical and routine organizational processes. Simulator training has been introduced as one solution that can help to solve the problem of reducing the time needed to train residents in acquiring the complex skills in question. Most residents began their residency without any manual skills in laparoscopy, hence one might expect this to be the the best point at which to introduce simulator training. However, there is, overall, a lack of research on guided simulator training in hospitals.

This study discusses a pilot simulator training program and presents initial results on the participation of residents in the program, and on the

motivation for training. The paper is organized as follows: The theoretical grounds for the training are introduced. A case study and training program in progress is presented. The aim of the study is set out, followed by analyses of the initial results. The results are discussed, with mention of the challenges that emerged in the study. We present brief conclusions concerning the training program in its present state, and make suggestions for the future.

2 THE THEORETICAL BASIS OF SIMULATOR TRAINING

Here we present the main factors that have contributed to the creation of simulators, and some practical ideas for investigating the pedagogical aspects of simulator training.

2.1 Challenges Regarding the Training of Skills

It is important to train novices specifically in laparoscopy, so that they can become automated in instrument manipulation and in discerning the transformation of spatial information (Gallagher and Satava, 2002; Villegas et al., 2003) before entering the OR. Surgical complications occur most frequently during the first ten procedures (Jordan et al., 2000). The technique has certain limitations, including fixed instrument entry points and limited degrees of freedom (Berguer et al., 2000). The risks of the operation are particularly great when one is working with instruments that are 30 cm in length, inside the abdominal area, close to fragile organs, without direct visual contact. The visual-motor tasks of laparoscopy require excellent hand-eye coordination. Problems of perceptual motor control arise when one has to adjust to operating while watching a two-dimensional monitor image, in a situation where the camera is held by someone other than the operating surgeon (Conrad et al., 2006). One of the main difficulties in learning laparoscopic skills lies in developing the ability to estimate the surface roughness of tissues (Brydges et al., 2005). Overall, it is clear that with this new technique the challenges in acquiring surgical skills have increased.

2.2 The Role of Simulators in Training

Simulator training has already given promising results and has taken on a significant role in teaching surgical skills, without putting patients at risk (Cosman et al., 2002; Schjiven et al., 2005; Villegas et al., 2003). In addition, research has confirmed a transfer of skills between the simulator and the OR (Ahlberg et al., 2005 & 2006). For trainees to achieve the required level of skill, simulator training should be integrated within the curriculum, and should rely on the teaching skills of experts (Ahlberg et al., 2005; Ström et al.,2002). Managing simulator training has to be an active process, in order to address the key issue of transferability from the simulated to the real environment (Kneebone, 2003). The advantages of using simulation have been listed by Kneebone (2003):

1. Training can be defined by needs of the learner, not the patient or the teacher.
2. There is permission to fail, and to learn from mistakes and failures, without risk.
3. The simulator provides objective proofs of performance and feedback.

The expectations of simulator training have grown at the same time as simulator technology has evolved. It has been shown that simulator training improves OR performance in laparoscopy. Simulators are regarded as useful tools for introducing equipment and training technical skills (Poulin et al., 2006). Simulators could also be used to assess the readiness of the resident surgeon to proceed to real patient surgery (Feldman 2004).

3 CASE STUDY: A SIMULATOR TRAINING PROGRAM FOR SURGICAL RESIDENTS

The training program was organized in the Central Hospital of Central Finland. This hospital caters for a population of almost 280 000. The program forms part of a multidisciplinary project bringing together knowledge gained from education, cognitive science and surgery. The study was performed in a medical skills learning centre using the interactive Simbionix Lap Mentor II virtual reality trainer. The training program was designed to teach laparoscopic skills to surgical residents, and to further develop existing skills.

3.1 Study Design – Equipment and Environment

The medical skills learning centre is an interactive room containing simulators, cameras and other

equipment. The idea was to create a peaceful learning environment where skills could be trained, whenever actual patient care would allow this. The Lap Mentor simulator enables the user to interact with a three-dimensional database in real time, and it offers games designed particularly for laparoscopic skills training, plus a realistic image representation of an organ system. The simulator has real instrument handles attached to the machine through robotic instrument ports; these give the sense of realistic "touch" contact with tissues and organs. Exercises vary from games and partial operation exercises to advanced complete operations, including laparoscopic suturing tasks performed in a simulated abdomen.

3.2 The Training Program and Data Collection

The training program for surgical resident education was launched in March 2008. Prior to resident instruction, the specialists were given time to become familiar with the equipment and exercises. Due to the complexity of the simulator as training equipment, both the specialists and the resident surgeons were offered additional help from the facilitator of the training program. Working independently or in pairs, the residents were instructed by a specialist in using the simulator and going through the exercises. The training program exercises were selected by a specialist surgeon who was experienced in simulator training. Figure 1 presents the structure of the simulator training, including three videotaped training sessions and two self-training periods.

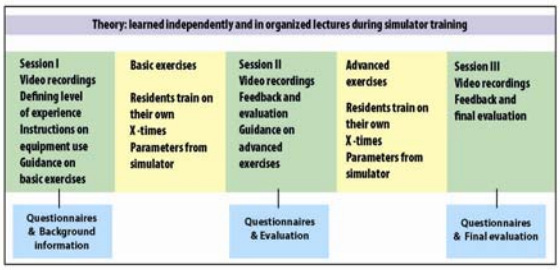

Figure 1: The training program for surgical residents.

The training program has three instruction and evaluation sessions in which both the specialist and the resident surgeon are present. Simulator training is seen as an element in surgical resident training, where the overall aim is to integrate the learning of theory and guided training within both authentic and simulated environments. During independent training, all the residents practise the same exercises until they themselves are satisfied with their performance.

Data was collected from the first part of the training program (Session I), and also when the participants made independent use of the basic skills trainer (Basic Exercises). The research data consists of background information on the surgical specialists and residents, plus information concerning skills training and exercises performed with the simulator. This information was collected via questionnaires. All the simulator exercise parameters were measured automatically. The parameters offer detailed information on the surgeon's performance, the amount of training, and errors. The research subjects were all surgical residents (N=19) who needed to practise their laparoscopic skills. Three sessions (See Figure 1) in which both specialist and resident surgeons participated were videotaped. The video data was collected with several cameras in order to get detailed information on the events and actions during the exercises.

4 THE AIM OF THE STUDY AND THE RESEARCH QUESTIONS

The study focuses on the first part of the training program, and the initial results of the residents' training. We formulated the following research questions:

1. What were the expectations of the residents at the start of the training?
2. What is the relationship between motivation and active participation in the training?
3. What is the relationship between one's own self-assessed skills and active participation in the training?
4. What kind of constraints emerged regarding participation?

5 RESULTS

The study investigated the main aspects of the training in its early stage. These aspects include the expectations and motivation of the participants, and the resources they allocated to the training program. An interesting aspect of the research was the self-evaluated skills of the participants, and the amount of practice that the participants put in.

5.1 The Expectations and Motivation of the Residents

The trainees were divided into three groups according to their level of experience. The beginners (Group A) had just started their surgical resident training in the hospital and were at an early stage in their basic three-year training period. The advanced trainees (Group B1) had done more than one year of basic training. The more advanced trainees (Group B2) had already completed three years basic of training out of the total of six years resident training.

The expectations (N=17) of the residents regarding the simulator training were obtained from the questionnaire data. The less experienced residents mostly expected to become better acquainted with laparoscopic techniques and instrument handling, and to adapt to the new surgical technique. They also expected to be able to comprehend a two-dimensional video picture while they were operating. The more experienced trainees mostly expected to achieve better dexterity and more efficient hand-eye coordination. They further expected to develop a routine in the procedure, and to learn new procedures. Seventeen out of the total of eighteen residents who answered agreed that simulator training would be useful for them.

Table 1: Motivation to participate in training.

Group	Motivated	Quite motivated	Quite non motivated	Total
A beginners	6	1	1	8
B1 advanced	4	1	1	6
B2 more advanced	1	3	0	4
Total	11	5	2	18

There were motivated trainees (see Table 1) in each group. The majority (10/18) of the residents rated as a demotivating factor future difficulty in finding the time to practise with the simulator. However, there was also a high rating (13/18) regarding the possibility to practise with the simulator outside normal working hours.

5.2 Levels of Participation and Constraints

The findings regarding the training program were based on the researcher's experiences of the activity of participants as well as on the questionnaires. Table 2 summarizes the levels of active participation.

Non-active training means that the resident participated in Session 1, but thereafter did not engage in independent practice with the simulator. Participation problems were reported especially by residents in Groups B1 and B2. The reasons for cancellations and involvement problems were listed by the researcher during the training, as follows: (1) time problems; (2) problems (for both specialists and residents) in sharing time for guidance sessions; (3) a lack of motivation for participation among more experienced residents. The reasons for cancelling scheduled sessions were usually related to extra workload situations in the clinic.

Table 2: Participation.

Group	Non active training	Actively training Basic exercises	Participation Session 2 within 3 months	Participation Session 2 within 8 months	Completed Basic skills, not advancing	Total Participation
A	2	1	1	3	1	8
B1	2	0	2	3	1	8
B2	1	0	2	0	0	3
Total	5	1	5	6	2	19

5.3 Skill Levels and Time Devoted to the Training

Residents were given the freedom to train their skills on the simulator without any upper or minimum limit on their training times. They were only told to practise until they felt confident and skilful in performing the task. There were a total of five different exercises within the Basic Exercises (see Table 3). Table 3 shows the mean amount of time (hours) spent by residents on each exercise. It also shows the mean level of self-assessed laparoscopy skill for each group, prior to starting the program.

Table 3: Residents skill level and practising times.

Groups	Skill level mean	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Mean practice time Exercise 1	Total practice time
A	0.6	9.5	10.2	7.9	6.0	6.8	31.4
B1	1.6	9.4	6.8	8.0	6.8	7.4	38.4
B2	2.8	8.6	9.5	7.6	7.6	8.3	41.6
Total mean	1.6	9.2	8.8	7.8	6.8	7.5	8.02

The most active trainees seemed to be the experienced trainees from group B2. This group also spent an almost equal amount of time on each exercise. The residents from group A had less participation in the more difficult exercises.

6 DISCUSSION

Simulator training is intended to aid surgical residents in the efficient acquisition of good operating skills. Since resident education tends not to be very systematically organized in hospitals, new training methods need to be adopted alongside traditional ones. In this study simulator training had a supplementary role within residents' traditional work-place learning; hence issues such as participation and motivation were regarded as crucial. Training with the simulator was a new and for the most part unknown issue, for both the specialist surgeons and the residents. The residents' expectations were in line with studies mentioned above, in which it was found that the simulator seems to provide efficient training in aspects such as depth perception and instrument control.

The motivation of the trainees was expected to be lower when their experience level was higher. Previous studies have recommended that simulator training should be used at the novice stage of training, due to anticipated higher motivation at this stage, prior to the development of "negative stereotypes" and incorrect practices (Ström et al., 2002). The presumption was that groups B1 and B2 would be on the whole less motivated. One unexpected finding in the present study was the extent to which motivated trainees were present in every group. There did seem to be more time available for training at the early stage of residency. Notwithstanding this, the motivation to train and participate was not strictly dependent on the level of the resident. Unmotivated residents did not take part in the training at all, whereas those who participated seemed to be committed to the training.

It had been anticipated that the residents would actively participate in the guided training sessions, and that they would also be willing to engage in independent training within the times scheduled for this. In fact, the levels of active participation of the trainees emerged as roughly similar for each group, with no decrease among residents with higher skill levels. Almost all the participants seemed to be loyal to the training program, and breaks in the training were taken only for clearly valid reasons such as maternity leave or transfer to another workplace.

The skills evaluations were consistent with the level of experience of the trainees. The residents evaluated their skills critically. Even if they had performed operations independently on several occasions, the skills were evaluated at no more than 4 in a scale of 1-10. The other hypothesis was that self-assessment of the skill level would correspond to the time spent on the simulator, and to the number of training exercises carried out. In fact, what we found was that the total hours of practice were highest in group B2, i.e. among those residents who already had the highest skill level; hence the causal relationship between skills self-assessment and time spent on the simulator could not be estimated directly. One interesting observation concerned the relationship between the times spent on training and the difficulty level of the exercises (which increased from Exercise 1 to Exercise 5). Group A (novices) did less training on the more challenging tasks than either group B1 or B2, who spent almost the same time on all the exercises.

The differences between the times spent on the tasks in each group could be explained according to the likelihood that the more difficult tasks would require more support and guidance in order to succeed. Without such guidance, the less experienced residents might well be deterred from working through the more difficult exercises. Whatever the reasons, the results do suggest that self-training – without control of the amount of training – may lead novice trainees to do merely the same amount of practice, or even less, than more experienced trainees. For this reason, the role of the specialist surgeon (as both evaluator and instructor) should be taken into account, as an essential element in the training – even if residents can arrive at a fairly objective evaluation of their own skills. Previous studies, too (Kneebone, 2003), have highlighted the importance of the teaching skills of senior surgeons as part of simulator training. In our study, no clear relationship was found between motivation and active participation, however the groups that trained most actively seemed to be slightly more motivated, if we consider that in Group B2 no participants fell into the "fairly non-motivated" category.

Surgical training seems to be approaching its outer limits, bearing in mind that no one knows what the alternative to traditional education might be. Over many decades, traditional training has become incorporated within the everyday routines of hospitals. Incorporating surgical simulator training within normal hospital protocols is a demanding and complex matter. It needs much more basic, longitudinal research, since the innovations in training methods that are clearly needed should be based on real knowledge. There seems little doubt that simulation has its place as a component in the training of surgeons, provided that it supports and is supported by research, technology, clinical practice, professionalism and education.

7 CONCLUSIONS

The study shows that it is possible to run a guided and structured simulator training program in a hospital where the primary task is patient care. The surgical residents feel positive about simulator training and wish to intensify and improve their skills with it. Those who start the training program seem to remain loyal to it. However, the study suggests that simulator training needs to be fully structured – and even mandatory – in order to get all the residents involved in the training. An effective and motivating training program necessitates intense commitment from all the participants, including the supervisors. Further study is required concerning problematic features such as time allocation and the commitment of residents, and the factors involved in providing adequate supervision and support. The next logical step would be the analysis of video-recorded training sessions. The main challenges seem to involve adapting new methods into hospital routines, and creating a new learning/teaching culture within the hospital setting.

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FOCUSING THE DIAGNOSIS FOR STUDENT MODELLING ON AN INSTRUCTIONAL DESIGN

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Keywords: Intelligent Tutoring System, Student Model, Cognitive Diagnosis, Non-monotonic reasoning.

Abstract: The advances in the educational field and the high complexity of student modelling have provoked it to be one of the aspects more investigated in Intelligent Tutoring Systems (ITSs). The Student Models (SMs) should not only represent the student's knowledge, but rather they should reflect, as faithfully as possible, the student's reasoning process. To facilitate this goal, in this article a new approach to student modelling is proposed that benefits from the advantages of Ontological Engineering, advancing in the pursue of a more granular and complete knowledge representation. It's focused, mainly, in the SM cognitive diagnosis process, and we present a method based on instructional design, providing a rich diagnosis about the student's knowledge state –especially, about the state of learning objectives reached or not-, with non-monotonic reasoning capacities, and supporting the detection and resolution of contradictions raised during the reasoning on the student's knowledge state. The main goal is to achieve SMs with a good adaptability to the student's features and a high flexibility for its integration in varied ITSs.

1 INTRODUCTION

The SM, core of ITSs, and, particularly, the cognitive diagnosis process, has always been one of the most important research lines in the area of ITSs due to its complexity. Ohlsson (Ohlsson, 1986) defines Cognitive Diagnosis (CD) like "the process of inferring the cognitive state of a person starting from their performance". The difficulty in solving this problem lies in giving an efficient answer to important questions such as the following ones: what types of knowledge about the student should be the basis of the SM so that it can be adaptive to the current individual characteristics of the student, and the diagnosis process can provide more complete information about the current cognitive state of the student?, what characteristics should the SM mechanisms have so that they can be applied to several domains?, how to manage in the diagnosis process the existence of inconsistencies that can arise in the student's performance throughout their learning?, how to solve the diagnosis so that it does not only allow to "detect" the state of the student's knowledge but it also serves as an essential support to the tutor to guide each individual student appropriately during their learning?, etc. In order to give proper answer to these questions, we present a new Student Modelling mechanism based on Ontological Engineering, a taxonomy to facilitate the adaptation and extension of SM to different types of ITSs and a rich diagnosis method with non-monotonic reasoning capacities able to infer the state of the learning objectives encompassed by the ITS and correspondingly infer the student's knowledge state.

This article starts with some highlights about Student Modelling and CD, proceeds with a description of the adopted solution including the ontology proposed for the SM, as well as the diagnostic process, based on a set of diagnostic rules and supported by a conflict manager. After an application example, some conclusions put an end to the paper.

2 STUDENT MODELLING IN ITS

So far, numerous approaches to SM have been

proposed in the field of ITS, representing different information types (Petrushin, 1995), (Holt, 1994) and using different methods to infer the student's cognitive state. Most of the approaches to SM just represent the state of the student's knowledge about the subject matter, including SMs that only represent correct knowledge (*Overlay* or *Differential Models*) and SMs that also represent wrong knowledge with different approaches to the development of the error library (Burton, 1982). A step forward are SMs that also represent the student's reasoning process, which, according to Clancey (Clancey, 1986), can be divided into *Behavior simulation models*, that only describe the actions the student is carrying out, and *Functional simulation models*, that describe the student's beliefs and goals.

In addition, some taxonomies for student's knowledge modelling deserve to be highlighted by their interesting contributions to this field. The taxonomy of De Koning and Bredeweg (Koning, 1998), based on the multi-stratified framework KADS (Wielinga, 1992), distinguishes as an added knowledge level the *strategic knowledge*. Worth mentioning is also the McCalla and Greer's taxonomy (McCalla, 1994), sustained in the idea of granularity-based reasoning. However, most approaches don't consider a complete taxonomy of knowledge about the student; also, most of them have validity only in certain domains or they are hard to be adapted for different ITSs. At the same time, most of them do not consider the student's individual features to carry out a truly adaptive teaching-learning process. Some exceptions are (White, 1990), (Del Soldato, 1992), or the Chen and Mizoguchi's proposal (Chen, 2004), where an ontology and an agent for SM are defined.

As far as Cognitive Diagnosis (CD) is concerned, the evolution in the methods and techniques for student modelling has forced the development of new CD solutions. The first advances were based on diagnostic methods coming from Artificial Intelligence (AI). Other works, such as the Self (Self, 1993), that uses the General Diagnosis Engine (GDE) paradigm (De Kleer, 1989), helped to define the nature of the CD problem, as a peculiar case of device diagnosis in AI but with differences. Later, an adapted version of GDE (Bredeweg, 1993), sought to solve one of the problems outlined previously by Self: defining a *meta-diagnostic level*. However, the fundamental limitation of all these approaches is that they try to apply model-based techniques. Frequently, the student doesn't have an only method for solving a problem, so there is not a concrete *a priori* device model to be managed by the cognitive diagnosis. In contrast, the decomposition-p method (Tsybenko, 1995) allows generating the *associated models* of the student that are used by the CD during the problem resolution.

Another research line in the field of CD is constituted by those methods that involve the student in diagnosis to improve the system adaptability, such as the collaborative student modelling (Bull, 1997), scrutinized learner models (Kay, 1999), etc. However, there are just a few methods that include in their formulation the non monotonic nature of reasoning about the student. Some exceptions are the Ikeda et al.'s diagnosis system SMDS (Ikeda, 1993) as well as the diagnosis system of the shell UMT (Brajnik, 1994), supported both by an ATMS (Assumption-based Truth Maintenance System). Besides, in general, the CD methods are not able to carry out a wide diagnosis that is based on a wide student's taxonomy for the SM, integrating different aspects like different types of demonstrated knowledge, learning objectives that have been reached, personal profile, traces of behaviour, etc.

3 PROPOSED SOLUTION

Our proposed solution for SM is based on a pedagogical design approach (Figure 1). The design of any ITS requires an instructional design for the subject matter to be taught (X), which implies, in our framework, defining a group of activities and the objectives that the student should achieve in each activity. For each activity that is effectively posed to the student, the Expert module, using an automated planner, will determine the steps or actions (application of operators) that should be carried out to conclude the activity successfully. Each operator should have been defined with a set of preconditions and consequences. The planner allows dynamic construction of solution plans taking into account the current state of the learning environment and the possible student's actions. When the student executes a certain action (operator), this execution is registered according to the SM ontology, which not only contains different concepts but also relationships among them, such as the ones that relate the learning objectives (meaningful for the tutoring module) and the knowledge objects (meaningful for the expert module) that the student should acquire in order to be able to reach those objectives. This relation is fundamental given that it
allows inferring the concrete student's knowledge state (*cognitive diagnosis*) from the diagnosis of reached or not learning objectives (*pedagogical diagnosis*).
Based on what action the student performs and how (registered during the activity in the execution

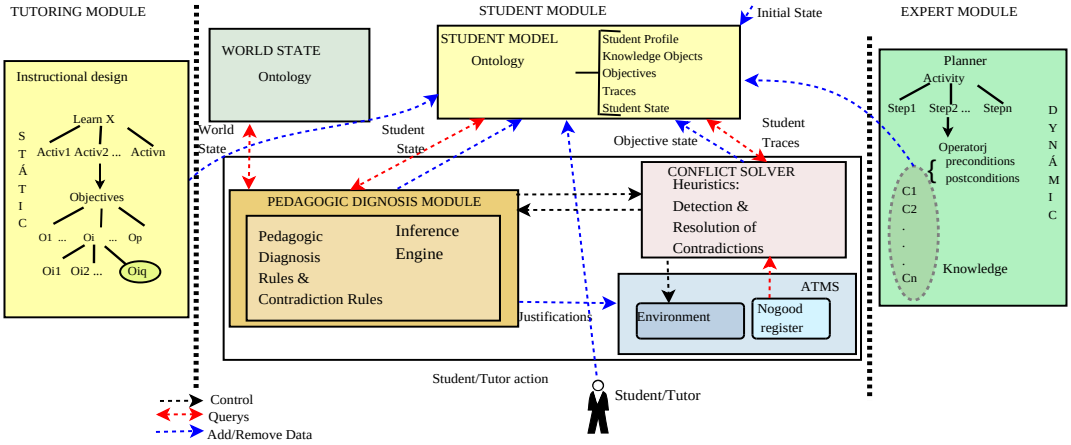

Figure 1: Diagram of proposed student modelling.

trace included in the ontology) and on the objectives that have already been reached or not when the action is executed, the *Pedagogic Diagnosis* (PD) module is responsible of determining the learning objectives reached or not by the student. For that purpose the PD uses a group of diagnostic rules. During the diagnostic process diverse types of contradictions can arise, and they must be solved by the *Conflicts Manager*. This last capability will be based on an ATMS system and a conflict solver (CS).

The main steps of the proposed diagnosis method are detailed below (Figure 1):

1. The initial state of the SM is established with assumptions about the state of the learning objectives (see section 3.2.1.).
2. The student executes an action in the context of the learning activity he is carrying out. Information could also come from the tutor if, during the learning experience, he supplies a hint or instructions, according to the tutoring strategy. This step implies adding information to the SM ontology regarding the trace, state and other knowledge related to the action.
3. The characteristics of the specific action executed by the student cause the triggering of some diagnosis rules defined in the PD module. By querying the SM ontology and an additional ontology describing the current state of the world, the PD module is responsible for inferring which objectives are acquired or not by the student. For this task, Jena forward chaining inference engine has been chosen (Jena, 2006). The inferences carried out by the PD module are informed to the ATMS as justifications, and are registered by it. If during the reasoning process of the PD module a contradiction is detected, then: a) The contradiction is communicated as a justification to the ATMS, which obtains the environment that supports the contradiction, storing it in the so-called *nogood* register and b) the PD module invokes the CS to solve the contradiction. Different contradiction types, depending on their cause, are solved differently, based on certain heuristics defined by rules. CS looks for candidate consistent environments checking the assumptions that maintain the inconsistency (*nogood*). The resolution of the inconsistency will mean the modification, as appropriate, of the objectives' state in the SM ontology.
4. The PD module continues the reasoning from the updated state of the SM ontology.

3.1 Overview of the Ontology

The SM representation is based on ontologies, using the OWL language and the Protégé tool. The Figure 2 shows some ontology's outstanding hierarchies.

Student_Profile represents student's personal information (demographic data, preferences, physical and psychological features, etc.).

Learning_Objectives describes the learning objectives defined for an educational process, at a cognitive, psychomotor or affective level (De Antonio, 2007).

Student_State describes the student's knowledge, their performance (regarding the execution of activities, actions and associated preconditions and postconditions, sessions, trajectories throughout the learning environment, etc.), their pedagogical state (regarding completion of the learning plan, courses, activities, etc.), their emotional state, and their general capacities and competences (memory, attention, etc.).

Student_Trace contains a temporal register of the educational path (sessions, activities, actions, trajectories, variables,etc.) and a historical register of objective states.

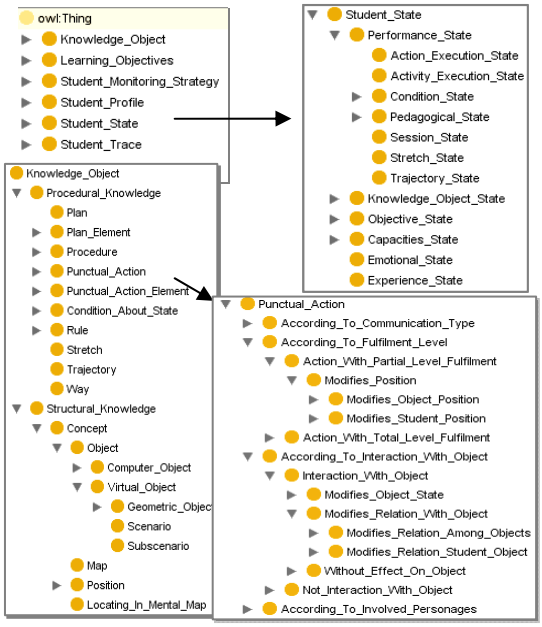

Figure 2: Important hierarchies on SM's ontology.

Knowledge_Object describes knowledge elements involved in student's learning. They can be structural, such as concepts (e.g., objects present in a 3D environment), or procedural (actions and their types, preconditions and postconditions, plans, etc.).

3.2 Pedagogic Diagnosis Rules

In the PD module, a set of rules to carry out the diagnosis process is defined. These rules will infer the state of learning objectives. When a rule infers that the student has not achieved a certain objective; the information that the SM provides on the student's trace will be crucial to determine if the student has forgotten some previously acquired knowledge or if he has never achieved those objectives. The pedagogic diagnosis rules match some rule patterns according to a taxonomy of diagnosis criteria:

Diagnosis according to the type of action that a student performs. These rules will infer the learning objectives that can be assumed whenever the student executes correctly/incorrectly a given action depending on its relevancy and appropriateness (e.g., if the student picks up a designated visible object correctly, it can be assumed that s/he is able to recognize the appearance of the object). Other rule patterns consider if the action is correctly executed but it is not in the target sequence of actions; if the action is in the plan but in the wrong order; if it is impossible to execute the action because some of the preconditions associated with the operator are not met; if the student tries to apply the right operator but to the wrong object; etc.

Diagnosis based on the number and type of questions formulated by the student. These rules infer the degree of knowledge that the student has of the existent objects in the scenario, of the operators, or of the activity itself, depending on the type of questions posed by the student (what is this object for? Where is the object X? What should I do next? Why can't I do this? What would it happen if I do this?...).

As an example, let's suppose that the student executes an action on an object, a type of tray, which is part of another object, a drawer, containing several trays, but the tray on which the action has been applied is not the correct one. According to the established diagnosis criteria, this example could match two patterns: a) an action involving interaction with an object (tray), with coincidence of the applied operator with the expected next one in the plan (put in something), but without coincidence of the objects to which the operator is applied, and b) it is related to choosing the wrong part (tray) of an object (drawer) that contains several parts.

$$
\begin{aligned}
R(a)\ :\ & \text{IF Apply\_To\_Obj}(opx,\ objx)\ \wedge \\
& \text{Obj\_Next\_Act\_Plan}(objx')\ \wedge \\
& \neg \text{Eq}(objx,\ objx')\ \Rightarrow \\
& \quad \text{Add\_SM}(\\
& \quad\quad \neg \text{Know}(\text{Obj\_Next\_Act\_Plan}(objx'))\ ) \\
R(b)\ :\ & \text{IF Apply\_To\_Obj}(opx,\ objx)\ \wedge \\
& \text{Op\_Next\_Act\_Plan}(opx)\ \wedge \\
& \text{Obj\_Next\_Act\_Plan}(objx')\ \wedge \\
& \neg \text{Eq}(objx,\ objx')\ \wedge \\
& \text{Part\_Of}(objx,\ objy)\ \wedge \\
& \text{Part\_Of}(objx',\ objy)\ \Rightarrow \\
& \quad \text{Add\_SM}(\ \neg \text{Is\_Able\_Of\_Choose} \\
& \quad\quad (\text{Part\_Of}(objx',\ objy))\ )
\end{aligned}
\tag{1}
$$

The defined rules for those situations (1), deduce: a) "The student does not know the object to be used in the following action", and b) "The student is not able to choose the correct part (tray) of an object (drawer).

3.2.1 ATMS Data Structures

The information about the student's knowledge inferred by the system is characterized by the lack of completeness. The initial SM must be configured with the assumed states for the objectives required by the learning activity. An assumed objective state can take the following values: *true* (the system knows that the student achieved the objective), *false*

(the system knows that the student didn't achieve the objective) and *unknown* (the system doesn't know anything about the objective achievement). An objective won't be considered completely achieved if the number of times it has been demonstrated doesn't reach a certain reliability threshold (these values are established by properties of the concepts *Specific_Objective* and *Objective_State* on the SM ontology). The PD module informs the ATMS of the initial objectives status with the following assumed ATMS nodes:

$$< \text{sup\_state\_obj}(\text{obj}_i, \text{state}_i), \{\{o_i\}\}, \{\{o_i\}\} > \quad (2)$$

The first term of this triple represents the state $state_i$ assumed for the objective obj_i and o_i is the assumption identifier.

The firing of instantiated diagnostic rules during the inference process is also informed to the ATMS with the following justifications:

$$\tilde{H}_i \wedge \theta_i \Rightarrow \text{state\_obj}(\text{obj}_i, \text{state}_i);\ \tilde{H}_i = H_1 \wedge \ldots \wedge H_m \quad (3)$$

$$\theta_i = \text{plausible}(r_i, \text{time\_exec}_{r_i}) \quad (4)$$

θ_i is an assumed node provided to the ATMS, which may be retracted in the case of the CS needs to annul the firing of the rule for solving an inconsistency, and *Hi* is a fact in RDFS triple format: *(subject, predicate, object))*. Moreover, the contradiction rule fire is also input as justification of ATMS.

3.2.2 Classification of Contradictions

The student's behaviour, reflected through action executions, tends to be inconsistent due to different reasons, leading to inconsistencies in the objective states. The contradiction causes are inferred by the CS module by means of different types heuristics.adapting the contradiction classification given by (Chen, 2004):

Contradictions caused by non-monotonicity in student's behaviour or knowledge:

- *Contradictions caused by changes in the student's mind*. The student keeps acquiring new knowledge, maybe giving rise to inconsistent objective states at one particular moment. A tutor providing a hint or an instruction could cause this contradiction type:.

$$\begin{array}{l} \text{Rule\_Mind\_Change}: \\ \quad \text{IF Contradict (objx)} \wedge \text{Current\_State(objx, true)} \\ \quad\quad \text{Obtained\_By\_Hints(objx)} \Rightarrow \\ \quad\quad\quad \text{Type\_Contradict (objx, mind\_change)} \end{array} \quad (5)$$

- *Contradictions caused by mistakes*. Domain dependent heuristics are defined in the PD module to detect typical errors in each subject matter. Also, domain independent heuristics can be defined to distinguish the following types of contradictions caused by mistakes: *Contradictions caused by the forgetting of knowledge* and *Contradictions caused by oversights*.

- *Contradictions caused by the student's own inconsistent knowledge*. This type of contradictions is not detected at the moment in the method although certain heuristics based on the analysis of objective traces could be defined. They should not be resolved (an effective tutoring strategy needs them).

- *Contradictions caused by the student's ignorance*. The student might behave sometimes apparently randomly.

Contradictions caused by incorrect assumptions adopted during the modelling: In the course of the student's learning process, some assumptions regarding objective states deduced by the PD module can become inconsistent.

3.2.3 Solving Contradictions

All contradictions except the ones caused by inconsistent knowledge must be solved by the method. The way of doing it is also based on heuristics. Generally, the most recent objective state in the contradiction is kept on the SM ontology, although there are exceptions (e.g., if a contradiction caused by a change in student's mind is detected, and later on another contradiction caused by oversight is detected on the same objective, it would be advisable to keep the previous state, not the most current one).

4 DIAGNOSIS EXAMPLE

To demonstrate the solution proposed we have designed a course to "Learn programming a washing machine". The possible operators for the course activities have been defined as well as the concrete objectives associated to them. The initially assumed state for the objectives presented here is *false* (property *acquired=false*) and this has been informed to the ATMS as assumed nodes (see (2)). The activity 2 of the course (phase 0), is being carried out by the student: "Programming the washing machine with laundry detergent". When an action is executed by the student, usually more than a PD rule is triggered, according to the possible mappings with the SM ontology state, but for brevity we will center here only in a pair of them. The student, after executing some previous actions, has put the washing powder in an incorrect tray, the bleach tray in the detergents drawer (this drawer consists of 3 trays for washing powder, bleach and softener). As a result, the rules R(a) and R(b) (1), among others, are triggered and the ATMS is informed of the associated

assumed node (3), and its corresponding justification (4). Focusing on the first rule R(a), "The student does not know the object to be used in the following action (put in washing powder)" is inferred by R(a). An assumed state for this objective was already stored in the initial model of the SM ontology (*Objective_State* → *Specific_Objective_State* → *state1*, with its property *acquired=false*). When the rule R(a) is fired, the action on the consequent, *Add_SM*, causes the value of the property *levelCurrentReliability* of *state1* to be increased in 1.

Afterwards, the tutoring strategy decides giving a hint about the correct object with which the student must interact (detergent tray). This tutor's action involves the firing of the rule (6). "The student knows the object to be used in the following action" is deduced as a result. For this objective, there was not an instance in the ontology with property *acquired=true*. The action *Add_SM* in this case sets to 1 the property *levelCurrentReliability*. Likewise, the ATMS is informed of the assumed node (3) and its justification (4). A contradiction detection rule is triggered and the ATMS is informed with the corresponding justification. Also, the CS is invoked and one heuristic rule (5) establishes the cause of the contradiction as a change in the student's mind and the contradiction is resolved by keeping the more recent objective state (*acquired=true*).

R(c) : IF Give_Hints(type_next_action)) ∧
Give_Hints(Req_Precond (next_act_plan, precondx)) :
Add_SM(Know (6)
(Req_Precond (next_act_plan, precondx)))

5 CONCLUSIONS

This article has described a solution based on ontologies to student modelling in an ITS. The general objective has been developing a SM with the following main characteristics: *genericity*, *adaptability*, *non-monotonic diagnosis*, *extensibility* and *reusability*. The associated non-monotonic diagnosis method has also been presented, relying on an ATMS, the Jena framework and a pedagogic diagnosis module.

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A TOOL FOR TIME MANAGEMENT IN THE NEW EUROPEAN HIGHER EDUCATION SYSTEM

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Abstract: The present education model is being modified according to the objectives of the European Space for Higher Education. One of the main changes is the adoption of the European Credit Transfer System as the criteria for measuring the workload of learning activities. Teachers should define the learning activities of their courses so that the global workload of a group of students is balanced along the term or academic year. And students should manage their time and organise their work to efficiently achieve the learning outcomes. In this paper, we present a tool that assists both, teachers and students, in time management so that the new education paradigm can be succesfully introduced. The paper also describes a first experience of the use of this tool and the conclussions of the pilot test.

1 INTRODUCTION

The Bologna Declaration was an initiative of twenty-nine signatory European states with the objective of making European higher education more compatible and comparable, more competitive and more attractive for Europeans and for students and scholars from other continents. Apart from this common goal, the Bologna Declaration establishes 2010 as the deadline when de European Space for Higher Education (ESHE) should be completed, based on a set of specified objectives:

- The adoption of a common framework of easily readable and comparable degrees,
- The introduction of a system based on two main cycles, undergraduate and graduate
- The adoption of the ECTS (European Credit Transfer System) as a compatible credit system covering lifelong learning activities
- Quality assurance, with comparable criteria and methods
- Mobility promotion for students, teachers and researches by overcoming obstacles.

This implies important changes not only in the organizational aspects of the Spanish university system, but also in the pedagogical and methodological aspects of knowledge transmission.

The main difference is that traditional methods based on teaching must be substituted by new methods based on learning. This means a significant decrease in the face-to-face intruction hours, which must be complimented with online learning and other alternative activities and methods. This approach is usually known as blended learning or b-learning (Marsh, 2003).

For the success of this pedagogical model (Picciano, 2008) in the context of the ESHE we have identified two key requirements: on one hand, students should be able to manage time and organise their personal work and, on the other, teachers should collaborate in scheduling the activities and tasks of their courses so that the global workload of the students is reasonably balanced along the academic year or term.

In this paper, we present the Academic Diary, a web-based tool to help both, students and teachers, to manage time in order to facilitate the adoption of the ECTS and the new education paradigm. This tool has three main objectives:

- To support students in their time and tasks management,
- To allow teachers and academic managers to analyse workload distribution along the term for every group of students, and
- To promote attendance to extra-curricular activities, such as conferences, seminars, forums, etc., by scheduling and integrating them in the Academic Diary together with other curricular events.

The next section of the paper analyses different Information and Communication Technology (ICT) solutions for learning support. Section 3 describes de main features of the proposed tool. Section 4 shows a practical experience of the use of the tool in a university course. Finally, the conclussions of the work are presented.

2 ICT FOR LEARNING SUPPORT

ICT systems have been introduced in the teaching activity since long. Examples of this are the use of slices and other multimedia materials to enhance learning experience in the classroom, electronic synchronous and asynchronous communication tools, like e-mail or chats or forums, the use of internet to search for and retrieve infomation, etc. (Tomei, 203)

The major use case of ICT in education can be found in distance learning, where specific platforms have been developed to integrate in one single system the three basic components:

- Diffusion of materials (course material from teachers to students and task results from students to teachers)
- Communication (private conversations or public discussions, synchronous or asynchronous, collaborative work)
- Assessment of outcomes achievement.

These platforms, usually called Learning Management Systems (LMS) or Virtual Learning Environments (VLE), have changed the traditional distance learning into online learning or e-learning. One of the most popular LMS is Moodle (http://www.moodle.org), an open source system that is being used by more than a million education institutions around the world with the purpose of supporting and complimenting face-to-face instruction.

In the last decade there has been a wide research initiative in the European Union promoting the use of e-learning platforms in universities as a support for the teaching and learning activities (Pls Ramboll Management, 2004).

Some of the more cutting edge research lines are t-learning (Baldi, 2006) and m-learning (Petrova, 2007), aiming to extend learning experiences to television and mobile devices; game-based learning (Aldrich, 2005), or virtual reality and 3D approaches to learning (Livingstone, 2005) .

Within the scope of the SUMA project, we have analysed the desire functionality in a specific b-learning tool and several new componentes have already been designed and developed. These components are connected to the LMS Moodle, extending its functionality to cope with the management of some elements specific to b-learning and face-to-face instruction.

In this paper, we present one of these componentes, the Academic Diary, and a pilot test in a university course.

3 A TOOL FOR TIME MANAGEMENT

The Academic Diary is basically a calendar that combines different types of events related to the academic activity. Users must be registered to use the tool, and every user has its specific set of events, depending on its role and the courses he is enrolled in. Apart from student, teacher and administrator roles (present in most learning virtual systems), the tool defines another role call academic manager.

This tool retrieves data from its own database, as well as from the LMS Moodle. All the events related to a course in Moodle are imported in the Academic Diary and shown to the corresponding teachers and studentes together with other personal or global events.

In the development of the tool we have used ActiveCalendar, a PHP Class that generates calendars (year, month or week view) as a HTML Table (XHTML-Valid). The source code is free. It can be modified or passed under the conditions of the GNU Lesser General Public License, published by the Free Software Foundation.

We have modified the design of this PHP class, changing the design using CSS (Cascade Style Sheets), modifying some of the functions of the Class, adding new functionalities in the insertion of events, creating the daily view and adding the navigation system in the weekly view. We have adapted the database for its use with PostgreSQL and adding new fields. To decrease loading times when showing the calendar or changing among the views, we have implemented AJAX functions, that asynchronously (using JavaScript) retrieve information from other files.

3.1 Roles

The presented tool distinguishes among three types of roles with different permissions. All of them are allowed to add, edit or delete personal events.

- *Students* can view all the events that are related to their courses, group, programme degree or those concerning the global university community.
- *Teachers* have the same permissions as the students in the Academic Diary. However, the tool retrives information from Moodle, where the teacher can create activities (tasks, questionaries, chats, etc.) or insert events in the calendar that will be displayed in the Academic Diary to the corresponding students.
- *Academic manager*s have a more active role in the tool, being in charge of adding events that concern different users groups, like clases timetables, periods of vacations, extra-curricular events, etc.

3.2 Events

The tool manages four groups of events.

- *Personal events* are created by any user and can be seen, edited or removed only by the user that created them. They are intended to allow the use of the tool as a personal calendar as well.
- *Curricular events* are those related to a certain course, for example an exam, a deadline for task delivering or a change in the course schedule activities. These events come from Moodle, where a teacher introduces them, except comprehensive exams' dates, which are introduced in the Academic Diary by an academic manager.
- *Extra-curricular events* are related to other complementary activities that take place in the university context: conferences, seminars, sports meetings, forums, etc. They are introduced only by an academic manager, and may apply to all the users or only the students and teachers of a certain degree program, group or course.
- *Academic calendar events* signal periods of classes, periods of vacations, periods of comprehensive exams, and other official dates along the academic year. Only an academic manager can introduced them in the calendar, as well as the courses' timetables.

3.3 Views

The user can choose among three different views.

- In the *Month view* (see Figure 1) only the event type is shown. The rest of information is displayed on an emerging block, when the mouse is placed on top of the event.

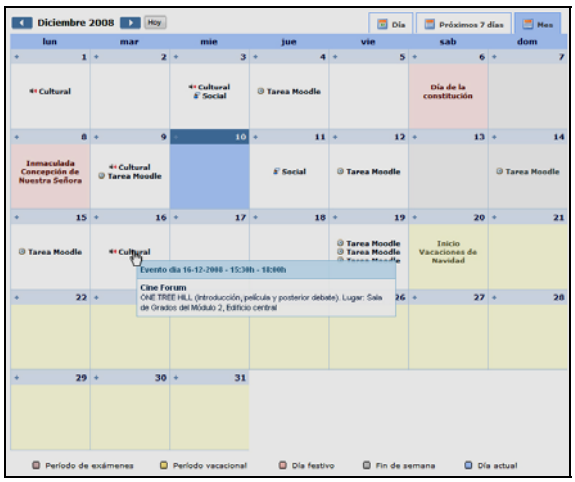

Figure 1: Month View.

- The *Weekly View* (see Figure 2) is the default view. It only shows the next 7 days starting on the present date. For every event, its name and start and end time or duration are shown. Each type of event is differenced by the background color. If we place de cursor on top of an event a more extended description is displayed. When we click in a day the tools changes to the corresponding daily view.

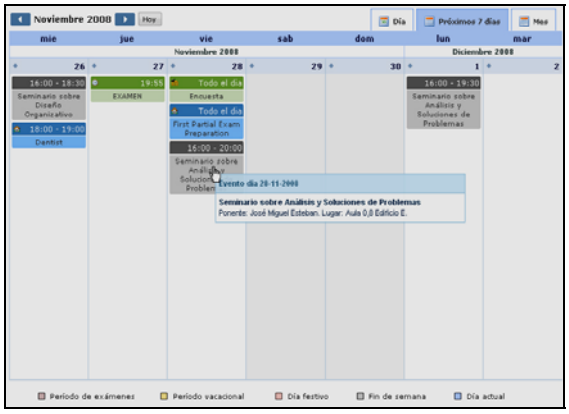

Figure 2: Weekly View.

- The *Daily View* shows all the information of the events of the corresponding day. It also allows users to delete o edit their own personal events.

In all the views, the navigation and insertion of personal events are possible.

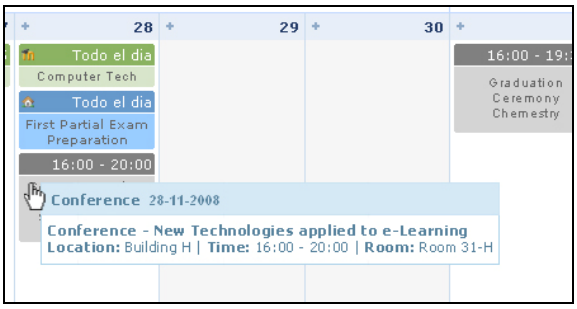

Figure 3: Detail of Weekly View.

4 PILOT TEST

A pilot experience is being now performed to check the feasibility of our approach. In this section we describe the main goals, framework and analysis methodology used along the experience.

This research activity is carried out within the scope of a wider initiative at the Universidad Francisco de Vitoria. It aims to improve learning processes by using IT in the academic environment accordingly to ESHE specifications and requirements.

4.1 Project Goals and Breakdown

The pilot test focuses on using the Academic Diary Tool under real conditions and fully exploits its possibilities as an element of a b-learning platform.

Since ESHE impose a looser and more independent learner-teacher relationship we considered a primordial need to help them planning face-to-face and homework assignments, scheduling deadlines and live sessions.

An additional functionality is to provide students with a supporting tool to keep them in contact with course and university activities.

Finally, Academic Diary can also help teachers to organize and equally distribute homework assignments so avoiding overloads due to the concurrence of several activities over the same time period.

The development of the pilot test fits the following work breakdown structure:

- Design and planning of the pilot course
- Customization of the b-learning tool accordingly with users requirements
- User (teachers and students) training
- A pre-course on-line survey to collect information about study practices and attitude towards IT technologies
- Pilot course
- A post-course on-line survey
- Personal interviews with teachers to collect their impressions
- Analysis of data collected (surveys, interviews and information provided by the tool).

4.2 Operational Framework

Pilot group is made up of 25 students of Excellens, a bilingual program that combines two undergraduate studies (Law and Business Administration) plus a grade in Professional Leadership.

The pilot experience has been planned within the first term of 2008-2009 academic year. Seven modules, belonging to different fields of studies will be included in the experience.

Teachers' information management (events, tasks, news) is carried out by a group manager.

As far as students are concerned, Excellens requires full dedication and a personal compromise as there are plenty of out-of-program activities designed for students to get a rich academic and vital experience. People in this workgroup require good time and task management techniques and tools. Class assistance is almost 100% as it is mandatory in order to be included in continuous assessment process.

4.3 Results

4.3.1 Pre-course Analysis

The pre-pilot test survey shows a student profile characterised by a high concern about time management. Some significant data are: 90% of the students declare to be aware of how they use their time, 70% design a plan for their activities and 70% have an appointment calendar and use it on a regular basis.

Following this line, 8% of the group considers that their schedule is overloaded mainly because: 1) amount of work proposed by teachers (50%) and 2) low task coordination among teachers (85%)

All the students are experts and heavy Internet users, but only 70% has Internet access at home. They have a low profile as far as computer knowledge is concerned but again they are heavy users of new communication technologies.

Finally, almost 90% of them recognize not to have previous knowledge of what ESHE and the ECTS imply.

On the contrary, teachers profile is quite assorted in reference to field of study and computing

knowledge. Their knowledge of what EEHS means is quite high. The entire group is aware of the need of changing accordingly to ESHE proposals. They also know about the consequences of overloading students with an incorrect task distribution. Their experience with internet or IT support is rare and the needed special training courses to get acquired with the b-learning platform.

4.3.2 Workload Distribution Analysis

One of the main activities of this pilot experience has been the analysis of students' workload along the term.

To calculate working hours it is necessary to previously estimate the face-to-face/autonomous work time ratio for each learning activity. Autonomous work is devoted to resolve exercises, prepare notes, documents or oral presentations, study for exams, etc.

The following table shows the ratios defined, by general consent, by the different teachers that collaborate in the project. These ratios may vary, however, from one discipline or module to another.

Table 1: Face-to-face/ autonomous work time ratio.

Activity	Ratio
Lectures	0,5
Seminars	0,25
Cases study	2
Discussions	1
Homework (group/individual)	3
Labs	0,5
Tutorship	1
Extra-curricular activities	0
Exams	10

Figure 4 shows the number of working hours per week (October-December period) for a common student. Blue bars represent face-to-face hours while red ones show autonomous work, as deduced from the activities planned in the Academic Diary.

Some conclusions can be obtained out of this graphic:

1) Total working hours per week exceed the desired one (40 hours/week)

2) Activities distribution over time is not well done as heavy peak loads can be appreciated

3) Hours of autonomous work are not directly proportional to the amount of face-to-face hours.

This analysis (considering the activities of all courses the students are enrolled in) shows how the

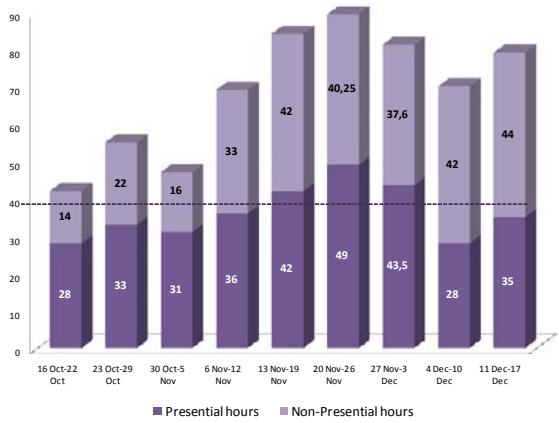

Figure 4: Working hours per week.

Figure 5 shows an analysis of student's time distribution per activity (Exams, extra-curricular activities, tutorship, labs, homework, discussions, cases study, seminars and lectures), along the same periods considered in Figure 4.

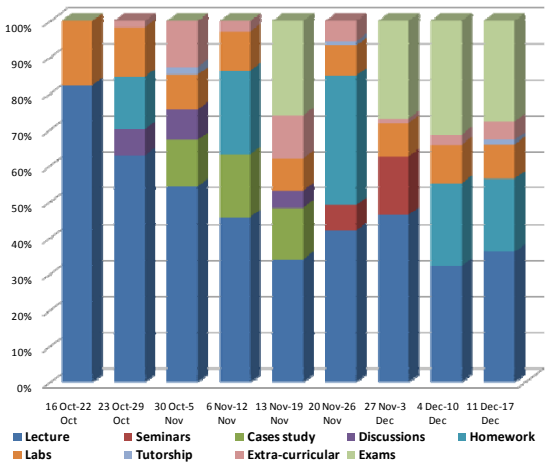

Figure 5: Student's time distribution per activity.

number of different activities increases as the term goes by, so requiring a better and tighter coordination, like the one the proposed tool can provide.

4.3.3 Post-course Analysis

As the pilot test is still going on, there is no student feedback yet. However, preliminary interviews with teachers allow us to draft early conclusions of the study.

General evaluation is good both, as a tool for better planning course activities as well as a way to approach and increase their knowledge of the ECTS

concept and its consequences in the academic activity.

The Academic Diary helps teachers to organise curricular and extra-curricular activities so avoiding peaks of workload. When planning an activity, they can take into account the ones proposed by their colleagues, thanks to the information provided by the tool, and make better decisions in relation to the activities scheduling.

5 CONCLUSIONS

B-learning requires IT support to enhance the experience of the student as a member of a learning community under the model of the incoming ESHE where autonomous work is encouraged out of the physical space of the classroom. The Academic Diary proves to be an adequate tool to support learning and teaching requirements under ESHE paradigm, allowing teachers to analyse the workload of students, and promoting a collaborative organization of the learning activities among all the teachers of a group. This will be a key factor in the success of the adoption of the new education paradigm.

The analysis of the information provided under the Academic Diary paradigm has been the starting point for some teachers to propose new directions of future work, as follows:

1) Building of multidisciplinary activities combining requirements of several disciplines in order to reduce students' workload.

2) Assignation of new task to students taking into account the number and type of other concurrent tasks.

3) Decreasing of lectures with a concomitant increase of other methodological approaches.

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A FRAMEWORK TO SUPPORT STUDENTS IN THEIR INDIVIDUAL STUDIES

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Keywords: e-Learning, Online learning, Framework, Narrative.

Abstract: Technology can be very effectively used to support students in their individual studies. However, this is a somewhat neglected area. The emphasis is on using technology to support dialogic constructivist learning environments. This is well justified, but can be problematic. Issues such as student diversity and engagement, the availability of tutor support within such environments and the demand for flexibility can profoundly affect the pedagogical effectiveness of students' learning experiences using these environments. This paper argues that the emphasis on dialectical constructivist learning environments would benefit from greater recognition of the importance of students' individual work. It also details a framework that supports tutors in designing learning experiences that encompass individual work as well as dialogic and collaborative work. The framework is based on three main constructs; Tasks, Narratives and Resources. It sets out a range of task types and also provides a model of resource production. In the narratives, it also provides tutors with a way of explaining their learning designs and engaging the students in them.

1 INTRODUCTION

The framework is comprised of three constructs; narratives, tasks and resources and is designed to support tutors in providing learning experiences that guide learners to an understanding of what they need to study, how they can study it and why they should do so. It was originally conceived as a framework to support online learners Pyper et al. (2007) because this is an environment where the risk of disengagement and subsequent impairment of learners' education could be most substantial. However, it is also applicable more generally in environments that make substantial use of educational technology in providing support for individual learning. The framework is inspired by and based on work by Weller et al. (2003) and Oliver and colleagues (1999, 2001, 2002).

Weller et al. (2003) were working with learning objects. A key aspect of learning objects is that they should be reusable. This means that they should be self-contained and decontextualised such that they do not refer to other learning objects.

One of the problems associated with decontextualising the learning objects is the loss of an educational narrative (Weller et al,. 2003). Narratives are widely considered to be important in education (McDrury and Alterio, 2002; Plowman et al., 1999), often in the form of storytelling. For this reason, a narrative learning object was provided that was designed to introduce the other learning objects and to integrate them in a theme for a given section of work. This was supplemented with the use of class discussions (Weller et al., 2003).

Oliver and colleagues (1999, 2001, 2002) provide a more abstracted approach by postulating a three component framework comprised of learning supports, learning tasks and learning resources. Learning tasks are the activities that students would be expected to engage in, learning resources the learning materials that would be available to them and learning supports describe aspects of the environment that support the learner, usually enshrined in the role of the tutor.

The framework is intended to provide a structure within which learning designs can be articulated and their different aspects described in terms of the three constructs above. So, the learning tasks, learning resources, and learning supports would vary depending on the learning design. The learning designs are intended to create a dialogic constructivist learning environment (Oliver et al., 2002).

The tasks, narratives and resources framework is influenced by the work of Weller et al. (2003) in their identification of the problem of the loss of narratives and by Oliver and colleagues work to provide an abstract framework that can be used to support the design of learning patterns. However, it diverges from the former in the extent and nature of the narratives provided and the latter inasmuch as it does not explicitly aim to create a dialogic constructivist learning environment.

Instead, the motivation behind the framework is to preserve the flexibility offered by the use of technology in education (particularly online) but to do so using designs that support the learner in their individual work. This does not represent a rejection of the importance of collaborative work and dialogues in learning design, in fact it is acknowledged as a fundamentally important aspect of learning and teaching. Rather, the contention is that the use of technology in education brings with it challenges that need to be addressed along with the potential for an enriching educational experience.

2 THE FRAMEWORK

As previously stated, the framework is composed of three constructs: Narratives, Tasks and Resources.

2.1 Narratives

The loss of narrative reported by Weller et al. (2003) is not a problem unique to learning objects, but one to which learning technology in general is vulnerable. Perhaps it is because narratives are often provided implicitly; substantial parts of tertiary education provision use inherently narrative forms (e.g. principally lectures, but also books and video (Laurillard, 2001)) and when the form is changed the narrative is lost. The result can be disjointed learning experiences whose rationale may not be explicitly available to the student, thereby impinging on their ability to make meaning out of what they are doing.

Narratives in the context of this framework are intended to have the following qualities:

- they are integrative- they provide structure to potentially disparate learning activities and resources;
- they are affective- the tutors personal opinions, views and experiences of a given topic are encouraged;
- they establish the level of discourse expected from students;
- they expose the tutor's conception of the topic at hand, an important part of initiating useful educational dialogues (Laurillard, 2001);
- they have a temporal aspect, so not only do they integrate learning activities and resources in the present but they link them to previous and future activities;
- they provide a rationale for what the student is being asked to do;
- they are reflective, this not only encourages reflective practice for tutors, but also provides an example of what the students are expected to do when they are asked to reflect themselves;
- it gives the tutor a more pervasive voice. As the students work, they get a sense that this is a course designed by the tutor, it reflects the tutor and is richer for it (it is not just some derivative set of learning resources);
- they support the metacognitive development of the students by exposing the metacognitive activity of the tutor;
- they foster the students' internal dialogue.

So, narratives have both a cognitive and affective role (Plowman et al., 1999). They are important in supporting students in placing their work in a coherent context and are intended to engage them with the tone of the narrative. Importantly, they provide a rich guide as to how they can engage in dialogue with the tutor and each other, even when they are not engaged in dialogue. Fundamentally, they bring something that is easy to lose in individual study and that is a sense of the human presence behind the design of the course.

Bruner (1986) differentiates between paradigmatic (logical argument) and narrative (story/ exposition) modes, something that relates well to domains in which the role of the narrative may be less clear. As an example Computer Science will be considered. As indicated before, narrative teaching forms make up a large part of teaching provision and so are inherently present in the teaching of Computer Science. However, in a technology-mediated, task based context, it is perhaps less clear. A significant part of learning Computer Science involves practice so a clear temptation is to create lots of tasks that emphasise practical work.

However, these tasks have meaning and rationale; they would not be set by the tutor if it did not. The implicit inclusion of these factors can usefully be made explicit in a narrative. Rather than using only a set of tasks to demonstrate control structures in programming, the tutor could provide a narrative specifying the importance of the control

structures, how they themselves approach their use, their own perception of the task at hand. In turn this could encourage students to express their own understanding of the topic. Initially a narrative account may seem more pertinent to them, and a combination of the paradigmatic and narrative could support them in framing their contribution to their learning.

The discussion of narratives has purposefully avoided grounding them in any particular technologies; indeed the framework as a whole is independent of technology. Nonetheless, there are implementation issues to be considered. There is a range of narrative media, any of which may be useful in mediating the tutors' narrative. However, in order to support the properties of a narrative as outlined above, the approach advocated in this framework is to offer a light narrative throughout the learning materials, something that is difficult to achieve coherently even using some of the narrative media (for example audio files and video files).

A key medium term aim of the use of narratives is to encourage students to construct their own narratives. This has been shown to be a useful means by which students can gain an insight into their own understanding of a topic (Plowman et al., 1999) and would also provide tutors with a rich representation of learners' understanding of a given topic.

Given a student population that is increasingly likely to be diverse in terms of their abilities and experience, it seems that this would be an important aid to the tutors supporting them on their terms.

2.2 Tasks

What the student does is the central construct in the framework, everything else is intended to support this. It is important to distinguish at this point between tasks and activities. Tasks are static designs; activities are what the student, alone or in collaboration with others, does with the tasks.

The framework essentially frames the curriculum design for a given course, and as such, has tasks as its remit rather than activities; these are the remit of the learner. What the learner does feedback into the learning experience and how technology influences it is something that is addressed in greater depth in terms of the production of learning resources. However, for the current discussion, the emphasis is on what the tutor does,

The influence of the tutor is substantial, both in terms of how they design the tasks and also how they engage the students in dialogue. However, with activities, learning should be led by the learner not the technology and, especially in the case of individual learning, not the tutor. So, the design of the tasks is clearly crucial; passing control to the learner can drift into abandonment if the tasks are not carefully designed and sequenced to support the learner's learning activities.

For this reason, the framework includes a range of tasks that is designed to inform learners of the kinds of activities they are expected to engage in, and also to support tutors in designing effective tasks. Such decomposition has been criticised for artificially reducing the complexity of tasks (Jonassen, 2001), however, the decomposition is necessary to account for cultural (Zhu and Schellens, 2008) and individual differences as well as maintaining the flexibility of the learners' study patterns (Collis and Moonen, 2002).

Tasks come in six main types: Reading, Research, Exercise, Practice, Reflection, and Discussion. These cover a range of activities that may be described in abstract terms as acquiring knowledge, developing skills and making your own meaning of them through meta-cognitive activities and dialogue. The idea is that if a learning experience contains an appropriate range and sequence of these task types, then the student will be provided with a learning environment that provides strong support in their individual studies and also guides them into engaging with others on their course. Moreover, it does this without making undue assumptions about individual learners and minimises the demands on when and how they study.

The task types are relatively informal and broad in order to allow tutors freedom in their curriculum design and also to support students in their understanding of the structure of a given session of a course. More detail about the types is available to tutors, as set out below, and this information can be made available to students as deemed appropriate by the tutor.

Currently, the greater level of detail can be found in the sub-types of the tasks, for example, the different types of reading. These also provide tutors with greater fidelity in the composition of their tasks and allow for the extension of the task types through their input of new sub-types.

2.2.1 Reading

Reading tasks cover a range of approaches beyond the most obvious. Reading tasks can simply be to read something, but they can include other approaches including skim-reading, critically reading and further reading (usually optional).

2.2.2 Research

Clearly research is a key task in tertiary education; the research task type represents the information gathering, collation and evaluation required in academic institutions. However it also has a more general meaning than academic research. Specifically research as a task type does not include the production element of research, for example a model or paper; this is classified as an exercise task (see below). Sub-types of research include; interview, web searches, archive searches, the history of a given place.

2.2.3 Exercise

Principally these are tasks which explicitly provide students with feedback based on their performance. These include formative tests in a wide range of formats including more traditional exercises such as MCQs and short answer questions or critiques of papers. Clearly there is a very wide scope for how exercise tasks can be designed and how feedback can be provided, however, they need to be designed carefully in order to preserve the students' control of their learning and to avoid overwhelming the tutors. An exercise that set a short answer question and required students to respond within a specified time would likely be problematic both for the students and tutor. These are key tasks in supporting students' individual study.

2.2.4 Practice

Practice tasks provide explicit opportunities for students to consolidate what they have learned. Practice lends itself to skills development, something that in some domains is an intrinsically important activity, but in all domains is important in developing transferable skills. Practice also applies more generally than skills development. Abstract concepts could be restated in novel contexts and tested and students can take what they have learned and apply it repeatedly in their individual learning.

So, the level of guidance is an important issue here, and must be a consideration in the design of the task.

2.2.5 Reflection

Reflection tasks are complex and open ended. Students are encouraged to not only construct their understanding of an issue, but also to understand how they did it. The intention is that this enables them to become more effective at self-direction, since they gain an understanding of how they learn. It also takes them from the domain of problem solving to one in which they can adapt their approach to problem solving; they are not engaged with the problem as much as they are engaged with strategies for solving it.

It enables them to not only approach a given proposition or problem in a conventional way, but also to assess the value of the approach. This is an essential part of tertiary education. It should be noted that reflection tasks, as with discussion tasks, are supported very closely by the narrative provided by the tutor.

2.2.6 Discussions

Within the framework, discussion tasks are included to emphasise their importance, and to inform the design of the other task types; they are not directly involved in the design of learning tasks that support individual learning.

Within this task type are a multitude of dialectical-constructivist (Moshman, 1982) learning patterns, and this is reflected in the range of possible activities; from simple discussions about a given topic to debates in which students must defend provided positions or take on specified roles.

2.3 Resources

Currently in the framework, resources is considered to be a unitary construct, because the research has focussed on methods of production, specifically the impact of intent (Pyper and Lilley, 2007, 2008a, 2008b). This does not mean that the categorising types of resources would not be a useful aspect of the research; indeed, such categorisation has been usefully applied tor media types (Laurillard, 2001). As such it is intended to be the subject of future work, once a better understanding of the impact of production methodologies has been developed.

The motivation for this was the idea that the way in which resources are produced is also an important factor in their educational effect. Setting out different types of resource categories would be usefully informed by an understanding of the potential impact of the way in which they are produced since this could effect a range of resource types.

A model for resource production, (Pyper and Lilley, 2008b) as shown in Figure 1, shows how learning resources may be created. Some learning or teaching activity generates learning content; this learning content varies across four main properties

(see below), such that it can be considered to be durable learning content or disposable learning content.

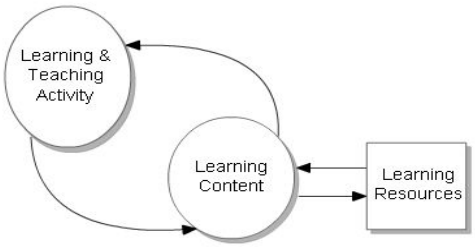

Figure 1: Model of resource production. The interaction of the process (learning and teaching activity) and the learning content (output) that may result in the generation of a product (learning resources) from Pyper and Lilley (2008b).

Disposable learning content, in the absence of technology, is only usually retained in memory in a processed form, if at all. It is usually verbal in nature. Durable learning content is designed to be retained, for example having quality control as part of its production cycle. It is also designed to be usable in contexts other than one within which it was created. This is much less the case for disposable learning content.

In essence, the distinction can be expressed in terms of intent; if learning content is intended to contribute to a learning resource or become one itself, then it is more likely to have the properties of durable learning content. If there is no such intent and the content is created as a by-product of learning activity, it is much more likely to be disposable learning content.

The following are properties of learning content:

- Intent: The motivation behind the creation of the learning content.
- Context: The extent to which the learning content is comprehensible or useful outside of the context in which it was created.
- Completeness: The extent to which the learning content contains enough information to be comprehensible to someone else.
- Longevity: The amount of time that the learning content intrinsically endures.

As an example, an educational dialogue between a tutor and a student could be described in terms of these properties. The conversation is a means to an end so is not intended to be the end product; the students improved understanding is. It is necessarily context dependent because the tutor must adapt their part of the conversation to the level of understanding shown by the student. It is unlikely to be complete, since partial sentences make sense and may be just as useful as full, carefully crafted sentences in the conversation. Finally, the main way in which the conversation will endure is in a highly processed form in the minds of the participants. Most of the learning content (the words and phrases) does not endure at all.

Of these dimensions, the most affected by the use of technology, is longevity. This is because if the conversation outlined above was mediated by technology, it could be retained without any further action by the participants. The learning content (the words and phrases used) would be disposable in all other dimensions, but by changing one, it gains the appearance of durability. It is stored, and so can be accessed at any point in the future, but it has none of the other properties of durability as captured in the properties above.

The distinction between durable and disposable learning content has been supported by previous research (Pyper and Lilley, 2007, 2008a). The two content types are useful in different ways but when mediated by technology tend to be used in similar ways.

This is of concern, because students are already faced with an extremely information-rich learning environment and even more learning content is being added as resources to this environment. Most importantly this is often happening as an unconscious side effect of learning activity, not as a considered product of it. So, we may be cluttering up an information-rich environment that is already overwhelming. It could be argued that students must develop their information literacy skills for this very reason, and that the selection of useful or salient learning materials is part of that development.

However, there seems little need to add yet more content to the information environment in order to provide students with this aspect of their education. It is of most concern that this is often occurring as an unintended by-product of learning activity. Quite often, it results from the use of technology to mediate longstanding learning activities. Dialogues have been used as an important example of this, but the effects noted can also be seen in other contexts. Examples include podcasts or video captures of lectures, synchronous or asynchronous tutorials where all the data are captured.

In more general terms, this is also the case for any learning activity in which the end goal is poorly defined or understood. It is important to note that these are quite often features of tertiary level learning activities.

This gives some idea of the ubiquity of the issue. Where technology is used in education the lack of

distinction between durable and disposable learning content can have an effect. If this effect impairs students' education then the problem is indeed a substantial one. This issue has been described in terms of usability, for example, Mayes and Fowler (1999). However, the usability of a system is not at issue here. Usability is a function of the extent to which a system fulfils the usability requirements set down for it. A word processor might be considered highly usable. Additionally it could be used to produce a cogent essay or a set of notes that make little sense to anyone other than the author. The question is about the educational application of the technology, not its usability. Academic conventions do not gain in clarity from being described in terms of usability conventions.

It is preferred here to attempt to understand the issue in purely pedagogical terms. It may be argued that the lack of distinction between disposable and durable learning content represents the capture of cognitive states as behaviour. It follows that this erodes the distinction between learning and performance, and given the fact that some technologies that are most prone to the problem are designed to support learning, not test performance, then they are having unintended side effects.

3 FUTURE WORK

Having established the overall structure of the framework, future work will concentrate on detailing the different components and their interaction. It is anticipated that resource categories would be elucidated and the support they provide for different task types set out.

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AN AUTHORING TOOL FOR DEVELOPING HIGHLY INTERACTIVE DIGITAL BOOKS
The IntBooks Platform

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Keywords: Authoring tool, Educational software, Interactive digital books.

Abstract: We present a document platform, denominated "IntBooks", that seamlessly aggregates web technologies into digital books, giving the reader an interactive, intelligent and rich environment, and authors a "simple" and collaborative way to build and share them. It addresses some of the common technical issues as: how should different media (e.g. mathematics formulae) be delivered and displayed in a large set of devices; how users interaction should be made and statistics collected; and how authors may reuse and mesh up content from different web repositories. A particular IntBook planned for the fifth and sixth grades of Basic Portuguese School is also discussed, emphasizing its specificities and additional features.

1 INTRODUCTION

Any multimedia educational software is a structured and varied blend presentation of multiple media, such as text, formulae, graphical images, animation, audio sound and full-motion video, by a computer-mediated software or a single interactive (web) application. Multimedia software may use some or all of these modes of communication, however, it is more than a collection of multiple media and hyperlinks (Chang, 2000). As a complex interaction of stimuli (McKerlie and Preece, 1993), multimedia software for education aims to put users in contact with a specific set of knowledge, in an organized and reactive way. In fact, it can be a powerful tool in the hands of the performance technologist and multimedia designers to be used by educators. The effects of multimedia-based instruction versus lecture-based instruction on teaching has been investigated in several works in the literature, e.g. in (McKethan et al., 2001). The last decades have witnessed a steady, irreversible trend toward the globalization of e-learning tools, and education through the use of software-intensive web technology in particular. But the production of multimedia artifacts demands guidance for both engineers developing software and designers generating content. This is a clear obstacle for non-technical technology aware authors (or educators) that want to produce multimedia educational software to be used in their teaching activities.

Here, we present a document platform, denominated "IntBooks", that seamlessly aggregates web technologies (as many as possible) into digital books (web applications), giving the reader an interactive, intelligent and rich environment, and authors a "simple" and collaborative way to build and share them. The developed platform strives not only for content deployment but also as a set of tools that enable authoring and re-usage of contents extracted from repositories. In an IntBook production, the author can use any mixture of formats, be it simple text, HTML, LaTeX, or any other which he is more comfortable with. It can also embed java-applets (e.g. Geogebra constructions or others), in fact, any current web technology (e.g. flash objects) and some application specific formats. All the source is written in a XML-structured file (the IBK format) and the set of tools takes care of the rest, transforming it accordingly and as necessary for a consistent web presentation in the client browser targeted for a specific device (a PC with a small or wide screen, a PDA, etc.). Figure 1 presents an example of a IntBook by Pedro Miguel Duarte of the University of Lisbon, generated from an IBK file that contains LaTeXand Java applets.

To achieve such high goals, there are a multiplicity of important issues and technical decisions that

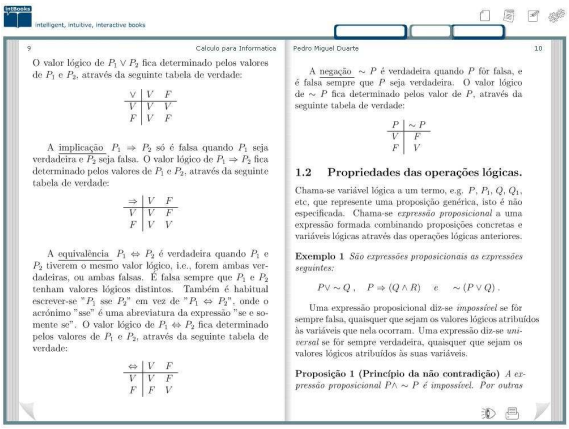

Figure 1: A snapshot of an IntBook, with a double-page layout, seen in the web browser of a widescreen PC.

must be considered. For example, the platform should produce digital books that render appealing mathematical expressions and formulae, e.g. to be suitable for the production of supporting material for courses at higher levels of education. Among the multiple types of content, mathematics presents the biggest challenge, since there is no consensus in the community about which format is simultaneously better integrated and produce the best visual results (e.g. PDF, MathML, LaTeX converted to an image as in Wikipedia), see (Borwein et al., 2008). Generally and briefly, we must clarify the following crucial points: (a) how mathematics (and other media) should be delivered and displayed in a large set of different devices; (b) how users interaction should be made and statistics collected; and (c) how authors may reuse and mesh up content from different web repositories. In this work, we convey our point of view, answering the above questions through the design model and development of the IntBooks platform. In Section 2, we focus in the display problem, presenting our "unified" model. Section 3 gives a sketch idea of how the platform deploys an IntBook (web application) from the IBK file (source code). The user interaction is discussed in Section 4 and the aggregation concept in Section 5. Section 6 makes a brief explanation of the platform management and access control. Finally, in Section 7 we present a particular digital book, covering the new curricula in mathematics for the 5th and 6th grades of the Portuguese Education System, which is a clear example of the potential and features of our authoring tool.

2 CONTENT MESH UP DISPLAY

In our everyday use of Internet and web experience, we interact with a multitude of technologies capable of displaying different types of documents and enabling different types of interaction. The most common are HTML and Javascript, but also Flash, SVG, Java, etc.. Browsers enable the presentation of content through external plugins or mechanisms already embed in their source code. Authoring complex web content requires more than one tool and various steps. Often one has to take *a priori* in account the final layout, the target device screen dimensions and capabilities, and the software to be used, before its real production. IntBooks reduces significantly the effort to create online interactive books, feeding content from various formats and sources. These pushes for the need of an unified and coherent representation of content, not only to avoid dependencies but also to be able to transform between formats (sources) in a consistent way. A file format specification was designed, in order to comprise such needs and to be extensible to open formats (see subsection 2.1). The user should also be able to produce rich content, regardless of end form of presentation, in the software more familiar to him. IntBooks takes this into account, and makes an effort to support as many formats as possible, and put your content where it needs to be, and how it needs to be. Using a back-end set of tools, it transforms the input into the suitable format for web usage.

Figure 2 shows a IntBook's page which was generated from three different source formats.

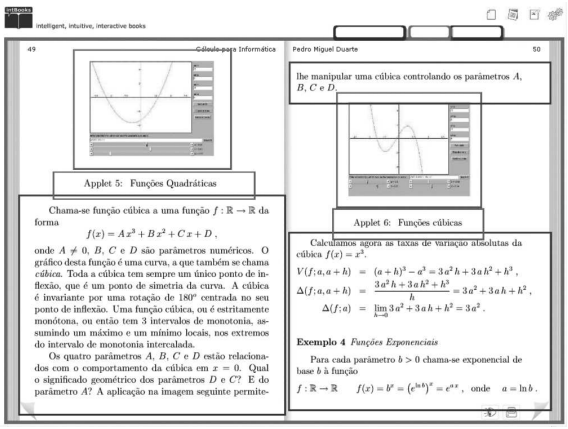

Figure 2: A snapshot of a calculus IntBook, where different source fragments are marked with boxes: LaTeX(the bottom boxes), Java applets (the interactive graphs), and HTML (the figure captions).

2.1 Structure and Language

The proprietary source package is a ZIP file containing a XML based file, so-called IBK file, and external binary files (e.g. images, videos, SWF files, etc.). The IBK file main purpose is to be a consistent container and structured aggregator of the different source formats (called IBK fragments, embed in specific XML tags), which additionally has the file referencing for the external binary content. It is a file structure intended for multi-format document amalgamation, editable in any simple text editor. In what follows, there is an example of the top level syntax of an IBK file:

```
<?xml version="1.0" encoding="utf-8"?>
<intbook-system>
  <book id="3" title="TexMat" authors="Geometrix" year="2008">
   <header>
     (information / parameters setting commands)
   </header>
   <body>
     (fragment / block commands)
   </body>
  </book>
</intbook-system>
```

The IBK file is then parsed and processed by conversion tools and filters, which apply to each fragment, in order to generate a visually consistent and interactive book (see Section 3).

2.2 Different Layouts and Devices

To enable content delivery to different devices some restrictions would need to be enforced and considered. Examples of potential targets are, the nowadays common, mobile devices, which have specific web capabilities (varying from manufacture and model), e.g. screen resolutions and web extensions availability are in general very limited. One key point is that authors (content producers) should not be obliged to produce different sets of content to different devices. The platform should (ideally) mold itself accordingly. However, content size and formation can be a real obstacle. IntBooks make use a set of algorithms that enable a reasonable and automatic splitting of content into blocks that best fit in the page size templates, pre-defined in the IBK file. This is possible since the server stores the original IBK source file, and not a compiled version, so it enables content re-edition and output generation on-demand, i.e. content may be recompiled with different parametrization and templates to better fit the graphical demands of the supporting layout and the different target devices. Figure 3 is a snapshot of the same IntBook of Figure 1, but with a different layout (template).

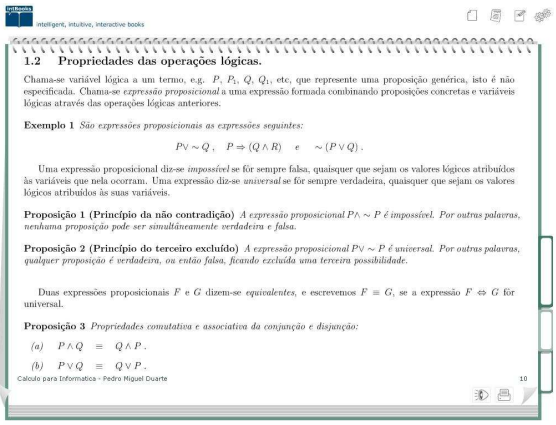

Figure 3: An IntBook with a one-page layout.

3 DEPLOYMENT

The processing and deployment of the source package (an IBK file + a set of external binary files) is very technical and deserves to be explained in detail in a future publication. In short, the processing is supported by the simple idea of a pipeline of transformations, where each IBK file containing some fragments formats are converted into a new IBK file with fragments with different formats. For example, we convert all the LaTeX to Flash vector scalable objects, which give the best visual and zooming performance.

After parsing and processing the IBK file, the output is intended for a multi-user server based environment. An installation step is needed in the server environment. Although this could be a simple package extraction process, and the content exclusively a client based application, the server-side also enables interaction and a user-based session.

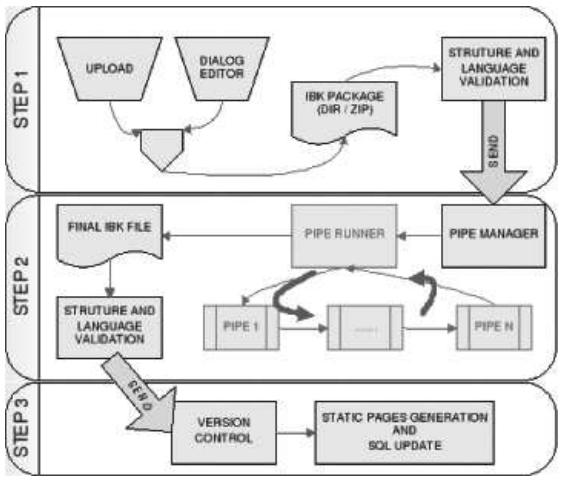

Figure 4: The IntBook processing scheme.

Although access to an IntBook may be restricted by an optional authentication layer, the installed book can be readably available for generic usage. Inputting the book URL into the browser starts the user interaction. The IntBooks web-application is responsible to deliver all the content and multimedia assets to the user browser, also providing the turn page functionality to the book. The generated content that initially could be supplied in the form of a LaTeX document, is now readable and has been transformed, for example, into Adobe Flash format. The server is also responsible to choose the most suitable output format, according to the browser capabilities.

For more sophisticated IntBooks, the server delivers a web-service for variables storage where the client application can read and optionally write. This functionality is configured as part of the IBK file. The IntBook's example TexMat (see Section 7) makes intensive use of this functionality, making it a highly responsive environment to user interaction (e.g. allowing randomly generated exercises).

4 RICH USER INTERACTION

The basic user interaction for every IntBook layout is the page turning functionality. But this can be a little limiting to the content that can be delivered. To warp this, a read/write link is available for the client-side delivered content, enabling conditionality linked to the smallest user interaction. This way during user interaction with the book, let's say a particular page as a multiple choice survey, and the next question would only appear after the previous is correct, using this read/write link, the client application could check if the answer was correct and record every answer the user would give.

Implementing a similar functionality with page refreshing would drastically increase band-width requirements, create a not so smooth user interaction, and would probably break page navigation. This is a relevant characteristic to maximize the user experience and intended for quizzes, pools, surveys, exercises, tests, etc, and it's achieved through storable variables on the server. It enables the application to "remember" the user, and the user to review all of his past answers.

These server variables are strong-typed and declared in the IBK file. During installation on the server the variables are allocated for a per user instantiation and changes to these variables are logged for usage by reporting tools.

5 AGGREGATION AND RE-USABILITY

In this topic we simply use the classical idea of "*re-use, not repeat*". IntBooks can also be viewed as a collaborative system, where a particular book can be built from fragments of other books or from other entire books. Different authors may work, for example, in different books, in different formats and merge everything in a uniform book. Obviously, the author dependencies are kept during all the process. Since the IBK format is a format for fragmented content, entire chapters can be imported from book to book. Because disciplines have similar chapters, concepts are interconnected. Since some courses are created from the merge of two intensive book courses and not all information is relevant, re-utilization is a key feature. Avoids content repetition and guarantees that an explained concept has only one meaning across the various books. The mechanism that manages fragments also incorporates bridges to some web repositories (e.g. for extracting LaTeX source from PlanetMath).

This linking between books is dynamic, so when a chapter or concept is improved with examples, the other books using that source are also improved. As future work we plan to improve the search engine that allow authors to find and link published contents of other IntBooks into their own books.

6 USER MANAGEMENT

As in most e-learning platforms, there is a trend to mimic the organizational hierarchy of an institution. In a learning environment there are the obvious student and teacher roles, and as in any user-based platform there are the typical administrator and manager. The IntBooks platform is no exception, and it requires a centralized, delivering and control system. The created authentication, authorization system, was molded as an institution library, makes only sense, because our object of development was centered on the book. An institution may have various libraries (sets of books) and books may be categorized. A teacher assigns a book to his teaching class (set of users), and all the students (users) can start using it. This might appear to be a complex system, but it's also very scalable. It can be as simple as an administrator uploading the books, and creating user accounts, and it's ready for usage. Using teachers role, enables decentralized management of users and permissions. This role is also meant for accessing the students data, and statistics collection. The administration system

enables creation of groups of institutions and sub-institutions (departments or pedagogical groups), allowing for the propagation of roles and books across all sub-institutions. A user might have different roles in different sub-institutions, for example: be an administrator of physics department and only a teacher in mathematics department, and a student of a art book. A sub-institution can have its exclusive users that are not users of the mother-institution. The administration interface model makes the IntBooks platform a vertical solution, enabling its deployment on large organizations. Figure 5 shows part of the administration interface developed as an Adobe Air application.

Figure 5: Snapshot of the Administration interface.

7 TEXMAT: A MATHEMATICAL INTBOOK EXAMPLE

TexMat is a highly interactive digital book covering the new curricula in mathematics for the 5th and 6th grades of the Portuguese Education System. Its design includes several features and capabilities as multilingual, modularity, the ability of being easily extendable by teachers (e.g., adding Geogebra constructions), model generated exercises, open questions, and centralized gathering of students statistics and assessments. But, technically, TexMat is a IntBook. A particular IntBook, sharing the same structure, but with additional features, specially designed for this book, since the target students need some particularities, mainly in the design and interaction level. In fact, TexMat was the application that originated IntBooks. Instead of developing a specific system, we have expanded the idea for a more general and abstract system that can build and control every book designed to be an IntBook, where TexMat can be included.

7.1 Content Display

In TexMat, almost every page is composed using Macromedia Flash. Because we are interested in keeping the users answers to the questions and in changing the appearance of several objects (visibility of text, images, animations, etc.) according to the users accesses and interactions with the book, it was necessary to define a communication protocol (using XML) to exchange information between the Flash objects and the server database. The IBK file, presented above, must now have more information about the dynamic variables and questions of any flash object.

Here is an portion of the TexMat IBK file, that represents a flash page:

```
<page>
    <flash filters="user">
      <vars_layout fName="GF19" src="flash" width="712" height="476"/>
      <vars_state>
        <var id="23" name="cErrado" property="imagem" value=""/>
        <var id="24" name="c1" property="imagem" value="caixa1a.swf"/>
        <var id="26" name="ver" property="imagem" value="ver.swf"/>
        <var id="27" name="text3" property="_visible" value="0"/>
        <var id="30" name="inp1" property="type" value="input"/>
      </vars_state>
      <questions>
        <question id="418" resposta="" tentativas="0"/>
        <question id="419" resposta="" tentativas="0"/>
      </questions>
    </flash>
</page>
```

Because of these dynamic variables, the book appearance changes in every usage, according to each user's performance.

7.2 User Interaction

As any IntBook, TexMat has two well-defined modes: student mode and teacher mode. However, in this particular case both modes have some extras, in addition to visit or edit the book.

7.2.1 Student Mode

Each user (student) must be associated with (at least) one teacher, and this defines the user's navigation in this particular book. While the student is interacting with the book, it goes changing (invisible text or images become visible, answers are given, images changed) and these changes are registered in a database. They become visible in the next user visit and in the teacher's view.

During the navigation, an interactive agent (developed in Macromedia Flash) guides the student through the book. It reacts to the user's actions according to his/her answers and controls the progress in the book, as we can see in Figure 6.

Also during the navigation process, and when a specific concept is explained in the book, it is added to the user's notebook, where he/she can add a particular note about the concept. The notebook is individual and can be acceded in any moment the user wants. If it is called from inside the lesson with a concept, goes directly to the respective definition of the associated concept. Otherwise, the notebook application opens

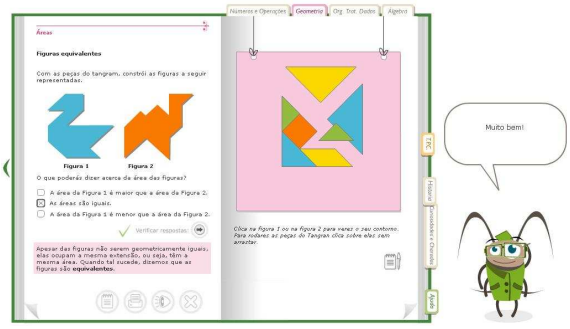

Figure 6: The TexMat agent reaction.

in search mode, permitting the user to search every concept in his/her own notebook.

7.2.2 Teacher Mode

As an editor, the teacher has full control over his/her own book, and may share it (or parts of it) with other teachers. Starting from the default TexMat book, a teacher can delete or add pages, in every location. He/She can construct a sub-book of Geometry, for example, deleting the remainder of the book. But, more interesting than deleting is adding. With a simple interface, adding pages to a book is a simple action that does not require high knowledge of web tools, and this operation can be previewed in real-time and be approved or not. Every type of document that can be viewed in the web can be added to the book, e.g. text, images, HTML, pdf, java applets, etc.. As a teacher, he/she has information about all his/her students' performances, receives the open question responses and may interact with the students directly from the book, sending particular messages or giving homework for a particular student or for all the class.

7.3 TexMat in Classroom

Not pretending to be a substitute for the classical manuals or competing with the math classes, TexMat can be used as a complement in the classroom. Specially the animations and videos can be very useful for explaining a concept, and the large amount of exercises can be used to practise. Also, the teacher can give homework directly from the book, during the class. In this case, the students are informed of the fact in the next time they open the book.

Another interesting feature of TexMat is that it can be used to plan particular lessons in the classroom. Since a teacher can add pages to his/her own book, he/she can prepare lessons from TexMat, using the included lessons or using only the platform with his/her own contents.

8 CONCLUSIONS

In this work, we have briefly discussed an authoring tool platform for an integrated and consistent delivered of multimedia content (containing different technologies) suitable to be presented in different layouts and devices, reducing the authors (content producers) effort in learning a specific set of technologies. This platform, by the set of features and structure model, is clearly different from standard projects as Wikipedia (or PlanetMath), iPaper or Google docs. In some sense, IntBooks could be viewed as a learning management systems and the generated books as learning objects. Its interface emphasizes the historical learning source of knowledge, *the book*. Integration of LMS and SCORM standards is an optional work in process. IntBooks has the simplistic model of creating the smallest dependencies needed to achieve the maximum features possible. Basing development in the standards would hurt development, and restrict ideology implementation. In this way, and using a KIS (keep it simple) architecture, standard compliance is a feasible future. Maintaining the sources, would be just a matter of adjusting the filters, to produce a compliant SCO. The IBK format, is intended for compilation, where as other formats deal with the compiled media form of the documents, emphasizing in document fragments, and enabling content reorganization, after installation, where as SCO's are the indivisible learning unit of general LMS. In IntBooks, content can be reorder to the simplest paragraph.

We hope that in, the future, IntBooks turn to be an favored and useful tool for authors to express their way of organizing and presenting educational content in a highly interactive and appealing form.

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DIGITAL INK AS A COLLABORATIVE LEARNING SUPPORT

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Keywords: Collaborative Learning, Digital Ink, Sketches.

Abstract: Collaborative Learning is a technique used in problem or task resolution where learning occurs through the exchange of knowledge between students, and between students and teachers. In some situations communication between partners is better undertaken through the use of sketches or diagrams. The proposed environment introduces several tools into a computer supported learning environment using digital ink to facilitate expressiveness and creativity.

1 INTRODUCTION

The "Information Era" has brought changes to society that reflect in the teaching/learning environment. Institutions now need to be more than knowledge transmitters, becoming creators of stimulating environments, which must allow for partnership, exchange of experience and, above all, allow the development of critical and reflexive thinking (Basso 2000).

Furthermore, several researchers defend the use of technology as a pedagogical resource through the replacement of traditional expositive classes with classes offered with an alternative, more attractive, methodology, using computers, with interaction through websites, software and pedagogical games (Almeida 2008, Moran et al. 2004).

In this scenario, Collaborative Learning is a methodology that has gained importance. It is used in problem or task resolution where learning occurs through the exchange of knowledge between students, and between students and teachers (Verburgh and Mulder 2002).

Computer Supported Collaborative Learning offers a "collaborative environment" composed of several tools structured in the form of a groupware whose objective is to support communication, collaboration and coordination in group-based learning activities (Nitzke et al. 1999).

There are several collaborative content environments available for use on the Internet. These include blogs, forums, discussion lists and wikis. In these systems, users express collaboration effectively through writing. However, there are many collaborative activities that are totally dependent on essentially visual content.

This type of content includes sketches, diagrams and technical designs, and is not well adapted to traditional environments, where information is basically presented in textual form. However, drawings/sketches can be used in the learning process to develop the habit of observation, the spirit of analysis, and the taste for precision. It would also be through drawings that purity of imagination is reactivated and the gift of invention enabled (Costa 2005).

The introduction of digital ink in the environment facilitates this type of activities, giving users greater freedom of expression, allowing them to exchange ideas in a more creative and natural way, enhancing communication, transforming some collaborative work difficulties in facilities.

Digital ink is a technology that represents drawings, sketches, and handwriting in its natural form. The use of digital ink is interesting because it allows for free expression, preserving the personality context of the person who writes. There is no restriction to a predefined structure, not even the need to write inside lines.

By exploring the digital environment, educators and students will be able to move on to a new, more powerful and more efficient paradigm of learning

(Tapscott 1998), making use of devices with native resources for digital ink, among them tablet PCs, smartphones, PDAs and others.

The drawing process associated with digital ink offers users benefits such as:

- It is fast, adequate to the short memory capacity.
- It is implicit and does not require sequential form or any special structure.
- It serves for analysis, verification and simulation.
- It is inexact and abstract, avoiding the need to include unnecessary details.

The main objective of this paper is to describe a set of tools for collaborative learning support that enhances the environment with digital ink. The tools present characteristics of interactivity and expressiveness by allowing the use of notes, sketches, diagrams and tracing as means for exchanging ideas, instead of limiting communication to writing. It extends the benefits of collaborative group work, giving users the possibility to create, edit and administrate visual content, in the same environment used for text.

The remaining of this paper is structured as follows. Section 2 presents an overview of the environment that results from the integration of the above-mentioned tools. Sections 3 to 6 describe each of these tools in more detail and Section 7 presents some conclusions from the work.

2 THE ENVIRONMENT

The proposed environment is a collaborative system whose goal is to provide advanced features to increase interactivity and expressiveness through the use of digital ink. As part of this system, a set of tools have been proposed and implemented:

- A **Digital Ink Wiki** that presents characteristics of interactivity and expressiveness by allowing the use of notes, sketches, diagrams and tracing as means for exchanging ideas, instead of limiting communication to text-based writing.
- A **Slide Annotator** that uses digital ink to integrate an electronic classroom environment based on slide presentations with a didactic knowledge. Through this tool, students have access to complementary material that will assist them in understanding and learning the subject being discussed in the classroom.
- A **Flowchart Designer** that integrates computer program flowcharts and digital ink to help first year students in the design of algorithms. The use of flowcharts has three main reasons: flowcharts have a minimal syntax; they are a universal representation; and they are easier than code structure for beginning students.
- A **Distributed Ink-based Whiteboard** that enables real-time interaction among a group of users by sharing a common, virtual, writing and drawing surface, which is presented to each user on its own device (typically a tablet PC). Users are allowed to ink on their local instance of the whiteboard while this ink is transmitted and rendered on other devices in the group via the classroom's wireless network.

The proposed environment has been developed inspired by the first year course on Algorithms and Computer Programming. This course has always presented a challenge for Computer Science Programs, probably because algorithmic reasoning is typically not part of the background students bring from high school.

Even though some of the tools have characteristics specific to this domain, most are generic and can be used for any domain where sketches and drawings are relevant.

3 DIGITAL INK WIKI

With the Digital Ink Wiki (DIWiki) (Almeida et al 2008), it is possible to share ideas in a more natural way, by allowing students to post drawings / sketches on the Wiki. These sketches can then be edited by other students using digital ink.

The tool also makes the correction activity easy. By using digital ink, users (teacher / students) will be able to use handwriting to annotate on content posted in the Wiki.

Furthermore, DIWiki (Figure 1) offers basic annotation features that allow users to mark, underline, emphasize or circle words in a sentence, as well as draw or make notations in the edges. These annotations or comments are reminders that we add to the documents to signal information or to highlight items of interest for subsequent reference.

Advanced features include sticky notes. This functionality offers flexibility in order to include several types of content in a document, for example, digital text, handwritten notes, "paint" aspects, or Web links.

The environment has two ink tool bars: *Drawing*, which can be used to draw and to write, and *Ink Annotations*. Both include a series of ballpoint pens, felt-tip pens and highlights to personalize the color and the width of the ink. It is possible to use the *Drawing* tool bar to insert diagrams, maps or images in the document being published.

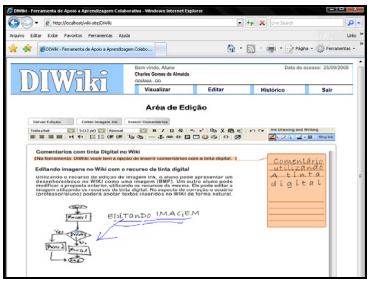

Figure 1: The DIWiki environment.

Data storage in the tool is done using the Ink Serialized Format (ISF), a file format specific for ink serialization that is compact, with high quality representation. Furthermore, the tool is able to recognize and export ink objects in different file formats, such as GIF and bitmap. This extensibility feature allows ink objects to be accessed through more than one interface (e.g., in devices with no native support for ink).

DIWiki offers a favorable environment for the knowledge construction process among students and among students and teachers, allowing collaborative learning through data sharing in several environments, such as wireless networks and mobile devices, guaranteeing users real-time access to the relevant information.

4 FLOWCHART DESIGNER

Sketches are handmade drawings with the goal of solving or clarifying a given problem or subject. As in handwriting, each person shows different characteristics when producing sketches. There are innumerable forms of drawing an object, and this can vary from person to person (Figure 2).

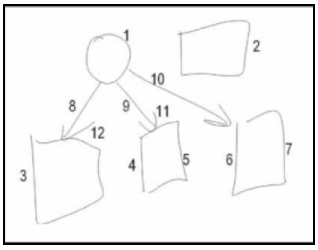

Figure 2: Different forms of sketching a rectangle.

To this, we can also add the inability of humans to draw curves and lines. This makes the recognition of sketches a difficult task (Davis 2007).

In Flowchart Designer, the process of sketcing is divided in two modules. First, the student freely sketches a flowchart with the aid of a digital pen. Second, the sketch is interpreted and converted into Java code. In the first module, the student creates the flowchart, using basic ink drawing functions such as erase, cut, paste, change color and select area for interpreting (i.e., execution of specific parts). At the end, the student selects the RUN button, and the flowchart is interpreted. If recognition is not satisfactory, the program offers a list of suggestions for the part of the sketch that was not recognized and the student can choose what the sketch really represents.

To implement the sketch recognition module, we use the LADDER system (Paulson et al 2007). It is based on the *Natural Interaction* system (or Magic Paper) (Davis 2007), which uses a hand scale that is in fact a constraint language of forms that describe the sketch, observing the direction, curvature and speed of sketching (Figure 3).

The sketch recognition language allows the description of more complex forms, based on more primitive ones and associated with a context. For example, Figure 4a shows the description of an arrow as the union of three connected lines with specific sizes (shaft, head 1 and head 2).

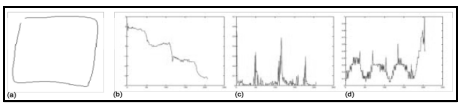

Figure 3: Features of a sketch. (a) sketch of a square and the direction of drawing (b), (c) curvature and (d) speed of drawing (Davis 2007).

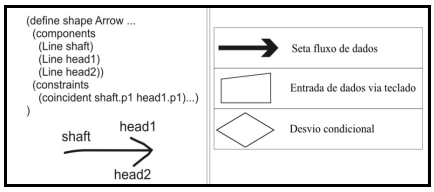

Figure 4: (A) Declaration of the arrow shape in LADDER (Paulson 2007). (B) Sample flowchart basic shapes.

During interpretation, if there is a syntactic or lexical error, the user is pointed to the part of the flowchart where the error occurred. The user can then edit the sketch to carry out the correction. When the flowchart is ready, the user can convert it into programming language code (Figure 5).

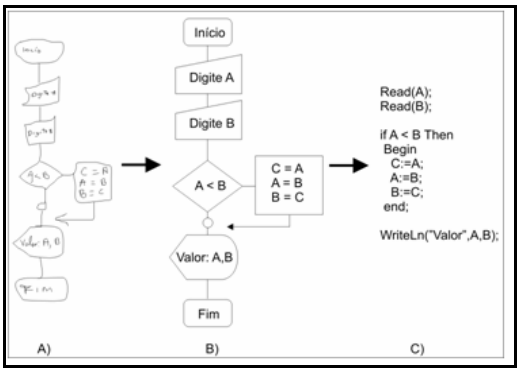

Figure 5: Sample flowchart sketch (A), recognized shapes (B), and result of conversion into code (C).

The sketch can be published and modified by other users (students). Modifications can be tested in the same way as the original sketch. Versions of the flowchart are kept, representing the modification sequence.

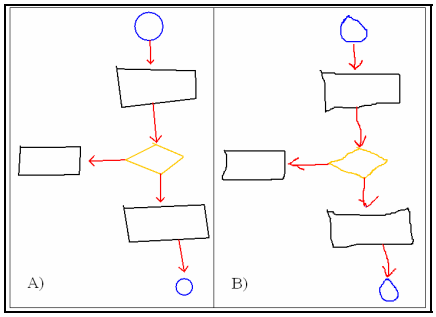

Figure 6: Shapes recognized by LADDER (A), and the original sketch without smoothing the lines (B).

5 SLIDE ANNOTATOR

The use of adequate and easily accessible didactic material (scientific articles, e-books, Web pages, among others) is essential to establish a permanent dialogue in a learning environment. For instance, this is important in order to give advice to students, to motivate learning and increase knowledge on the worked subjects, to promote critical understanding of contents, to instigate the student for research, and to make possible the supervision and evaluation of the learning process (Neder 2001).

In this sense, the Internet is ever increasing its presence in the daily life of students. However, one of the most important challenges is the retrieval of relevant documents. Depending on how the query is made, the selection of relevant material may be very time consuming.

The identification of relevant information is carried out by human beings in a natural way by analyzing the document's context. The simple reading of a heading or a summary, for example, can elucidate the content of the material at hand. When carried out by an automated system, this task is no longer trivial.

The Slide Annotator tool allows students to retrieve relevant didactic material associated to the subject being presented by the teacher. This can be done in class, while the teacher is explaining the subject, or later, when the student is reviewing or studying the subject.

The electronic classroom environment in consideration here assumes that lessons are delivered in synchronous form, with teacher and students co-located in the same environment at the same time. The tool was inspired by Classroom Presenter (CP), a presentation tool developed by the University of Washington that allows the sharing of digital ink in slides between teacher and students (Anderson et al. 2007).

With CP, all students receive, in real-time, working copies of the teacher's slides. CP allows teachers to interact with students through digital ink annotations on the screen, used to clarify questions and propose exercises, among others. Students can also send questions to the teacher and receive feedback.

Slide Annotator builds upon CP by allowing students to select words contained in the presentation and access a set of documents related to the context being shown in the slide display area.

For example, take the slide presented in Figure 7. If the student marks the word "alphabet", the tool analyzes the slide's context and verifies that the subject being treated in this lesson is related to "state diagrams" and selects documents that deal with alphabets in this specific context and not just any alphabet. It is worth noting that documents are not limited to text, but can include drawings, demonstrations, exercises, simulations etc.

Moreover, when opening a slide using the tool, information recovery techniques, applied automatically to the document, identify words considered relevant in a slide and convert them into hyperlinks, allowing students prompt access to complementary didactic material, either previously selected by the teacher and stored in a repository, or retrieved from the Internet.

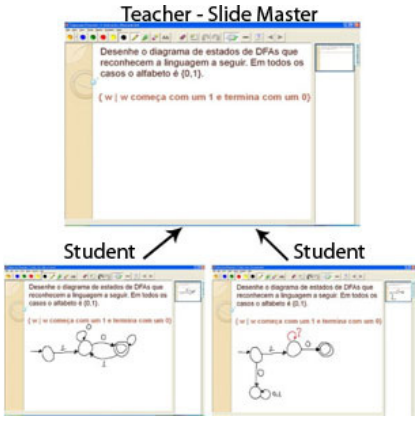

Figure 7: Example of interaction between teachers and students on Classroom Presenter.

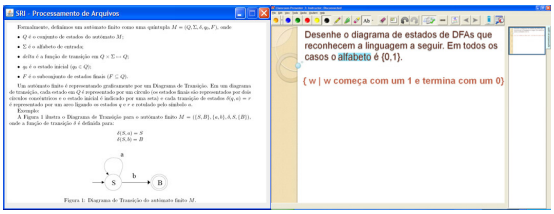

Figure 8: Example of recovery of contextualized teaching material.

The retrieval of relevant material is done using query expansion to better contextualize the original user query. The technique consists in the addition of related terms to those originally defined in the query. To enable query expansion, an analysis of the presentation and the slide content is undertaken to identify related terms, such as synonyms, stemming variations, or terms that are physically close to the query terms in the slide.

Original query: **computer programming**

Query expansion: **computer programming program data language algorithm programmer** …

Figure 9: Example of query expansion.

6 DIGITAL INK WHITEBOARD

It is widely known that the ability to share and exchange content is vital in the learning process. This is especially true about content that students produce during lectures and other classroom activities as part of the cognitive processes that take place while learning a new subject. In particular, we are interested in group-based learning, whereby students gather around a virtual shared space where they can express their ideas in a natural way using digital ink. Drawings, annotations, sketches and other forms of graphical representation drawn by a student are immediately transferred and rendered on the screen of the other students in the group. Problem-solving activities are a natural fit for this kind of collaboration tool.

While a number of tools exist that allow this kind of interaction in the classroom, among them Jarnal (Levine and Teege, 2008) and Group Scribles (Roschelle et al. 2007), we observe that they typically suffer from poor quality of interaction due to networking problems that are common in a congested local wireless network such as in a busy classroom where each student has his own wireless device. Typical problems include packet loss and delay, which may cause, respectively, the loss of vital ink strokes or their late reception by some users. In most situations, besides being a nuisance to users (as interaction through digital ink becomes out of sync with face-to-face interaction), may cause misunderstandings as, e.g., parts of a sketch or formula may be missing on some users' screens.

To tackle this problem, we designed and implemented an adaptive middleware platform that is able to autonomically reconfigure the underlying communications mechanisms in order to alleviate or eliminate packet loss and delay (Provensi et al 2008). Such adaptations are performed on behalf of users in a transparent way, requiring no user interaction with the middleware and, in the typical case, enabling user-to-user interaction to proceed without any noticeable change. Typical adaptations include compression and/or reduction of the quality of ink representation (without noticeably compromising its rendering), as well as configuration of network packet sizes.

The ink-based whiteboard was then implemented on top of this adaptive middleware platform, resulting in an interaction environment that guarantees the quality of service that is required for a meaningful real-time collaborative application. We plan to implement other collaborative applications on top of this middleware platform, such as ones that use rich multimedia content at real-time. We also plan to experiment with this platform to build applications aiming at distance-based collaboration.

7 CONCLUSIONS

The goal of this work was to describe a collaborative learning support environment that integrates digital

ink into the learning environment. This allows for more freedom and creativity in the environment, adapted to situations that require visual interaction by means of drawing and sketches.

In this context, the paper presented concepts, forms of interaction, main features, aim and functionalities of the proposed tools. These tools form a rich classroom environment, especially for teaching and learning activities that involve group-based problem solving.

We have begun to use these tools in a number of courses on Introductory Computer Science, both for major and non-major students. These courses are offered in a tablet PC laboratory, where students have access to digital ink technology in a one tablet per student basis. The PBL methodology (Schmidt 1983) is used to introduce the course syllabus, complemented with lessons using ink-annotated lecture notes. Students are encouraged to seek the solution collaboratively and independently of the teacher that acts only as a guide. The proposed tools are used to facilitate communication and enhance discussions within and between groups.

One of the main outcomes has been a substantial increase in student engagement, evidenced by higher class attendance levels and lively discussions among the students, both during and after class.

As future work, we plan to integrate the four tools described in this paper, in order to ease the process of switching from one tool to another and also to enable the meaningful exchange of ink data among them.

ACKNOWLEDGEMENTS

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THE ROLE OF LEARNING STYLES IN INTELLIGENT TUTORING SYSTEMS

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Keywords: e-learning, learning styles, Intelligent tutoring systems.

Abstract: The Bologna Process changes the educational paradigm, to be focus on the student and in the learning outcomes. The majority of e-learning platforms are used as mere repositories of content, based on the classroom paradigm and don't support the individualism of each student learning process. Through the integration of new pedagogical methodologies based on students learning styles, we present an approach to intelligent tutoring systems in order to improve the learning process. This article is focused on the importance of learning styles to create the student model in intelligent tutoring systems and what was the student's feedback about the adaptation of the system to each learning experience.

1 INTRODUCTION

E-learning is increasingly spread in various levels of education, whether in education support presence, either in the distribution of the distance courses.

The e-learning platforms today, known generically of virtual environments for learning, offer several features that allow the management of courses, communication and distribution of content.

The vast majority of the platforms are based on the paradigm of the classroom, where knowledge is transmitted the same way for all students. This paradigm uses the contents as the only means of transfer of knowledge.

The Bologna process that aims to create a European Higher Education Area by 2010, pretends to change this paradigm, in order that focus the educational process on the student and in the learning outcomes, reflecting the new demands of knowledge-based societies, which implies a more personalized education.

According to Dias (2004), building spaces for online learning is a challenge that goes beyond the simple transfer of content to the Web. This approach tends to transform the environments in online repositories of information and not in the desired spaces of interaction and experimentation.

To allow a greater adaptation of the learning environment based on the student's profile, it is proposed the adoption of theories of artificial intelligence in education, based on the experience of students so that the content and contexts of learning can be reused and adapted to new situations.

In the last three decades, the artificial intelligence has been adopted in various forms of education. The initial experience of adoption of artificial intelligence in education dating back to 1984. Several other approaches appeared in the adoption of artificial intelligence in education, and in 1988 one of the first architectures of intelligent tutoring systems was developed by Burn and Caps.

One of the most important issues in the adaptation of an intelligent tutoring system is the modulation of student behaviour in order to adapt the pedagogical model to the student model.

This adaptation to be more effective is necessary to identify the student profile, based on several parameters. One of the most important parameter is the student learning style. Each student has his own style of learning, which influences the collaboration during the learning process

In this context, the development of adaptive learning environments, based on the student profile, this type of systems can contribute to the change in

the educational processes, based on new pedagogical methodologies integrated with artificial intelligence techniques in order to provide learning environments adaptable to the needs of each student.

The main motivation of this work focuses on the development of intelligent tutoring systems, to improve the educational paradigm, considering the student learning style and the collaboration in the learning process.

2 LEARNING STYLES

The basic theory of learning styles is that different people learn in a different way. One way to see the learning styles is to connect them with the learning cycle advocated by Kolb (Kolb 1984), where learning is seen as a continuous process based on practical experience that incorporates a set of observations and reflections.

Later, this model was developed by Honey and Mumford (1986) creating a questionnaire of learning styles based on the model proposed by Kolb. It was identified by the authors four learning styles, related to the four stages of the learning cycle proposed by Kolb: activist, reflector, theorist and pragmatist.

Each learning style has the follow characteristics (Honey and Mumford, 1986):

• Activist - Students with an active style involve themselves fully and unreservedly in new experiences. Have an open mind, are optimistic, which makes them enthusiastic about something that is new. Tend to act first and consider the consequences later. They engage in many activities and when they lose the enthusiasm they change to another activity. The main philosophy is to try everything they can. They have great enthusiasm with the challenges of new experiences, but discourage with the implementation and consolidation of ideas. Tend to get involved in tasks with other people, but usually try all activities centred on them.

• Reflector - The reflector like to be more in the rear to observe and reflect on experiences from different perspectives. Collect data and prefer to think about that before making any conclusions. Its main philosophy is to be cautious. They are very balanced, preferring to consider all possible angles and implications before taking any action. They prefer to watch other people in action. The reflector people are by nature discreet.

• Theorist - People with a predominantly theoretical style incorporate comments into complex theories, but they are logical. They consider the problems on a vertical way, step by step and in a logical way. Assimilate facts based on consistent theories. The main philosophy is "if it is logical then it is good." They have an independent spirit and like to formulate principles, theories, models, assumptions and thoughts. The approach of the problems is mainly logic.

• Pragmatist - The pragmatists tend to experiment the ideas, theories and techniques for checking whether they work in practice. Having new ideas they seek for an opportunity to try it in practice. They are impatient in discussions with subjective or vague ideas. They are essentially practical and like realistic decisions to solve problems. The main philosophy is: "there is always a better way to do things" or "if it works then it's good."

The styles of learning have become increasingly important in education, given the change in the paradigm of education caused by the transition to the knowledge society. The lifelong learning paradigm leads to new learning context, which are increasingly more heterogeneous, where is important to take into account the learning styles of each student to provide an education more effective and focused on the student.

Figueiredo and Afonso (2005) consider the context and content as the key elements of the learning model. The learning model defines the learning activities as the situation in which individuals learn. The content is the information that is structured and consists of text, materials, multimedia resources and lecture. The context is a set of circumstances that are relevant to the student to build knowledge through its connection to the content.

In the model presented, the teacher has a bipartite role in the presentation of content and creating the learning context. The context can be a classroom or a virtual learning environment, in which the role of teacher is more focused on content in the case of a classroom, and the context in the case of a virtual learning environment.

The contents assume the role of transmission knowledge, where information is transformed into knowledge through a given learning activity.

The integration of intelligent systems in the learning support, allows an adaptation of content and contexts to the learning style of each student, providing adaptive tools to support collaboration (Lesgold et al. 1992, Goodman et al. 2003).

3 INTELLIGENT TUTORING SYSTEMS

The adoption of artificial intelligent in education has the goal to improve the learning process adapting the contents and the learning environment to the student profile. The student profile is based on his learning style, learning needs, goals and choices.

The first systems adopting artificial intelligent techniques were the Intelligent Tutoring Systems (ITS). Kearsley defined an intelligent tutoring system as an application of artificial intelligence techniques to teach students (Kearsley, 1987). Sleeman and Brown defined an intelligent tutoring system as a program that uses artificial intelligence techniques for representing knowledge and carrying on an interaction with a student. According to Sleeman and Brown, an intelligent tutoring system must have its own problem-solving expertise, its own diagnostic or student modeling capabilities, and its own explanatory capabilities (Sleeman & Brown, 1982).

One of the first architectures of a ITS system was presented by Burn and Caps in 1988. This architecture was based on four main components: curriculum module, student module, tutor (pedagogical module) and the interface module between the student and the system. This basic architecture was improved by several researchers, including Ong and Ramachandran in 2003, Thomas in 2003, Bass in 1998, Choquet et al. in 1998, Titter and Blessing in 1998 and Nkambou and Gauthier in 1996.

Modern intelligent tutoring system architectures (Figure 1) are very similar to the Burn and Caps proposed architecture. The four modules are represented frequently as the domain module, student model, pedagogical module and the interface module.

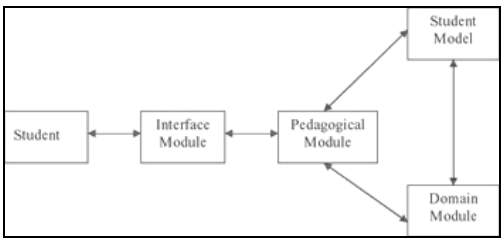


Figure 1: Components of an intelligent tutoring system (Ally, 2004).

The student has the main role in the intelligent tutoring system. All the features of the system have the mission to adapt the interface and the pedagogical material to the student profile and his preferences.

The domain module is a knowledge management system, storing all the concepts that the system pretends to transmit to the student.

Connected to the domain module are the student model and the pedagogical module. The student model represents the learner behavior, his profile, learning style, motivation level and his interests. This model is based on artificial intelligent skills that simulate the human behavior. All the student behavior is recorded in the system and used for "reasoning" and adapt the domain module to the leaner needs. The pedagogical module acts has a virtual instructor, presenting the contents in an appropriate sequence, based on the student skills and his learning style. This is an interactive process and this module has the mission to explain the concepts to the student given several points of view and supporting all the learning process.

With the capacity to communicate and interact with the student, the interface module has an extremely important mission. If one ITS had a powerful pedagogical, domain and student model, but the interface module is very poor, the ITS will not be effective because the interface is the front of all the system and has the ability to cap all the attention of the learner. To develop a good interface module is necessary to consider the usability issues of a user computer interface, because this module interacts with the user and the other components of the system. If the interface fails all the other modules fail too.

The type of intervention of the pedagogical module in the system is very important for the student creativity and motivation. Wenger considers that is more efficient to let the student search for the solution for one problem before make any intervention (Wenger, 1987).

In order to adapt the tutoring system to the learning needs, we propose the adoption of Learning styles to intelligent tutoring systems in order to provide a more effective adaptation, taking in consideration student motivation and the effectiveness of each learning tool according to the student learning style.

4 THE ROLE OF LEARNING STYLES IN ITS

The current generation of learning management systems is fundamentally based on the concept of

virtual classroom, allowing the distribution of contents and its discussion, but are still not very efficient in the collaboration.

The learning management systems, even those that are based on constructivist theory, where collaboration is essential, not suggest ways of adapting the learning process to specific needs of each student.

The next generation of e-learning platforms, it seems that this concept will changed, where the learning support it will be the most important component, leaving the teaching and production of contents as less prominent. Thus, the adoption of intelligent tutoring systems can contribute to the improvement of learning, adapting the presentation of content and offering support in its interpretation and discussion, which allows a personalized education and adapted to the learning style of each student.

The intelligent tutoring systems have been developed for the typical individual education (computer-student). With the advent of the Web in education, several authors studied the adoption of tutors in collaborative environments, giving them the capacity to work together, using collaborative tools (Lesgold et al. 1992, Goodman et al. 2003).

Khuwaja (1996) says that while intelligent tutoring systems are implemented with considerable success, they are not practical enough to be used in the real world. This may change with the introduction of new methodologies applied to multiple areas, in case of face-to-face education or at distance.

ITS systems are based on computer-based training (CBT) technologies and are learner centric. The main disadvantage appointed to these systems is the limitation of the student creativity, because the student needs some autonomy in their process of knowledge construction. In the other side if the system is very passive the motivation of the student can decrease quickly.

The heterogeneity of students in higher education will be increased as a result of the demands of society and knowledge economy, which demands a life-long learning approach.

The lifelong learning has been defined as one of the priorities of the Bologna Process. Thus, it will be increasing the number of students in different contexts of learning. To meet these new challenges is a necessary a greater customization of learning methodologies, to support each student learning style.

The identification of the student's learning style is an important requirement for the ITS systems to adapt the learning environment to the needs of each student.

To implement this approach we develop a generative intelligent tutoring system (GITS), based on the student learning style, to module his/her profile.

The student module is based on Honey-Alonso learning styles questionnaire (CHAEA), adapted and validated for the Portuguese language by Miranda (Miranda 2005).

To identify the learning style of each student it was integrated in GITS system the CHAEA questionnaire. The student when accesses the system is invited to complete the questionnaire.

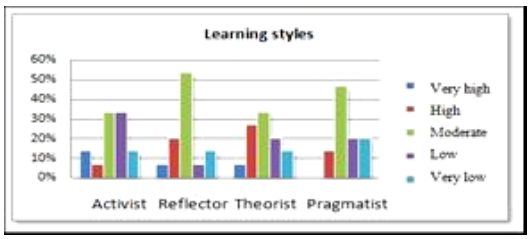
The questionnaire consists of eighty questions enabling the identification of preferences for each style: active, reflective, theoretical and pragmatic.

To evaluate the GITS system we made a case study in two different groups. One of Introduction to Computer Science, composed by 20 students, and other of Web Development, composed by 15 students. The number of styles identified is less than the number of users of the platform, because the answer to the questionnaire is voluntary and does restrict the use of the GITS system.

To identify the students' learning styles we consider only the experimental group, which used the GITS. The control group used a different platform without the ITS system.

The experimental group of Web Development had a smaller membership in response to the questionnaire that the group of Introduction to Computer Science.

The analysis of the results indentifies a moderate preference for each style: active, reflective, theoretical and pragmatic. Only 7% of students had a very high preference for reflective style and 13% by the theoretical. There isn't any student with a very high preference to the pragmatic style. The moderate level is the predominant.



Graphic 1: Learning styles of research group.

In the adaptation of learning context made by GITS to each student style, shows that most of the students had a moderate preference, which implies a very narrow adaptation.

Figure 2: GITS interface to add notes to contents.

Only for students with a very high preference for the active style the GITS made an adaptation of the learning activities to explore the potential and students creativity. For students with a very high preference for the reflexive and theorist styles, the system did an adaptation on forums, to improve reflection, and on the Chat for the Active style to promote a direct discussion.

The GITS system modulate the user behaviour based on the student learning style, but with a main moderated preference for each style most of the students had a standard view of the system. Only the high and very high preferences change the appearance of tools, contents and activities.

4 CONCLUSIONS

The use of intelligent systems has several advantages in the support and personalization of e-learning. The intelligent tutoring systems are typically used in computer-based training (CBT) and don't support the collaboration and cooperation like groupware and cooperative work technologies. We propose the adoption of generative intelligent tutoring system to support Web-based Educational Systems.

The validation of the prototype was done through data collection of the GIST prototype. We do two case studies in two subjects, one in Introduction to Computer Science and other in Web Development.

Based on the results we can conclude that the adoption of collaborative and adaptive capabilities to intelligent tutoring systems, like forums, and the possibility to add notes to contents to share knowledge, is a good feature to improve the learning experience.

The organization of contents using learning activities was highlighted as very important by most of the students in the survey and the adoption of learning styles to model the user profile was considered important for the students.

The GIST system supports the student in their learning activities, collaborative work, portfolio management, agenda management, and shows several points of view of some subjects, suggesting Web resources to complement the student knowledge.

These capabilities it was considered by the students very important to improve the knowledge and the collaboration, which can be adopted in several learning management systems to provide a more effective support in the learning process, going in the direction of the needs of knowledge based societies.

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THE INCREMENTAL DESIGN OF SCRIPTS BASED ON MULTI-AGENT SYSTEM

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Keywords: Collaboration Scripts, Tracking Learners, Traces, Design Method, Multi-Agent Systems.

Abstract: Collaborative learning is not always effective; its effects depend on the richness and intensity of interaction between students during the collaboration (Dillenbourg, 2002). This collaboration is structured using collaborative scripts. Hence, the design of these Scripts is not trivial; it requires information on learners and on their interaction. We believe that when learners are the target of any design, this one needs to be evaluated on the basis of the learners themselves. However, most of the design approaches do not use experimental feedback on the learners' collaboration to improve the initial design. We propose in this article a method for the design of scripts basing on the experimental feedback. We suggest the use of multi-agent systems to provide help and information to the scripts designers.

1 INTRODUCTION

These recent years, researchers stress more the importance of learning design. Among these researchers, Robe Koper and Tattersall (. Koper & Tattersall, 2005) who state that "the key principle in learning design is that it represents the learning activities and the support activities that are performed by different persons (learners, teachers) in the context of a unit of learning".

Koper thinks that the key of the success of the learning environments is the activities and not the pedagogical objects. Consequently, he proposes, to specify the learning situations, the Educational Modelling Language (EML) which focuses on the pedagogical activities. This language was adopted by the IMS Global Learning Consortium to propose the standard IMS Learning Design (IMS LD).

The result of the design of the learning situation is called a script which is considered as a sequence of phases.

In our work, we affirm that this concept (script) is linked to the concept of trace. This later can contribute to the changing of the script, either in a dynamic way in order to regulate the learning, or at the end in order to evaluate and reuse this script.

In this paper, we propose an approach for the construction of scripts taking into account the experimental feedback on the learners' collaboration. The idea is to track the learners when performing the different activities prescribed by a script which is designed at first (preliminary design) and provide feedback on the execution of this script in order to review the preliminary design).

2 OBJECTIVE AND MOTIVATION

We A collaborative script (or scenario) is a set of instructions prescribing how students should form groups, how they should interact and collaborate and

how they should solve a problem (Dillenbourg, 2002). It structures the collaborative process in order to promote specific types of interactions (Dillenbourg, 2006 (a)). A script includes multiple activities, occurring at different various social levels (Dillenbourg, 2006(b)): individual activities (e.g. reading, writing…), group activities (e.g. solving a problem with a peer…), and class wide activities (lecturing, discussion…).

A variety of design methods of scripts have been proposed but none of them take into account the experimental feedback and use it in an incremental way in the process of scripts design. In fact, these methods rarely use the feedback to improve incrementally the initial design and most of them focus more on the results of collaboration rather than the process of design itself.

Also, designers have to take in consideration the learners and their behaviours because they are at the end the main actors of the designed script.

Our framework of scripts design is based on the following six ideas:

1. The process of design is incremental based on a loop of four phases which are: Scripting, Specification, Execution and Evaluation (Fig 1.).

Scripting is the phase of writing, for a group of learners, of the different rules of collaboration and describing the different activities, the different roles, etc. In this phase a natural language can be used.

In the phase of specification, the script is specified using a specific formalism. Then, this script will be executed and finally it will be evaluated on the basis of the learners' traces during the scripts execution.

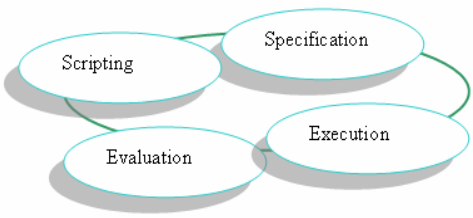

Figure 1: The different phases.

2. The Scripting must be considered as a whole and not only through its outcome i.e. we have to take into account:

- The starting point (the different data).
- The final point (the outcome).
- The transformation from the first point to the second one.

3. A design method is to guide without any constraints the designer who must take into account the human factors involved in the execution of the script. The execution model of the script must be considered as a task or activity model and not a data model.
4. Human factors play a central role in the process of design. Designers require information on learners and on their collaboration in order to favour the desirable interactions. For this reason we suggest the tracking of the learners.
5. Formalism for the specification of scripts is used. This formalism enables the designer to express his choices and not only to describe the result.
6. An integrated environment is desirable for the scripts design in order to facilitate continuous communication between the various "activity spaces" of the design process. Hence, in an incremental approach of scripts design the designer can move from the evaluation spaces to the specification spaces and to the implementation spaces. We propose that the use of such environment provides a way to overcome the problem and gives designers tools to go beyond the assumptions of standard design.

3 THE INCREMENTAL DESIGN OF SCRIPTS

The developer of pedagogical scenario can not judge a design choice only if he evaluates its consequences in a real situation based on the feedback of the learners interactions. Also, we recommend an iterative process in which the results of the developed scenario evaluation are analyzed and interpreted in order to be used for the adaptation or for the improvement of the scenario.

The execution of the script should be considered as a task or activity model and not as a model of the different resources offered to the learners.

- The idea is to allow the designers to express their choices and not only describe the script. Indeed, the script is the expected result but some choices may be important as they are represented. For instance they can be used in the reuse and adaptation of scripts.

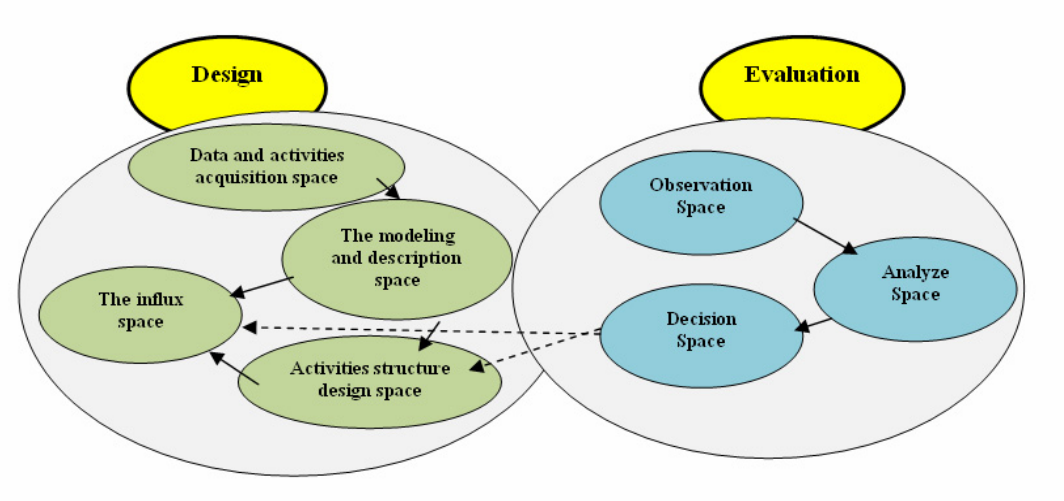

Figure 2: The different activity spaces.

- To facilitate the proposed design work, an integrated environment is essential to allow the designer to move between different areas of activity. Indeed, the designer is evolving from assessment space, to specification and implementation spaces.
- The constraints of such approach are the automatic generation of script that can be possible only by a formalization of the outcome of the design and the use of a set of artificial agents that will act in the different activity spaces listed below.

What Activity Spaces and how to Skip from an Area to Another?

The steps concepts must be distinguished from that of space activity in a design. Indeed, a stage characterizeed a specific product and design methods are described in terms of stages. The activity space characterizes a state of the developer's activity. We have identified and characterized the different activity spaces of the design process. These spaces and the links between them are presented in the following figure (Fig.2.).

We can identify seven activity spaces useful for the designer over two phases: the design and evaluation. Each activity space represents an identifiable viewpoint of the designer on its design task.

For the design phase, we have identified four areas of activity spaces:

- *Data and activities acquisition space* in which information is collected: pedagogical resources, profiles, learning activities...
- *The modeling and description* space: allows the designer to have key abstractions and a clear vision and accurate information it will use. This is similar to application development approaches.
- *Activities structure design space:* the designer main concern is developing a model of activities or pedagogical resources stemming from the task for which the script is designed. This model is different from a data model.
- *The influx space:* provides the designer with the means to specify how to change the specification of the script structure to the instantiated structure of the target script.

For the evaluation phase, we suggest the following three areas:

- *Observation Space:* The main concern is to observe the progression of learners in accord with their requirements and profiles.
- *Analyze Space:* Actions and interactions of the learners in the groups are analyzed from the observation delivered in the precedent space in order to have synthesized information about the learners' progression in the group and about the designed script.
- *Decision Space:* The main concern is to have some decision about the script to be presented to the script's designer in order to refine this later.

4 THE CONCEPTUAL MODEL OF MULTI-AGENTS BASED SYSTEM FOR THE SCRIPTS DESIGN

Jennings and his colleagues (Jennings et al., 1998) argue that the use of agents is attractive because they are able to characterize naturally and easily a variety of applications, and also to represent the different entities of a system or a domain.

The agent paradigm is the most powerful paradigm to provide abstractions for complex organizations analysis and modelling. Humans and software systems can be considered as entities which interact and collaborate to perform their tasks in order to achieve their goals.

In order to run a successful multi-agents simulation in this approach, a script (scenario) must be provided to agents. A collaborative script differs from a program in that no explicit specification is given in advance. It is necessary to propose a conceptual model that models agents at an appropriate level of abstraction by executing the script and indexing actions and interactions of learners in the learning environment.

The script author and an agent developer agree upon activities as the interface between them. The script author describes scripts using a language, while the agent executor implements the activities to be performed by learners and extracts interactions from the script. The script author describes scripts Using the learners' activities and interactions in the group.

The script executor conducts experiments in a real environment, and then the experiment outcomes are used by the script writer in order to refine the original script.

The evaluation agent observes learners interactions by collecting different traces of learners during their collaboration.

5 AGENT FOR PROBLEM AREA

Learners are different and it is difficult to have an adequate script for the entire group from the beginning. In order to help the designer to modify his script on the basis of learners, we suggest the use of a set of agents having the following roles: decision, interpretation, execution, observation and tracking learners.

The work of the agents starts when the different learners interact with the system.

A Graphical User Interface (GUI) is used to facilitate the learners' interactions with the system. Each learner has to introduce his profile using this interface. These profiles are stocked in the '*Profiles Base'* by '*The Decision Agent'*. This agent has a direct relation with '*The Interpretation Agent'* which has to specify the script in a comprehensible format for the other agents. This script is executed by '*The Execution Agents'*.

'The Tracking Agents: keep track of the learners and stock the different traces in '*the Traces Base'*. '*The Observer Agent*' controls the works of the other agents.

The Decision Agent: Basing on the learners profiles, the decision agent selects a script (which is adequate to the profiles of the learners and not to the behaviours/collaboration of learners) to be executed in order to structure the learners' collaboration.

Moreover, this agent is able to access directly to 'the Profiles Base' and 'the Traces Base' in order to provide the designer with the necessary information.

The Interpretation Agent: The script is specified using a format which is different from that used by agents; consequently, this script will be interpreted by *'the Interpretation Agents'* to make it comprehensive.

The Execution Agent: '*The Execution Agents'* execute the interpreted script taking into account the different learners' profiles.

The Observer Agent: The execution of the script will be controlled by *'the Observer Agents'*. These agents monitor the work of the other agents to provide general information on the execution of the script.

The Tracking Agent: They collect the different traces of the learners during their collaboration.

6 A CASE STUDY ON THE ARGUEGRAGH SCRIPT

The ArgueGragh (Dillenbourg, 2002) script is a macro script aimed to trigger argumentation between peers. It consists of the following five phases:

1. Each learner responds to an on-line multiple choice questionnaire and for each answer he is expected to argue his/her choice.
2. When all the learners answer the questionnaire and argue, the system produces a corresponding graph where the learners are positioned according to their answers. Then, the teacher or the system forms pairs of learners who provided different answers in Phase 1.

3. Each pair has to respond to the same questionnaire in Phase 1 and provide arguments. They can see their answers and justifications provided by each peer in Phase 1.

4. For each question the system calculates the answers given individually and in collaboration. The results are used in a debriefing session where learners comment their arguments.

5. Each student writes a summary of all the arguments collected for a specific question. The summary should be structured according to the framework used in the debriefing session.

Application of the Proposed Model to the ArgueGraph Script

When the learners are present, the decision agent informs the interpretation agents in order to rewrite the script in a comprehensible format for the other agents. Then, this script is executed by a set of execution agents. These agents provide the learners with the questionnaire and each learner responds to it and argues his/her choice.

According to the learners answers the decision agent produces the corresponding graph. Then, the teacher or this agent forms pairs of learners who have conflictual answers.

Each pair has to respond to the same questionnaire in Phase 1 and provide arguments. The decision agent allows the learners to see their answers and justifications in Phase 1.

This agent calculates for each question the answers given individually and in collaboration. The results are used in a debriefing session where the learners comment their arguments.

The different interactions of the learners with the system are collected by the tracking agents and during all these phases, the observer agents monitor the other agents in order to provide a general idea on the execution of the script.

In this way the designer can modify his script and adapt it on the basis of the learners assisted by a set of artificial agents which gave him the necessary information about the learners' interactions and actions.

6 THE AGENTS IMPLEMENTATION

To allow learners to access the learning system, a distributed learning environment is proposed for learners located anywhere and connected to learn at any times. It's a multi-agent based distributed learning environment which provides a multitude of learning object for learners of the group which are referenced by the script author.

The learning system consists of the client side and the server side. On the client side it has a JSP (Java Server Page) user interface. On the server side, the servlets and a multi-agent platform implemented using JADE (jade: http://jade.tilab.com).

JADE (Java Agent Development Framework) is a software framework for the development of multi-agent systems and conforms to the FIPA specifications (fipa : http://www.fipa.org/).

When learners log on the system through Web based applications, a learner agent upload the profile and requirements and the learner is affected to the assigned group. The script is uploaded and the execution of the script will be performed.

7 CONCLUSIONS

Collaboration has certain advantages for learning. To profit from these advantages, the learners' collaboration should be structured and organized. Hence, scripts are used to structure the desired interactions among learners.

The design of these scripts in not easy, for this reason we suggest the use of an incremental script to help the designer to take into account the behaviours of learners and their interactions.

In this paper we presented a multi-agent based system for the incremental design of collaborative scripts. The main agents of this system are, namely, '*The Decision Agent', 'The Interpreter Agents', 'The Execution Agents', 'The Tracking Agents'* and *''The Observer Agents. These agents have* the following roles: decision, interpretation, execution, observation and tracking learners.

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ADAPTATION ENGINE CONSTRUCTION BASED ON FORMAL RULES

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Abstract: With last achievements in research and practical development of adaptive hypermedia systems, they start being more and more promising for e-learning adaptable to personal learner needs, style and performance. Every year there are constructed new technology enhanced platforms with adaptation engines controlling content management and delivery. A great problem with adaptation engine designs is that few of them facilitate a flexible and manageable control over adaptation processes. This paper is focussed exactly on problems with effective conceptual construction of adaptation engine, by means of formalization of our adaptation model for hypermedia learning courseware management and delivery. The article describes in brief a formal definition of both adaptive rules and adaptive process supporting the model. The approach proposed for adaptive engine's construction follows a rule-driven approach and is consistent with that formalization. The implementation of the platform is under development and relies strongly on conceptual separation of adaptive rules from business logic. This guarantees an ability for editing adaptive rules at run time and, thus, to manage the adaptation process in a very flexible way.

1 INTRODUCTION

In last decade, many software platforms for technology-enhanced learning have been developed. However, only few of them offer adaptation of e-learning process according needs and expectations of individual learners. Adaptive platforms such as adaptive hypermedia system (AHS) are entirely oriented to individual user's goals, preferences and knowledge (Brusilovsky P., 1994). AHS use various decision mechanisms and methods of assuring adaptation and of provisioning educational content in a way most satisfying student needs (Dagger, D., Wade, V. & Conlan, O., 2005). Some AHS achieve it using widespread techniques such as adaptive navigation, structural adaptation, adaptive presentation and content selection. These techniques could be used for implementation of static adaptation or of dynamic one - driven by an engine controlling the adaptation. Other of them introduce additional level of system self adaptability based on the idea that different forms of learner model can be used to adapt content and links of hypermedia pages to given user. All of AHS have built-in engines controlling adaptation by choosing what adaptive technique to apply and managing the entire process.

The present paper discusses an approach construction of adaptive engine by defining and executing symbolic rules. Symbolic rules tend to be most suitable for implementing our conceptual model of an adaptive hypermedia system. Using symbolic rules for construction of AHS promises to be very universal thanks to abilities for run time redefinition and control and, also, possible system redevelopment for supporting other adaptation models. After providing a comparison of most prominent adaptation methods, the paper goes to a brief description of our triangular conceptual model of AHS. The functionality of the adaption engine is formalised and two ways for its construction are discussed: one by using Drools rule engine (Proctor, M. et al., 2008) and another one by rule descriptions in SWRL. Both these ways allow flexible software construction of the engine allowing easy expandability and adaptation control at run time.

2 COMPARISON OF ADAPTATION METHODS

There are various well-established ways for ensuring adaptation. Following them, the adaptation engine

Table 1: Comparison between methods for construction of adaptation engine.

Criteria \ Methods	*Symbolic rules*	*CBR*	*IMS LD*
independence	YES (adaptation rules are defined independently)	NO (it depends on the cases and not only on adaptation rules)	YES (by a XML meta-language allowing scenarios to be separated from learning materials)
reuse / repurposing	YES (adaptation rules are used for each learning material under certain conditions)	NO (a consequence of the independence)	YES (various pedagogical strategies describing by XML files can be applying in different learning materials)
implementation complexity	NO	YES	YES
level of adaptation	high (depending on defined rules, it can allow possibility for self adaptation)	high (it allows possibility for self adaptation)	average (its adaptation is based on pre-defined methods, conditions, calculations, etc.)
interoperability	YES (for rules' description, there can be used XML based languages such as RuleML, SWRL or first-order logic predicates)	NO (there is not a standardised way for CBR description)	YES (it is a specification and can be used between systems supporting it)

can be constructed by means of methods as follows:

- symbolic rules – this is one of the most illustrative methods for presenting adaptation. The adaptation is described by setting rules of type <if-then>. The rules set conditions and actions to be implemented when these conditions are observed.
- case-based reasoning (CBR) (Zongmin Ma (Ed), 2006) – an approach that stores a set of past situations with their solutions and, in similar or same cases, uses them or a similar solution. There are four phases of implementation: retrieve, reuse, revise and retain. Usually this approach is used to assess learner knowledge and perform instructional tasks (Guin-Duclosson, N. et al., 2002).
- IMS Learning Design (IMS LD) (Berlanga, A. et al., 2006) – this is a meta-language for learning scenarios description maintained by IMS Global Learning Consortium. Adaptation can be provided by defining conditions for the presentation of learning content and sequencing of learning activities.

Here we present a comparison between these three ways for construction of the adaptation engine as summarised in table 1. The selection criteria are based on our main requirements to realization of adaptive engine (namely, it should be flexible and manageable) and its easy implementation. The goal of this comparison consists in selection of the most appropriated method among them. Based on the results obtained from table 1 and in accordance with our aims defined in the introduction, we choose to use symbolic rules for defining of adaptation mechanism.

3 AHS CONCEPTUAL MODEL

The AHS model described in details in (Vassileva D. & Bontchev B., 2006) follows a metadata-driven approach, explicitly separating narrative storyboard from the content and adaptation engine (AE). Fig. 1 represents the triangular structure of our model which refines the AHAM reference model (De Bra P., Houben G.-J. & Wu H., 1999) by dividing in three each one of the learner's (or, generally speaking – user's), domain, and adaptation models. At first level, the model is based on a precise separation between learner, content and adaptation model, while at second level each of these sub-model is divided into three others sub-models (Vassileva D. & Bontchev., B., 2006).

Fig. 1 represents the triangular structure of the model. Unlike other approaches, in the learner model we separate goals and preferences from shown knowledge and performance, as the first sub-model is static while the second one is rather dynamic and takes a part in the event-driven storyboard monitoring. The model of learning style (learner characters such as activist, pragmatist, theorist, or reflector) is detached as another learner sub-model and can be used for choosing contents for

given learning style. While the learning style can be determined in the very beginning of the learning explicitly by the learner or by appropriate pre-tests, other tests should be exercised during the e-learning process in order to assess prior or gained knowledge and performance results of each individual student.

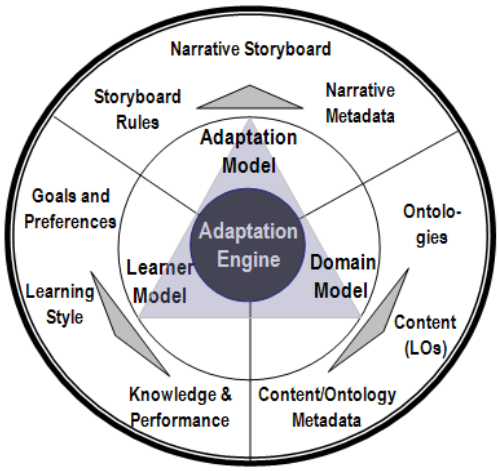

Figure 1: Structure of the triangular conceptual model.

The domain model is composed of content itself (granulized in learning objects (LOs) according to the SCORM standard) (López, M. et al., 2006), LO's metadata (LOM) and LO's content assets (images, text, tables, etc.) forming a logical taxonomy for the knowledge domain built upon domain ontology during the course composition process by the course author. The content LOs are placed by the instructor on course pages, while pages represent nodes within course storyboard graph. Content pages delivery is controlled by the adaptation engine (AE) for choosing most appropriate content for presenting it to the user with given learning model. Instead of choosing dynamically a page (i.e. node of the storyboard graph) with its content, we propose choice of best working path within the graph for specific learner with given learning style on one hand, and shown prior knowledge and performance on the other.

The adaptation model (AM) captures the semantics of the pedagogical strategy employed by a course and describes the selection logic and delivery of learning activities/concepts. AM includes a narrative storyboard sub-model supporting course story-board graphs, which may differ for different learning styles. It consists of control points (CP) and work paths (WP). Moreover, AM should provide a schema of storyboard rules used for controlling the e-learning process. Storyboard rules determine sequencing of the course pages upon inputs from learner sub-models. The narrative metadata sub-model sets such rules for passing a CP (e.g., as threshold level of assessment performance at that CP) or for returning back to the previous CP.

The core of our model is the adaptation engine (AE) which is responsible for generating the actual adaptation outcomes by manipulating link anchors or fragments of the pages' content before sending the adapted pages to a browser. The AE uses an event-driven mechanism for controlling the storyboard execution based on the storyboard rules applied to the inputs from the learner model. AE selects the best storyboard WP within the graph by evaluating weight coefficient of the pages within the WP for the given learner style (Vassileva, D., Bontchev, B. & Grigorov, S., 2008).

AE is responsible for performing all necessary adaptation mechanism for content delivery to a specific learner. This includes content selection, content hiding, link annotation, link hiding, etc. When learner starts a new course, adaptive engine finds the best path for him/her in the course graph. The best path is that one with the highest weighed score. For a particular user, the best path is calculated by a sum of multiplications between page parameters values and weights of their correspondent learner's characters.

4 FORMAL SPECIFICATION OF THE CONCEPTUAL MODEL

For description of formal model, there can be used Object Constraint Language (Richters, M. & Gogolla, M., 1998) like in the Munich Reference Model (Koch, N. & Wirsing, M., 2002), descriptive language for specification like in GAHM (Ohene-Djan, J. et al., 2003) or predicate logic like in the Dexter Hypertext Reference Model (Halasz, F. & Schwartz, M., 1994). In order to assure an easy construction of adaptation rules, we preferred to use predicate logic for formal model description.

Predicate logic is extension of propositional logic with separate symbols for predicates, subjects and quantifiers. Its formulas contain variables which can be quantified enabling clearer adaptive process understanding and more precise adaptive rules description. By means of predicates, we formalise the learner model (e.g., by a predicate we show the level of belonging of a user to given learning style), the domain model, the adaptation model and, finally, the adaptation engine. Once we have defined the predicates describing main functionalities of the

triangular model we can begin giving adaptive rules. They can be presented by defining relationships between the predicates. The adaptive rules can be divided into three main groups in accordance to their purpose:

- starting rules - describe learner knowledge and initial conditions for starting a new course, for example if the user knows all learning objects contained in a subject, then she/he knows that subject:

  (1) $\forall user_i \exists subject_j (\forall lo_k\ lo\_4\_subject(subject_j, lo_k) \wedge user\_knows\_learning\_object(user_i, lo_k)) \rightarrow user\_knows\_subject(user_i, subject_j)$

- pass-through graph rules – consist of rules for the graph crawling, e.g. if the learner does not pass the test at a control point, she/he continues backward:

  (2) $\exists k(user\_performance(user_i, subject_j, control\_point_k, fail)) \rightarrow next\_cp\_path(user_i, subject_j, control\_point_{k-1})$

- rules updating learner model – related to learner knowledge and performance, such as the following: if the learner passes all control point's tests for particular subject then the learner knows it:

  (3) $\forall k(user\_performance(user_i, subject_j, control\_point_k, pass)) \rightarrow user\_knows\_subject(user_i, subject_j)$

5 ADAPTATION ENGINE

In this chapter, there is presented in brief a proposal for construction of adaptation engine by means of symbolic rules. For realizing such a goal, the most suitable means to be used are a rule description language such as SWRL (Mei, J. & Boley, H., 2006) and its execution engine, or a rule execution platform such as Drools (Proctor, M. et al., 2008) and Jess (Hill, E. J. F., 2006). We have chosen to present our rules both through Drools and SWRL. Motives to select exactly them are that on the one hand, for Drools and SWRL, there are available very good and convenient graphical editors and tools for presentation, editing and reviewing rules such as Protégé for SWRL and RuleFlow for Drools. On the other hand, SWRL aims to be the standard rule language of the Semantic Web, which will allow interoperability between different rule engines. Also, Drools can reduce complexity of components that implement the business rules logic in Java applications, and it is easy to maintain or extend the business logic by declarative programming.

5.1 Drools Overview

The Drools is an open source rules engine Java implementation expressing business logic rules in a declarative way. The Drools architecture is based on three main components: production memory that stores the rules, working memory that stores the facts and the inference engine. The rules can be writing using a non-XML native language – Drools Rule Language (DRL), a XML native language as an alternative of DRL which allows capturing and managing rules as XML data and in a spreadsheet format (supported formats are Excel and CSV).

Drools development platform comes in two flavours: as an Eclipse plug-in Drools IDE and as Web application Drools BRMS. The Drools IDE provides developers with an environment to edit and test rules in various formats, and integrate it deeply with their applications from within Eclipse. The IDE has a textual/graphical rule editor, a RuleFlow graphical editor, a domain specific language editor. Other advantages of the Drools are:

- it separates your application from conditions which control the flow:
  - rules are stored in separate files
  - changing rules does not require to recompile or redeploy the application
  - putting all rules into one place makes it easier to control the application flow
- problems are not solved using a complicated algorithm, but via rules, which are easier to read and understand than code
- Drools is supported by an active community of Java developers

5.2 Drools Rules

The structure of a Drools' rule includes one or more attributes providing a declarative way to influence the behavior of the rule, one or more conditions (in *when* section), and a list of actions (in *then* section). For example, the rule (2) given within the previous chapter can be written as Drools' rule like this:

```
rule "Fail the test in control point on level k"
  when
    UserPerformance(user_i:user_id,
                    subject_j:subject_id,
                    control_point_k:control_point_id,
                    value=="fail")
  then
```

```
    eval(NextCpPath(user_i, subject_j,
                control_point_k-1));
    end;
```

where in the section *when* is described the left hand side of formulas (2) and in the section *then* is described right hand side of (2). Thereby, all the formulas formally defined by predicates should be converted to DRL rules. The resulted DRL rules are used by the inference engine together with the facts (e.g., data about both the learning model and the adaptation model).

5.3 SWRL Overview

SWRL is intended to be the rule language of the Semantic Web. SWRL is based on OWL and all rules are expressed in terms of OWL concepts. A SWRL file is an OWL ontology, whose axioms are extended with rule axioms. It thus extends the set of OWL axioms to include Horn-like rules and enables Horn-like rules to be combined with an OWL knowledge base. The SWRL rules can be described through Abstract Syntax, XML Concrete Syntax and RDF Concrete Syntax. SWRL allows users to write Hornlike rules expressed in terms of OWL concepts to reason about OWL individuals. The rules can be used to infer new knowledge from existing OWL knowledge bases.

The SWRL Specification does not impose restrictions on how reasoning should be performed with SWRL rules. Thus, investigators are free to use a variety of rule engines to reason with the SWRL rules stored in an OWL knowledge base.

5.4 SWRL Rules

In common with many other rule languages, SWRL rules are written as antecedent-consequent pairs. In SWRL terminology, the antecedent is referred to as the rule body (*rule_eml:_body* tag) and the consequent is referred to as the head (*ruleml:_head* tag). The head and body consist of a conjunction of one or more atoms. At present, SWRL does not support more complex logical combinations of atoms. SWRL also supports literals, built-in predicates, which greatly expand its expressive power. For example our rule (3) can be written in SWRL XML Concrete Syntax like that:

```
<ruleml:imp>
    <ruleml:_body>
            <swrlx:individualPropertyAtom
        swrlx:property="user_performance">
                <ruleml:var type="xsd:int">
                        user_i</ruleml:var>
            <ruleml:var type="xsd:int">
                        subject_j</ruleml:var>
            <ruleml:var type="xsd:int">
                        control_point_k</ruleml:var>
            <ruleml:var type="xsd:string">
                        result</ruleml:var>
        <owlx:Individual owlx:name="#pass"/>
      </swrlx:individualPropertyAtom>
    </ruleml:_body>
    <ruleml:_head>
      <swrlx:individualPropertyAtom
        swrlx:property="user_knows_subject">
            <ruleml:var type="xsd:int">
              user_i</ruleml:var>
            <ruleml:var type="xsd:int">
              subject_j</ruleml:var>
      </swrlx:individualPropertyAtom>
    </ruleml:_head>
</ruleml:imp>
```

5.5 Comparison between Drools and Jess Rule Engines

Now, we will do a comparison between the two rules engines selected above (Drools and Jess) for construction of our adaptive engine. For the purpose of comparison we define several criteria (table 2). In the table, they are described rule engines properties for each defined criterion. As we see, Drools outweighs Jess especially because of availability of very good means for rule creating and editing and of its maturity and open solution.

Table 2: Comparison between Drools and Jess.

Criteria \ Rule engine	Drools	Jess
Interoperability	no	no
Rules tools	yes (special IDE, Rule-Flow)	no
JSR94 support	yes	yes
Maturity level	++++	++
Availability	open source	commercial with academic license
Mode of working	run from JVM	shell or batch, plugin in Protégé
Classes and instances	Java objects	CLIPS file

6 CONCLUSIONS

Future years will prove the potential and great promise of adaptive hypermedia proposals being nowadays under discussion. The present paper

introduced a new conceptual approach for self adaptive hypermedia applications using triangular conceptual model. The proposed model offers many advantages but the main one consists in assuring strong independence of any of the building models and, at the same time, in facilitating a flexible adaptation of content delivery. The adaptation makes use of adaptive presentation, navigation support and content selection; it is not locked to any given learner model. In order to be able to describe polymorphic learner profiles, we use concepts of given domain such as characteristics of the learning style, psychology characters, etc.

The adaptive process for e-learning content delivery was formalized through usage of predicates and relationships between them. On the base of such predicates, there were built formal rules controlling the adaptation process and executed by the adaptation engine. For describing the rules, two approaches have been considered – Drools Rule Language and SWRL. Both the approaches are supported by rule engines which executes rules described in correspondent language. Thanks to the fact they both support rules defined by first order logic predicates, we conclude they are suitable for constructing an adaptation engine supporting the conceptual model. Based on this comparison showing the weaknesses and advantages of the rule engines, we may choose Drools for the ongoing implementation of the adaptation engine. The choice of Drools is strongly influenced by the facts it provides advanced rule management tools, detailed documentation, and open source license. The adaptation engine is going to be integrated and tested within a adaptive e-learning platform providing an authoring tool for construction of learning courseware and an instructor tool (Vassileva, D., Bontchev, B. & Grigorov, S., 2008) for structuring the narrative storyboards and planning the instructional design.

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SEMANTIC ANNOTATIONS AND RETRIEVAL OF PHARMACOBOTANICAL DATA

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Abstract: Images repositories would become a costly and meaningless data pool without descriptive metadata. This paper addresses the problem capturing knowledge necessary to register and retrieve pharmacobatonical data using semantic descriptions. We propose a Semantic Web-based Learning Management System based on Web services to provide a semantic reasoning layer between students' queries and stored data, our approach enables students to handle shared data and get semantically rich results through the use of web-enabled semantic database queries.

1 INTRODUCTION

In recent years, there has been awareness about environmental issues and the use natural healthier products. Scientists and governments need informatics to support their efforts in shaping public policies and managing natural resources. The use of natural products derived from medicinal plants is increasing and needs more pharmacobotanical investigations. They demand integration of vast amounts of information from different sources, ranging from environmental observation to chemical and anatomical analysis. Therefore, the study of medicinal plants and its natural products also needs to handle semantic data heterogeneity (Sheth, 1999).

Pharmacobotany involves morphological, anatomical and chemical studies and they are dependent on complete and accurate documentation of experiment processes. Before computerization of scientific equipments, paper notebooks were the primary scientific record. But, with the advent of mobile computing, satellite images and environmental sensors the complexity of this kind of investigations scaled and the overall numbers of experiments performed have increased, stretching traditional manual annotation methods to beyond their limits. As these trends continue, and as experiments and research teams themselves become more distributed and cross-disciplinary, the whole research process must become self-documenting. Richer, more detailed, more searchable annotations are required. Thus, metadata generated by distinct tools used within an environmental project will have to be integrated to provide a complete picture of the scientific research being performed.

The semantic aspects of information integration of data are drawing attention from research community, and ontologies are a valuable artefact for databases integration (Gruber et al., 1993). They capture the semantics of information and can be used to retrieve, annotate or store the related metadata. Although multiple engineering artefacts exist in the domain of Biology, do not exist to the extent as, for instance, in teaching pharmacobotany (Keet, 2005).

At this time, plants images, maps, textual and multimedia files are essential part of the pharmacobotanical scientific records. The significance of images for identifying (plants, drugs and anatomic details) cannot be underestimated.

Images are semantic instruments for capturing aspects of the real world, and form a vital part of the botanical record for which words are no substitute. Yet, an appropriate set of images can even be used to help to identify new natural products originated from medicinal plants which can be further used to either develop new formulations, reducing the dependence from pharmaceutical laboratories or healing the so called tropical neglected diseases (Hotez, 2008).

In this paper, we took advantage of lessons learned from developing ontologies in other biology fields, most notably in Molecular Biology. To introduce some amount of intelligence and adaptively in this field of knowledge, we developed a Semantic Web-based Learning Management System (SWLMS) to enhance teaching and learning activities. We present a SWLMS named SIM that provides a user-friendly semantic reasoning layer between the users and the data. It enables: teaching, learning, collaborating with colleagues and executing other educational activities by managing such metadata. Section 2 describes the importance of Pharmacobotany. Section 3 describes the semantic approach used on the architecture. In Section 4 discusses the main characteristics of extending Plant Ontology. Section 5 we describe a web-based architecture used by Biology and Pharmacy undergraduate and graduate students at Federal University of Rio de Janeiro. Section 6 concludes the work.

2 TEACHING PHARMACOBOTANY

Pharmacobotany is one of very comprehensive and complex field of human activity; it shows direct relation with the natural living world, especially within the plants of a given ecosystem. It strives not only to learn about and to utilize the diversity of the plants as widely as possible, but it also has an interest in its preservation (Opletal, 1994).

Teaching pharmacobotany in academic pharmacy institutions has been given new relevance, as a result of the explosive growth in the use of herbal remedies in modern pharmacy practice. In turn, pharmacobotany research areas are continuing to expand, and now include aspects of cell and molecular biology in relation to natural products, ethnobotany and phytotherapy, in addition to the more traditional analytical method development, phytochemistry and morphological and anatomical systematization of medicinal plants.

Unfortunately, some of these fields of knowledge still apply traditional teaching practices that consist mostly of face-to-face lectures given by teachers; use of scientific equipments and chemicals and, little use of educational systems. Besides, researchers have to use lots of images and make lots of manual unstructured annotations about location and shape of botanical material in environment. After that, preparing samples, slicing it and taking another set of images of the different parts of plant´s anatomy. Thus, experiments execution is costly in terms of time and materials; its results, images and annotations are hardly ever shared.

To overcome these lacks, a SWLMS seems to be a feasible way to engage researchers to seek new natural products; to enhance interaction process between learners and teachers, and to foster collaboration in scientific community (Weitl et al., 2002). A pharmacobotanical SWLMS can: (i) aid teachers to plan, deliver, and manage learning events; (ii) offer better conditions for composing and reusing learning materials for different purposes; (iii) enhance student's online collaboration and sharing annotations at lower costs.

To face the challenges of teaching such traditional discipline, we propose a architecture based on Semantic Web services (Berners-Lee, 2001) (Hyvonen et al., 2003) that provides a semantic reasoning layer between users and stored data, improving Web-based education, and providing more independence, and intelligence from traditional classes.

3 LEARNING MANAGEMENT SYSTEMS AND PHARMACOBOTANICAL ANNOTATIONS

Learning Management Systems (LMS) have become a broadly accepted approach to e-Learning in universities to give support for virtual activities in the teaching and learning processes (Devedžić, 2003). Even so, the pharmacobotanical educational characteristics (as described in Section 2) are not yet satisfied. There is little interoperability between LMS; they failed to handle unstructured and widespread heterogeneous data. Managing annotations for botanical images has been of vital

importance because the value of images depends on how easily they can be located, searched for relevance, and retrieved. Images are usually not self-describing.

The problem of searching large image repositories according to their content, has been the subject of a significant amount of research in the last decade (Carneiro et al, 2007), some approaches are commonly used to retrieve and annotate biological images, such as: keywords, controlled vocabularies, classifications and free text descriptions. Unfortunately, they present open issues, such as the absence to provide relations between the terms and inheritance, which provides a controlled means to widen or constrain a query against the repository, they are often fraught with errors due to factors such as annotator familiarity with the domain, amount of training, personal motivation and complex schemas. Thus, in order to avoid these issues, we decide to use the ontological approach, we propose a simple ontological model of the concepts involved in Botany.

4 EXTENDING PLANT ONTOLOGY

As far as we are concerned, there are no ontologies that describe pharmacobotanical data. Thus, in order to fulfil this gap and to support knowledge sharing and reuse without losing interoperability, we have extended Plant Ontology (PO).

PO is an ontology adopted on Plant Biology scientific communities, it has been developed and maintained with the goal to facilitate and accommodate functional (genome and proteome) annotation efforts in plant databases (Avraham et al, 2008). PO is not an extensive collection of botanical terms, but rather a complex hierarchical structure in which botanical concepts are described by their meaning and by relationship to each other. The main purpose of these concepts is to facilitate cross database querying and to foster consistent use of these vocabularies in the annotation of tissue and/or growth stage specific expression of genes, proteins and phenotypes. Educational aspect of the plant ontology is to some extent limited; this is imposed by the structure of the ontology itself and the limitations of the current software. Thus, in order to enrich the PO ontology concepts and augment queries capabilities on a SWLMS, we have extended Plant Ontology to encompass Linnaeus taxonomy (Animal Diversity, 2008), (Legendre, Legendre, 1998). We add common pharmacobotanical concepts describing morphological and anatomical structures, ethobotnical and phytotherapical features exclusive to medicinal plants. Besides, the unambiguous classification of species represent the foundation of scientific any Botanical research. It is especially significant with respect to helping scientists to understand the evolutionary process; it identifies the fundamental divisions of life and its progression from the simple to the complex structures.

To expand PO we applied Kauppinen et al. approach (2008) where association rule mining techniques were applied to find and rank interesting relationships based on existing pharmacobotanical annotations, taxonomy and PO ontology. Briefly, to find the concepts that occur often in annotations, we therefore apply a method that consists of three phases. First one creates the candidate relationships. On the second phase we prune out all those association rules that already exist in PO ontology. On the third phase, a transitive closure is inferred for the ontology. Hence, these phases ensure that concepts which already have a close relationship in ontology will not get associated again. PO extended ontology was implemented as OWL file into Protégé-2000 and represented as a RDF Schema.

5 SEMANTIC IMAGE MANAGEMENT ARCHITECTURE

The major goal of SIM is to support pharmacobotany teaching. In this scope, ontologies can be associated with reasoning mechanisms and rules to enforce it. SIM was designed with some educational goals in mind: preserve and share knowledge about medicinal plants; support students and teachers in managing research activities in teaching and learning experimental pharmacobotany; enable the adaptation to individual learner characteristics, since no two students have the same learning pre-requisites, skills, aptitudes or motivations.

Plants images were created as part of pharmacobotanical ongoing research and teaching efforts by Ana Vieira and her team, who have also provided us with user requirements, for instance: browse images by species name, anatomical details, or PO concept, preferably with images presented as

thumbnails; search for all images of a given medicinal plant or taken at a given research site; browse images from a particular natural product. Each image is described by a domain-specific metadata.

5.1 SIM Goals

SIM is one of the first of what might be called pharmacobotanical SWLMS. It combines the ideas behind the Semantic Web and Web Services. SIM is a Java open-source web enabled architecture, it is a distributed architecture based on a set of semantic Web services (Wroe et al., 2003) which aids teachers and students to store/share educational materials like: biological images and pharmacobotanical annotations. SIM allow users to retrieve images metadata and annotation through semantic queries; browse the ontology to restore semantically related images; recover images according ontology's concepts that describe plant´s anatomical details or characteristics from its geographical localization. All images and plant specimen are georeferenciated (they were associated with longitude and latitude coordinates), since researchers and students can further return to the site to make complimentary investigations, to take new images or to collect new specimens. Optionally, coordinates can be used to recover satellites images provided by a third party service provider, like GoogleEarth (2008) and TerraServer (2008) at very low costs. Such approach provides researchers users with a comprehensive aerial view of an environment. Satellite and aerial images can be used to manage lands and map environments. It also can be used to monitor or analyze areas that would be prone to having damaged during forest fires or floods. This imagery is a unique opportunity to expand a student's understanding of the environment around the medicinal plants.

5.2 SIM Architecture

In this section we introduce the SIM Conceptual Architecture that has been designed to enable semantics-driven Web Service applications. Figure 1 depicts the overall SIM conceptual architecture.

The architecture we distinguish three main layers: (i) *SIMWeb*, it allows querying and browsing semantics-based Web services. It's also used by teachers for administrating and managing the overall system and students to retrieve data using built-in SPARQL queries; (ii) *SIMComponents*, provides the required functionality for realizing Semantic Web enabled Web services. This layer comprises Tomcat-Apache Server which acts as the Web services Server; (iii) *SIMStorage* and external components allow data's persistence, mainly relying on the use of the ontology.

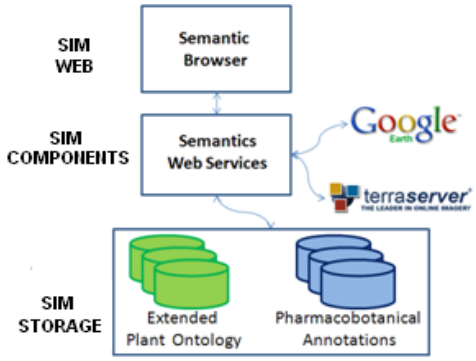

Figure 1: SIM Architecture.

SIM architecture not only stores the images and its annotations, it also registers the geographic coordinates (latitude, longitude) of the moment of which the plant was collect, abundance, habitat, flowering and fruiting periods and collector's data. So, students are able to retrieve, at a single search all available medicinal plants description, its geographical position and also GoogleEarth/TerraServer satellites point of view. They can investigate detailed anatomical images and annotation made at the laboratory, such approach augments correlation between environmental and microscopical observation of the drugs and plant anatomy (figure 2).

Figure 2: Overview of interaction between SIM and GoogleEarth.

Figure 3 shows a screenshot of the annotation query interface. SIM semantic browsing has an interesting feature; it assists users in filtering information by selecting or combining categories, for instance, if a student queries images and annotations about given medicinal plant or pollinator

agent, an annotation tree (presented as directed acyclic graphic) is automatically built, showing all annotations about the plant.

One major advantage of SWLMS over a traditional system is related with the ability to perform concept-based searches. This type of interaction enables students to query and manipulate information in an intuitive manner without having to construct logically sophisticated queries, which requires specialised knowledge about query languages and the underlying data model. Besides, SIM Architecture allows students to search for specific concepts; for example, a search for "active principia" or "drug" will give same result even though these are two different lexicalizations of the same concept.

Figure 3: Annotation query interface.

6 CONCLUSIONS AND FUTURE WORK

This paper gives some indication on how a semantic data retrieval tool might work. Semantic annotation allows researchers and students to make use of concept search instead of keyword search. It paves also the way for more advanced search strategies.

Building ontology's for large domains, such as Botany is a costly affair. Thus, we took advantage of experience in modelling practices on other domains and extended Plant Ontology to encompass pharmacobotanical annotations. SIM Architecture uses such extension, allowing students do make and share annotations and retrieve semantically related images from medicinal plants.

The contributions of this paper are threefold: (i) it helps students to reduce the number of scientific experiments and consequently the manipulation and waste of hazardous and expensive chemicals once they can collaborate by sharing and retrieve knowledge about plants data, images or annotations about experiments previously realized; (ii) it aids teachers to plan, deliver, and manage learning events that occurs outside traditional classroom, they were also allowed them to manage students, keeping track of their progress and performance across all types of training activities; and (iii) it shows the feasibility of building a Semantic Web accessible image repository, SIM demonstrates that although existing Semantic Web browsers do provide more flexible user interfaces, they still have limitations in supporting a real-world scientific usage. Some of the missing functionalities are likely to be required in different application contexts, such as supporting combinations of ontological concepts; while others are required by the challenges of presenting image data and its metadata collected in a collaborative way by different users.

In a near future we are going to start both qualitative and quantitative analysis to evaluate SIM. But, at this time we have observed improvement in the student's satisfaction such as through the use the architecture we noticed an increasing ability to integrate and share diverse sources of data. Finally, we also noticed that students were able to perform complex queries over the annotations.

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e-LANGUAGE, e-CULTURE, e-LITERATURE WITHIN A VIRTUAL LEARNING CONTEXT *Secondlife.Com*

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Keywords: Web-based learning, Virtual instruction, Web 2.0 (strategies and tools), Language, Literature, Culture.

Abstract: Already having an impact on language instruction, the lack of space offered to the implementation of new technologies and the Web 2.0 within the humanities is particularly absent in the culture and literature teaching fields. This absence has originated the proposal we introduce here. Along our discussion we seek to demonstrate the projection and validity of the execution of these tools and its advantages for our potential consumers, college humanities professionals, whom in general are not very familiar with the usage of ICTs in the classroom. By offering students the opportunity to surface and network with some of the Web 2.0 tools on Second Life.com, a Web-based space, they will face the acquisition of language, culture and literature through a challenging and dynamic approach, which represents a novel and motivating way of learning. Used as an educational tool, Second Life serves as a context where users can meet, communicate and learn from speakers of other languages and cultures in a synchronous way by transforming themselves into cyber-characters, the so called avatars. Thus, residing and actively participating in Second life can be for virtual students, more fruitful than learning through traditional instruction, since cyber-students interact without time or space limits, breaking conventional classroom barriers. As a consequence, the Web 2.0 offers the potential of a wide range of resources for variable kinds of innovative teaching/learning purposes which will contribute to enhance teaching within this discipline.

1 A FEW REASONS TO INCLUDE TICS IN LITERATURE AND CULTURE TEACHING

Several reasons to illustrate the contribution of the implementation of new technologies to the humanities area, more specifically to the literature and culture teaching will be discussed ahead. Worldwide, technology is transforming the world of art. Artists make efforts to employ it as craft for their masterpieces understanding this unusual combination as a vehicle to integrate science and humanities, positioning themselves at the forefront of innovation. Under this premise, we will come up with several questions; may technology also revolt the world of humanities teaching as it is now transforming the world of arts? Can traditional culture, literature and language teaching be enhanced by using conventionally opposed concepts such as science and arts? How would this revolution take place in traditional scholarly? The answer to these enquiries is positive, if we consider emerging in a virtual world based on the Web 2.0 as an expansion of the traditional teaching/learning methodology.

Language teaching has emerged in Second Life and teachers and educators are taking an innovative approach by combining Second Life with voice messengers such as Skype and other online teaching tools. Among other possibilities, Second Life offers its residents both an internal voice and written chat as a way of communication. The synchronous nature of chat or Skype provides users with "spontaneous responses promoting active culture learning" as Mike Levy states (2007). For instance, through

chatting on line the technique known as role-play, which makes students imagine an agreed situation and act it out, extends far beyond traditional limits and takes on dimensions simulating reality and fantasy in this virtual world, "when the deepest identity change is possible with a single mouse click, the opportunities to play are endless" (Au, 2008, p. 79). In other words, a role is played starting with the learners´ design of his/her avatar's tailored outer shell to act and react to multiple forms of situational contexts with other cyber-characters.

By means of written or spoken chat or even E-mail, Cyber-students or avatars can interact at any time, anywhere and with anyone they come across, so conventional classroom scheduled obstacles like limited time, restricted space, monolingual together with monoculture constraints and authentic identity fade into the setting. For these reasons, a cyber-world hosts the potential of opening up a wide range of development for variable kinds of e-learning exercises in a faster and wide-ranging manner.

2 SECOND LIFE AND WEB 2.0: A CHALLENGE TO IMPLEMENT ICTS WITHIN THE HUMANITIES

Worldwide, ICTs are starting to be seen as a powerful tool for language training. However, the perception of new technologies as a positive strategy for the culture and literature teaching has not been deeply considered in higher education yet. In our proposal, we aim to reveal the projection and validity of the implementation of this tool and its various resources for our potential consumers, college humanities professionals, whom in general are not very familiar with the use of ICTs in the classroom. By registering in this course, students will face the acquisition of language, culture and literature through this challenging method which will embody a ground-breaking approach for specific learning purposes.

Our proposal is consequently centered on the analysis of user-learner capacity to engage and interact in the acquisition of foreign languages, culture and literature. We believe total immersion in the learning scenario of virtual worlds and Web 2.0 tools offer exposure to elements of interaction, providing the means to create motivating environments (Figure 1) for students to learn. (Strevens, 2008).

Figure 1: Motivating environments for students.

Inspired by Neal Stephenson's novel *Snow Crash,* Second Life is a virtual world created in 2003 by Linden Lab. In this parallel cyber-world people can communicate and culturally interchange by turning themselves into virtual characters, or avatars. In the same way, a novel approach motivated computer engineers to create this analogous world, now we intend to inspire people within the humanities to approach literature, culture and language from a more lively and pleasant perspective. This constructivist point of view consists on exploiting emerging technological concepts, strategies and tools (wikis, blogs, videos, video blogs, podcasts, networking, directories, tags, etc.) related to the Web 2.0 through Second Life.

2.1 Some Advantages of using Web 2.0 Tools for Culture and Literature Teaching as Target

The complete role-play practice is based on several factors most of which are learner rather than teacher oriented (Edwards et al, 2008). In this sense, a great amount of attention is placed on the learner and the teacher acts merely as a guide:

A) there is certain personal investment and identification on the part of the learner involved in creating an avatar and in carrying out his/her actions. The avatar can ideally become an alter ego of the student and experience the advantage of learning in a 3D scenario.

B) role-play and social interaction are not limited to actual lesson time, but rather, can be lengthened over time (Figure 2). In this sense, Second Life is a creative and enjoyable environment which opens up the traditional classroom walls dynamically. This interaction

can be positively enhanced through the use of forums, wikis, blogs and other tools related to Web 2.0.

Figure 2: avatar performance and role-playing.

C) avatar performance is directed by the learner who encounters and creates interaction in simulated settings. Statism of regular classroom where students only interact with classmates becomes more dynamic since users are now offered real distant contact to increase their language practice and enrich their specific cultural and literary knowledge.

D) avatar actions become gradually multifaceted as she/he accumulates a past, lives out its present, and makes future plans.

E) both the avatars' physical and psychological features can vary, be true to life, or materialize into “want to be” aspirations. In other words, something like if our humanity students could step outside their body and experience life from a remote point of view.

F) Edwards et al (2008) argue that the identity of the real life learner is fundamentally wrapped in a protective simmer behind the concealing shield of his/her avatar, which may be a particularly eye-catching characteristic to motivate students to take learning risks. A similar shield found in writing or reading can be overcome by providing more freedom and interest in learning, when transforming into a virtual identity.

3 A COURSE PROPOSAL FOR LANGUAGE, CULTURE AND LITERATURE e-LEARNING

3.1 General Objectives

In general terms, the usage of these new tools (blogs, wikis, podcasts, videos), supposes promising possibilities in several humanities areas for new generation of students in a coming future. Major differences can be noted between traditional methodologies and the resources of the World Wide Web, for example, computers and its capabilities for searching information immediately allows Internet to be conceived as a global virtual encyclopedia. The net offers something radically different to traditional sources of knowledge, given that it facilitates students to quickly deepen into contents in opposition to conventional slow searching in library catalogs and indexes. Using Internet and Second Life from a methodological approach is challenging since it will open up the classroom walls and boundaries engaging students with new experiences such as immediate and active language and cultural interaction, literature discussion etc.

Keeping in mind the aim of the study, the feasibility of using the potential of the Web 2.0 for literature, culture and second language learning will be developed under the general hypotheses of how much motivation, engagement and learning could lay beyond the walls of the traditional classroom space (Figure 3).

Figure 3: learning literature within a fast and inspiring context.

Using the topic of travel literature as a pretext for teaching our proposal is built as follows:

- Introducing collaborative language / literature teaching and learning (Web 2.0);
- Developing a new medium of foreign language and culture transmission; and understanding of ICTs and its application
- Introducing the topics of emigration and identity in literature within the general topic of Travel Literature.

3.2 Specific Objectives

- Giving educators the opportunity to research on the roles of management platforms and virtual environments in literature, culture and foreign language learning and teaching.
- Offering educators the opportunity to plan strategies in order to apply the methodology learned along this course with their future potential students, especially younger learners of foreign languages because they already see the Internet as a natural place to learn and play (Gibson, Aldrich, and Prensky 2007).
- Introducing migration and identity through the presentation of different virtual worlds and environments within the context of travel literature.
- Promoting interactive and collaborative tasks as a means of acquiring linguistic and cultural knowledge and developing communicative competence.

4 COURSE PROPOSAL: INTEGRATING LANGUAGE, CULTURE, LITERATURE AND ICT WITHIN THE HUMANITIES CLASSROOM

Language teaching in virtual worlds is still at an early phase of development, yet it is necessary to generate research proving the advantages of the Web for culture and literature training. Under this emerging need, this project is aimed at being a starting point conceived to be directed to teachers/educators/ researchers of language, literature and culture. The overall course will be divided into ten sessions (forty-five minute each), along which a certain amount of time will be devoted to train users not familiar with certain technological concepts to design and implement a collaborative and interactive course in the Moodle platform which will help them to enhance their knowledge acquisition in creative ways.

After briefly stating the advantages of using Moodle and other Web 2.0 tools, this article will focus on the distribution of content and methodological tools in the following charts (Figure 4).

SESSION	Language / Culture and literature objectives	SL/WEB 2.0 Instructions	Web 2.0 methodology and tools
SESSION 1	Introducing participants into the course and travel literature (migration and identity)	Logging in Second Life virtual world First contact with Web 2.0 tools (wikis, blogs, video, chat, Skype)	Web 2.0 (reading online, blog posting, forum, tagging, videoconferencing etc.) as a global communicative language Collaborative learning Real distant interaction Social constructivism
SESSION 2 Sub session 2a	Presenting the literary context of travel literature Introducing the books and authors that will serve as samples	Knowing, analysing the capabilities of Web 2.0 and the Moodle platform SL instruction and potentials	Collaborative learning; constructivism; interaction. Tools: videoconference; hypermedia; Second Life, Moodle platform.

Figure 4: Table of content and methodological tools.

Sub session 2b	Introducing the topic of emigration to the USA Presenting videos made by students at the end of the previous session	Analysing SL as a teaching and collaborative environment SL instruction and potentials	Collaborative learning Interaction; Tools: Web 2.0 video; blogs, hypermedia; hypertext; Second Life. Communicating and interacting online (forum, wiki, etc.)
SESSION 3 Sub session 3a	Introducing multiculturalism, identity, discrimination, etc. through the presentation of different virtual worlds and environments	Analysing SL as a teaching and collaborative environment Developing knowledge through hypermedia	Collaborative learning; constructivism; interaction; developing knowledge through hypermedia Tools: voice; chat; hypermedia; Second Life Reading online; chat; video; oral debate; slide presentation
Sub session 3b	Analysing multiculturalism, identity, discrimination, etc. through the presentation of different interactive applications	Developing knowledge through hypermedia	Interaction; collaborative learning; constructivism. Tools: video; hypertext; Second Life; social networks, Facebook Communicating and interacting online; sharing files; video presentation
SESSION 4 Sub session 4a	Analysing literature excerpts/stories Exploring the potentialities of SL as a teaching and learning environment	Exploring the potentialities of SL as a teaching environment Second Life potentials: voice tool. Web 2.0: social networks; video sharing; online communication Moodle: quizzes	Introducing and teaching Moodle multiple-choice quizzes (use of quizzes for micro—skills acquisition) Collaborative learning; constructivism; interaction; developing knowledge through hypermedia Tools: voice; hypermedia; Second Life; Moodle
Sub session 4b	Cultural and historical background on emigration to the USA	Methodological exploitation and use of the tool in SL Web 2.0 potentials: webpage; hypermedia	Collaborative writing /critical thinking Interaction; collaborative learning; constructivism Tools: images; hypertext; Second Life; wiki; blog Communicating and interacting online; oral debate; uploading images

Figure 4: Table of content and methodological tools (cont.).

SESSION 5	Analysing literary excerpts dealing with emigration and identity	SL instruction and potentials of Web 2.0: use of COVCELL whiteboard; social networks; video sharing; online communication	COVCELL whiteboard Collaborative learning; constructivism; interaction. Tools: voice; hypermedia; Second Life; Moodle Reading; chat; oral debate; forum
SESSION 6	Giving a lecture in SL: Literary excerpts dealing with emigration, identity, discrimination and cultural differences	Second Life potentials: oral presentation Web 2.0: video sharing; online communication Moodle: creation of content	Collaborative learning; constructivism; interaction Tools: voice; video; hypermedia; Second Life; Moodle Reading; chat; oral debate; videoconference; PowerPoint presentation
SESSION 7	Literary excerpts dealing with cultural differences	Exploring SL virtual world SL instruction and potentials	Introducing Webquests; Interacting in the Moodle platform Constructivism
SESSION 8	Discussing multiculturalism and multicultural aspects of language learning	Exploring SL virtual world Teaching/Learning how to make a blog	Blogging Social networking/communication Collaborative learning; constructivism; interaction Tools: voice; hypermedia; Second Life; Moodle; Webquest Reading; chat; oral debate; videoconference; PowerPoint presentation
SESSION 9	Discussing multiculturalism and multicultural aspects of language learning Coming in contact with historical and cultural concepts	Exploring SL virtual world Planning a closing meeting in SL	Collaborative learning; constructivism; interaction Tools: voice; hypermedia; Second Life; Moodle; social networking/communication Reading; chat; oral debate; blog
SESSION 10	Evaluate and reflect on what participants have learned to extend discussions, to conclude projects and to look at what the future holds	Developing an interactive and collaborative course in the Moodle platform; Second Life potentials: oral and content presentation; social interaction; role playing Web 2.0 potentialities and tools	Collaborative learning; constructivism; interaction Tools: voice; hypermedia; Second Life; Moodle; social networking/communication; social networks Reading; chat; oral debate; blog; wiki; Webquest; videoconference

Figure 4: Table of content and methodological tools (cont.).

5 CONCLUSIONS

The intention of our proposal based on performing and developing innovative expansions of the Web 2.0 capabilities through Second Life, is to introduce new teaching approaches, which place a high value on participant's creativity, participation, sharing, and cooperation when learning (Figure 5).

Figure 5: Interaction and collaborative work in SL.

Our project helps users to discover e-language, e-literature and e-culture by adopting collaborative and interactive Web 2.0 tools. Despite the fact that in the traditional classroom, the role of a teacher is of an information deliverer and that of students is a passive receiver, in Second Life both teachers and students can co-tailor a learning atmosphere, being an option to conventional classes when compulsory circumstances are met. Even though in many universities and other higher learning institutions, the development of web-based projects is often the consequence of casual acts of improvement initiated by risk-taking individual researchers, as a variety of adaptable, e-learning formats, programs and sites become available, both teachers and students will become fascinated in making the most of the potentials of www.secondlife.com.

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EDUCATION WITH "LIVING ARTWORKS" IN MUSEUMS

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Keywords: Museums, Conversetional Agents.

Abstract: Museums need to find innovative ways of communicating if these institutions want to survive in the new era and want to play their active role of educators. In this paper, we will present our idea of *living artworks*. Using *conversational agents* we want to give artworks the capability of talking to visitors. A *living artwork* attracts attention, being a funny and novel combination of art and technology. The mix of experience and action has a beneficial effect in learning new concepts or facts. We will then present our methodology for building *living artworks*, the enabling technologies, and a case study.

1 INTRODUCTION

There is a growing interest in using museums as places where to informally deliver educational contents (Severino, 2007). Artworks are not simply "artists' messages to audience" but also tools to create links between cultural contents and audience. Yet, to positively play the role of informal educators, museums have to deliver content in a novel way. According to the analysis reported in (De Biase, 2008), many visitors, around 33%, forget the names of artists and the artworks they saw into museum, 50% of the visitors remember not much about artworks, and 32% of them mixed subjects up with others never seen. These are clear indicators that somehow traditional museums are not well suited to play this important role of informal educators.

To win against different media and forms of entertainment, museums are seeking innovative ways to deliver their contents to the public. In their battle for surviving, these institutions are opening to novel technologies. There are active communities looking and monitoring new trends in technologies. The MuseTech Central[1] is a place to share information about technology-related museum projects such as social tagging for artworks (Trant and Wyman, 2006). The awareness of the role of informal educators and the technology fertile ground make museums wonderful places where to experiment with novel and informal ways of communicating educational content. This will be beneficial both for museums and for audiences.

Our idea is to create *living artworks*. We want to give to artworks the capability of talking, in order to have a "dialogue" with visitors. We will use *conversational agents*. In a nutshell, conversational agents are software systems that can have conversations with users. These software systems come from the tradition of Artificial Intelligence (AI). Building systems able to replicate the human ability to communicate is one of AI's main goals, see for example the Turing Test (Turing, 1950). Conversational agents have been already used for educational purposes and we believe that artworks that can tell their own history will attract people.

In this paper, we will present this idea of *living artworks*. We shortly review the related work, i.e., the use of conversational agents as tutoring systems (Sec. 2). We will then present enabling technologies and our methodology for building *living artworks* (Sec. 3). We finally describe the application of our methodology (Sec. 4).

2 CONVERSATIONAL AGENTS IN EDUCATION

Education is showing a growing interest towards new technologies and new media as innovative means to

[1] http://www.musetechcentral.org/

support learning. Multimedia technologies mix language and images that are the basic blocks in the process of thinking and learning. These technologies build new suitable communication channels for teachers that want to exchange educational messages with their students. Yet, technology will not substitute but broaden pedagogical strategies available for teachers (Dede, 1992).

Artificial Intelligence (AI) has been often seen as an interesting way to support traditional and distance learning. AI systems can make distance learning more attractive (Moore and Kearsley, 2005). People, in general, and children, in particular, are increasingly more acquainted with contents delivered with new technologies. Children play with videogames and chat over the Internet with astonishing ease. Using new technological channels can attract students stimulating their curiosity. A simple way to introduce new technologies is to use software embodied agents, i.e., virtual puppets on a screen, as storyteller. In (Damiano et al., 2006), these agents have been used to guide children inside a museum. A more attractive way is to use interactive agents called *Conversational Agents*. These are able to establish interactive communication with users using natural language. Conversational agents have been used for language education in (Jia and Ruan, 2008) or for teaching physical and procedural tasks using a virtual reality environment in (Rickel and Johnson, 1998). Some recent works in Human-Computer Interaction field (HCI) (Core et al., 2006) explored the use of virtual agents for educational and training. In this environment, users train their skills interacting with virtual agents like in a videogame.

3 REVITALIZING MUSEUMS WITH "LIVING ARTWORKS"

Museums need to find innovative ways of communicating if these institutions want to survive to the new era and want to play their active role of educators. We believe that our idea of *living artworks*, i.e., an artwork extended with the capability of talking about itself, can help in this difficult challenge. The integration of different cultural experiences adds value to knowledge accumulation process (Severino, 2005).

We firstly define a *living artwork* and analyze the beneficial effects for museums (Sec. 3.1). We then present the enabling technology, i.e. the stimulus-response conversational agents, (Sec. 3.2) and the procedure to use it (Sec. 3.3).

3.1 "Living artworks" as Educational Tools in Museums

A *living artwork* is a combination of an artwork and a conversational agent. We want to extend the positive experience of storytelling in museums (Damiano et al., 2006) integrating principles and technologies of conversational agents used for educational purposes (Core et al., 2006). The agent should involve visitors in conversations about the artwork.

A *living artwork* wants to attract attention, being a funny and novel combination of art and technology. At the same time, it wants to generate new knowledge. It acts as instrument of cultural communication and as tool of cultural production. A *living artwork* allows a bidirectional communication helping the shift from passive spectator to active spectator. The combination of experience with action has a beneficial effect in learning new concepts or facts.

Given an *artwork*, we can build the related *living artwork* if:

- we have a conversational agent platform with a simple language for describing the knowledge needed for the dialogue
- we completely define the knowledge base to have conversations about the *artwork*

In the next sections, we firstly introduce the conversational agent platform we use (Sec. 3.2) and secondly we define a methodology to build the knowledge base (Sec. 3.3).

3.2 Conversational Agent Technology

A Conversational Agent (CA) is a software technology that uses the natural language utterances to interact with users. Conversational agents can "have a conversation with a user". Among all the possible CA technologies, we selected the simplest, i.e., those following the Behavioral psychological theory (Watson, 1928). According to this theory, human mind can be studied only relating received *stimulus* and emitted *responses*. The human behaviors can be described by the following function:

$$R = f(S) \tag{1}$$

When an individual is exposed to *stimuli* his response is a function of these stimuli.

The behaviorism has inspired one of the first emulative conversational agents. In 1966 Weizenbaum build a software program called Eliza (Weizenbaum, 1966). This artificial agent simulated the Rogersian psychologist behavior. The interactions was grounded on the agent ability to hold control about dialogue,

using as first interaction (stimulus) a question for the user, which will response based on stimulus and his environment. After this, the interest on conversational agent field grew up, drawing the attention of many different research fields like Psycholinguistics or Software engineering. An important mention for ALICE (*Artificial Linguistic Internet Computer Entity*) (Wallace, 2004) that implements a simple framework allows somebody to create its conversational agent by creating a collection of stimulus-response pairs. When a user will ask a question to the agent, the stimulus is searched in the collection. If this stimulus is in the collection, the agent will reply with the related response.

In this study we use ALICE as it offers a simple language to write stimulus-response patterns. This simple technology in the last years has inspired many research works that proposed extension of this technology (e.g. (Pilato et al., 2004)).

3.3 Building Personality of Conversational Agents

As we saw in the previous section, ALICE is simple to use. Building the agent *personality*, i.e. its way to answer to questions, means to write stimulus-response pairs. Furthermore this technology allows to model and store data about current dialogue topic, other data about user, or dialogue in general. This makes possible to program the agent to reply to a great amount of questions with different languages, e.g., a colloquial language with idioms or jokes.

The process we follow to build the collection of stimulus-response pairs has two phases:

- *Wizard-of-OZ* phase: using a standard model to collect data for dialogue systems, i.e., the Wizard-of-OZ (Fraser and Gilbert, 1991), our first phase is to collect possible dialogues using people that simulate the behavior of the system. Dialogues collected in this phase are used to produce a first collection of stimulus-response pairs.
- *Controlled Wizard-of-OZ* phase: the system is deployed with the first collection of stimulus responses. Dialogues are logged in order to analyze failures. The initial collection is then augmented with new stimulus response covering failures.

4 CASE STUDY

In this section we present an initial application of the *living artwork* concept. We describe the target audience and the target artwork. We then report on the related personality-building phase.

4.1 Target Audience and Target Artwork

Children with an age range 8-12 years are our initial target audience. We want to try if it is possible to capture their attention on artworks for which they do not show a natural interest. We believe that children can be more open to technological communication channels and that a novel way of approaching artwork with entertaining conversational agents will help them in better learning.

Among many artworks, we selected a painting representing a scene with many people having interesting story to tell. Many subjects in the scene give us the possibility of better experimenting with a conversational technology as we can focus the attention in many parts of the painting. We then selected the painting "The Hunt of Diana" (see Figure 1), placed in Rome in the Borghese Gallery and Museum, painted by Domenico Zampieri called Domenichino in 1616/17. In his masterpiece Domenichino revived antique literary and mythological themes such as an archery scene deriving from Virgil's Aeneid (V,485) and the depiction of nymphs. Many characters in the scene have a story to tell.

We divided the painting in five areas (see Figure 1). Each one connected to a particular subject, according to the general intention to let audience to choice the topic to study in depth.

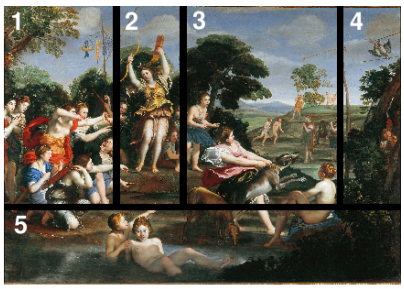

Figure 1: "The Hunt of Diana" painting.

4.2 Building the Conversational Agent Personality for the Case Study

For the construction of the personality, we followed the two-step procedure described in Sec. 3.3: the first phase where the system is simulated, the *Wizard-of-Oz* phase, and the second phase where the system is deployed and its failures detected. Before starting

Table 1: A sample dialogue with the simulated Agent.

Agent:	Hello, do you want to know something about this painting? Play with us and answer to some questions. What is your name?
Child:	asia
Agent:	Hello Asia, do you know the title of the painting ?
Child:	no
Agent:	It's "The Hunt of Diana" and it placed in Rome in the Borghese Gallery and Museum. It was painted by Domenico Zampieri in 1616/17. Do you know why it is called Domenichino (Little sunday)?
Child:	because he works only on sunday.
Agent:	Clever but it is not the right answer. He was short! ...

we collected a document describing the particular artwork. We organized this document as if it were a collection of stimulus-response. It contains general information about painting and painter's life, information about specific parts of the painting, and particularities of the artwork. We used this document to drive the first phase.

We organized the Wizard-of-Oz phase as follows. We used 3 classes in a primary school as focus group. The Conversational Agent has been simulated with Microsoft MSN. The language used by the simulated system, i.e. the operator, is simple and colloquial. At the end of this phase, we gathered 10 dialogues. An example of these dialogues can be seen in Tab. 1. This set of dialogues has been used to design the real stimulus-response collection. We defined around 130 stimulus-response pairs.

The second phase is currently running. The system has been deployed on a web site and it is accessible over the net[2].

5 CONCLUSIONS AND FUTURE WORK

This paper presents a novel idea that we called "living artworks". We believe that this paradigm can be useful in two ways: making museums more attractive places and increasing the effectiveness of museums as informal educators. This is a preliminary work and we need to study if the above two claims can be supported with empirical evidence. We then need to deploy our "living artworks" in a museum and measure whether the knowledge retention indicators (as those used in (De Biase, 2008)) have a beneficial effect.

[2]http://lirfi.lettere.uniroma2.it/ArtiD

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PROOF GRANULARITY AS AN EMPIRICAL PROBLEM?*

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Keywords: Proof tutoring, Granularity, Machine learning.

Abstract: Even in introductory textbooks on mathematical proof, intermediate proof steps are generally skipped when this seems appropriate. This gives rise to different granularities of proofs, depending on the intended audience and the context in which the proof is presented. We have developed a mechanism to classify whether proof steps of different sizes are appropriate in a tutoring context. The necessary knowledge is learnt from expert tutors via standard machine learning techniques from annotated examples. We discuss the ongoing evaluation of our approach via empirical studies.

1 INTRODUCTION

Our overall motivation is the development of an intelligent tutoring system for mathematics. Our particular interest is in flexible, adaptive mathematical proof tutoring. In order to make progress in this area it is important to reduce the gap between the existing formal domain-reasoning techniques and common mathematical practice. In particular, the step size (granularity) of reasoning employed in proof assistants and automated theorem provers often does not match the step size of human-generated proofs. This hampers their usability within a mathematical tutoring environment. For example, when the theorem prover Otter (McCune, 2003) was used in the EPGY learning environment for checking student-generated proof steps, it sometimes verified seemingly large student steps easily, whereas other, seemingly trivial steps were not verified within an appropriate resource limit (McMath et al., 2001). This criticism applies foremost to machine-oriented theorem proving systems, for example, systems based on fine-grained resolution or tableaux calculi. Techniques and calculi that are apparently better suited in this context include, for example, tactical theorem proving (Gordon et al., 1979), hierarchical proof planning (Bundy et al., 1991; Melis, 1999), assertion level theorem proving (Huang, 1994; Autexier, 2005), (super-)natural deduction (Wack, 2005), and strategic proof search (Sieg, 2007). Such techniques reduce the amount of unnecessary technical details in the generated proofs, support the application of sequences of inference steps as tactics or even the direct application of entire lemmas in single inference steps (assertion level theorem proving). However, the question remains how large a proof step shall or may be within a tutoring context (comprising a particular proof problem, the didactic goal, and the (assumed) prior knowledge of the student) and how many and which intermediate reasoning steps may be performed implicitly.

To investigate this issue we have analyzed a corpus – the DIALOG corpus (Benzmüller et al., 2006) – of tutorial dialogs on proofs. This corpus has been collected in experiments in the DIALOG project (Benzmüller et al., 2007). Exploiting assertion level proof search (where each inference is justified by a mathematical fact, such as a definition, theorem or a lemma) proofs in this corpus have been reconstructed and represented formally in the mathematical assistant system ΩMEGA (Siekmann et al., 2006)[2]. The analyzed students' proof steps generally corre-

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[2]We did not attempt to model erroneous proof steps.

1 We assume $(y,x) \in (R \circ S)$ and show $\underbrace{(y,x) \in S^{-1} \circ R^{-1}}_{\Gamma}$.
2 Therefore, $(x,y) \in R \circ S$
3 Therefore, $\exists z$ s.t. $(x,z) \in R \wedge (z,y) \in S$

4(a) Therefore, $\exists z$ s.t. $(z,x) \in R^{-1} \wedge (z,y) \in S$
Tutor: "too small"

$$\frac{\exists z : (z,x) \in R^{-1} \wedge (z,y) \in S \vdash \Gamma}{\exists z : (x,z) \in R \wedge (z,y) \in S \vdash \Gamma}\ Def.Inv.$$

4(b) Therefore, $\exists z$ s.t. $(z,x) \in R^{-1} \wedge (y,z) \in S^{-1}$
Tutor: "appropriate"

$$\cfrac{\cfrac{\exists z : (z,x) \in R^{-1} \wedge (y,z) \in S^{-1} \vdash \Gamma}{\exists z : (z,x) \in R^{-1} \wedge (z,y) \in S \vdash \Gamma}\ Def.Inv.}{\exists z : (x,z) \in R \wedge (z,y) \in S \vdash \Gamma}\ Def.Inv.$$

4(c) This finishes the current part of the proof.
Tutor: "too big"

$$\cfrac{\cfrac{\cfrac{\Gamma \vdash \Gamma(closed)}{\exists z : (z,x) \in R^{-1} \wedge (y,z) \in S^{-1} \vdash \Gamma}\ Def.\circ}{\exists z : (z,x) \in R^{-1} \wedge (z,y) \in S \vdash \Gamma}\ Def.Inv.}{\exists z : (x,z) \in R \wedge (z,y) \in S \vdash \Gamma}\ Def.Inv.$$

Figure 1: Proof sample (for the proof problem $(R \circ S)^{-1} = S^{-1} \circ R^{-1}$, where $^{-1}$ denotes relation inverse and $\circ$ denotes relation composition) with three alternatives for the fourth step, together with tutor's granularity rating (taken from the ongoing experiments), and (partial) assertion level proof reconstruction (as sequent trees).

sponded to one, two or three assertion level proof steps and very seldomly to four or more. This provides evidence that the step size of assertion level proof comes quite close to the proof step sizes observed in the experiments. However, often combinations of single assertion applications are preferred – even in very elementary proofs.

An example (partial) proof is presented in Figure 1: the student has already performed steps (1)-(3) and three alternatives, 4(a)-4(c), for the next step are investigated. They have been annotated (cf. Section 5) by a mathematician concerning their step size. Below these alternatives we outline parts of the corresponding assertion level proofs. Note that the step consisting of only one assertion level inference has been annotated as too small. Here the different classes of step size coincide with different lengths of the associated assertion level reconstructions. Our hypothesis is that such a coincidence generally exists – clearly, not as simple as here – and that we can learn and represent it and exploit it for intelligent proof tutoring. To confirm this hypothesis we are currently performing an empirical study which we discuss in this paper.

In Section 2 we present our modeling technique for classifying the step size of proof steps in a tutoring context. Our approach uses data mining techniques to generate models from samples of proof steps which have been annotated by human experts. Our system can be used in the diagnosis of student steps (to detect whether a student proceeds with unusually small or unexpectedly large steps (Schiller et al., 2008)), or for the presentation of proofs at a particular level of detail (Schiller and Benzmüller, 2009). In order to facilitate and support the collection of annotated sample proofs, we have developed a dedicated, new system environment, which is motivated in Section 3 and presented in Section 4. We report on an ongoing empirical study using this new environment in Section 5. Key questions of this ongoing study are: (i) How well can we model the judgments of the expert? (ii) How much do judgments differ among various experts? (iii) How well do learned models transfer to other domains? (iv) What are (empirically) relevant properties for classifying the step size of proof steps? We present a summarizing discussion of our approach in Section 6.

2 GRANULARITY AS A CLASSIFICATION PROBLEM

As the basis of our approach to granularity, we hypothesize what properties of compound proof steps[3] may be relevant to judge about their perceived step size. As a result of reviewing our DIALOG corpus of proofs (Benzmüller et al., 2006), we identified the following key features (among others):

- How many different concepts (mathematical facts, such as a particular definition or theorem) are involved within the same compound step? (feature *concepts*)
- How many (assertion level) inferences does a compound step correspond to? (feature *total*)
- Are the employed concepts mentioned explicitly? (feature *verb*)
- Is the student familiar with the employed concepts of the compound step? (feature *mastered/unmastered*)
- What theories do the employed concepts belong to (e.g. naive set theory, algebra, topology)? (features *settheory, algebra, topology, etc...*)

[3]We use the notion *compound proof step* in the following for any proof step, including those that can be decomposed into the application of several individual inferences - which is not the case for (atomic) proof steps such as single natural deduction inference applications.

1. total $\in \{0,1,2\} \Rightarrow$ "appropriate"
2. unmastered $\in \{2,3,4\} \wedge$ relations $\in \{2,3,4\} \Rightarrow$ "step-too-big"
3. total $\in \{3,4\} \wedge$ relations $\in \{0,1\} \Rightarrow$ "step-too-big"
4. unmastered $\in \{0,1\} \Rightarrow$ "appropriate"
5. _ $\Rightarrow$ "appropriate"

Figure 2: Sample rule set generated using the data mining tool C5.0[5] on sample data. Rules are ordered by confidence for conflict resolution.

Respective feature observations can easily be extracted from assertion level proofs[4]. We also employ a simple student model to keep track of the concepts the student is (presumably) already familiar with.

We treat the decision whether a particular step is of appropriate granularity as a classification problem. Given the properties of a particular step (as a collection of its features) we use a classifier (a mapping of feature vectors to class labels) to assign one of the three labels *appropriate*, *step-too-big* and *step-too-small* to it. As classifiers, we use rule sets, which are learned from annotated samples. As an example of such a rule set, consider Figure 2. All our features are numeric, e.g., *unmastered* counts the number of concepts we assume the student is not yet familiar with, *total* counts the number of assertion level inference applications, etc. For example, the proof step 4 (b) in Figure 1, which results in a feature vector (concepts:2, total:1, verb:false,mastered:0,unmastered:1,relations:1, ...) is assigned the label *appropriate* via the rule set in Figure 2 (the first rule fires). Such rule sets can be generated from annotated samples via data mining tools, such as C5.0[5].

3 PREVIOUS EMPIRICAL DATA COLLECTION AND LESSONS LEARNED

The DIALOG corpus collected data from proof-tutoring dialogs. In these dialogs human tutors (mathematicians) were asked to judge the step size of each student proof step, resulting in a corpus with granularity annotations. This was then used for evaluating the classification approach outlined above. Using standard data-mining tools (e.g. C5.0 and Weka[6]), we generated classifiers from the data and estimated their performance (as reported in (Schiller et al., 2008)). However, it became apparent that for an in-depth study of granularity, more focused studies are needed since (i) both the students and the wizards were experimental subjects, and the resulting interactions were more geared towards the identification of specific phenomena rather than a controlled experiment, and (ii) both parties were allowed to use natural language freely, which resulted in a large variety of surface realizations of proof steps, often including comments and questions, which may have had an influence on the judgments of the tutors. Consider for example the dialog fragment:

Student: $(R \circ S)^{-1} = \{(x,y)|(y,x) \in R \circ S\} = \{(x,y)|\exists z(z \in M \wedge (x,z) \in R^{-1} \wedge (z,y) \in S^{-1})\} = R^{-1} \circ S^{-1}$. Can I do it like that?

Tutor: That's a little too fast. Where do you take the second equality from?

By adding the question to the equation, the student reveals uncertainty, which might have effected the tutor's judgment and reaction to some degree.

4 A SYSTEM ENVIRONMENT FOR EMPIRICAL PROOF GRANULARITY STUDIES

The idea of our new environment is to better control the parameters pertaining to the student, in order to more accurately observe their effects on the judgments of the tutor. Therefore, we simulate the student, using: (i) assertion-level proof search in ΩMEGA, (ii) pattern-based generation of simple natural-language output, (iii) randomization of proof step output (producing compound steps of random size, counting assertion level inferences, and randomizing whether concept names are explicitly named, or only the resulting formulae are displayed), (iv) automatic collection of all relevant data, including the proof step output, the names of the employed assertion level inferences, the corresponding granularity features, and the corresponding granularity judgments from the tutor.

The expert providing the granularity judgments uses the interface in Figure 4. It presents the proof step output and collects the expert's judgments. The expert may deny the judgment for a particular step, in which case a different option is presented. When combining several inference steps to a compound

[4]Even though the approach is generally not limited to assertion level proofs, we use this proof representation in our study for convenience.

[5]Data Mining Tools See5 and C5.0: `http://www.rulequest.com/see5-info.html`

[6]`http://www.cs.waikato.ac.nz/ml/weka/`

Proof Step Output	Inferences	Granularity Feature Vector	Judgment
We assume $(y,x) \in (R \circ S)^{-1}$ and show $(y,x) \in S^{-1} \circ R^{-1}$...because of definition of equality and definition of subset	Def.$\subseteq$, Def.=	hypintro:1, total:2, concepts:2, verb:1, ...	appropriate
Therefore, $(x,y) \in R \circ S$	Def. Inv.	hypintro:0, total:1, concepts:1, verb:0, ...	appropriate
Therefore, $\exists z$ s.t. $(x,z) \in R \wedge (z,y) \in S$ ...because of relation composition	Def. $\circ$	hypintro:0 ,total:1, concepts:1, verb:1, ...	appropriate

Figure 3: Sample of the data collected in our study.

step, only inference steps of the same direction (either forward, or backward) are combined, a phenomenon which we clearly observed in the DIALOG corpus.

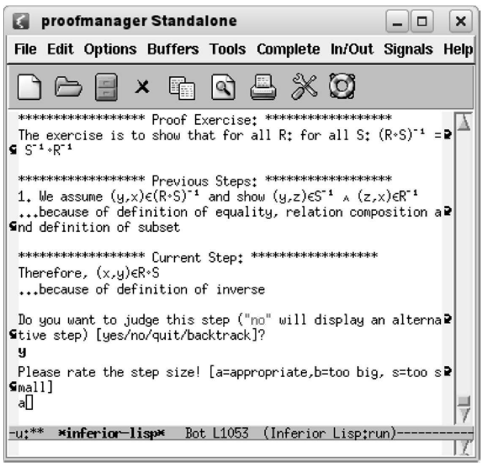

Figure 4: The data collection environment interface. Proofs are presented stepwise. For each step, the display reminds the user of the theorem to be proven and the previous steps in the proof. The user is requested to provide a granularity rating for the step under consideration.

The knowledge and mastery of the simulated student – relative to which the expert has to provide the granularity judgments – is determined by the formal representation of the proof exercise (including relevant definitions and lemmas) provided to ΩMEGA and corresponding entries in the student model. At the start of each exercise (and during the exercise on request), the expert is provided with a list of concepts the (simulated) student is supposed to know, and a list of concepts the student is supposed to learn. Figure 3 shows a sample of collected data.

5 AN EMPIRICAL STUDY ON GRANULARITY

Our approach to granularity relies on two assumptions which we investigate empirically:

- We assume that we need an adaptive approach to granularity, which learns from human experts. The experiments reported in (Benzmüller et al., 2006) hinted at the possibility that experts do not always agree with respect to what step size they consider appropriate. We want to compare samples from different experts with tutoring experience and examine the inter-rater reliability.
- We assume a set of features which we consider relevant for classifying granularity (currently around twenty features plus indicator features for each theory and each concept). Our goal is to evaluate (i) which features are most salient, and (ii) what features are potentially relevant?

Therefore, we perform an empirical study, where several mathematicians with tutoring experience judge proof steps presented to them via our data collection environment. Exercises are taken from the fields of naive set theory, relations (such as our running example), and topology. The recently conducted first experiment session, where a mathematician judged 135 proof steps using our environment, will be followed by sessions with two or three further experts, so that differences in their judgment can be examined. The mathematical experts are not instructed about assertion level proofs and the features we use in our classification before completion of the experiment, to avoid an artificial bias. Afterwards, we discuss our approach with the experts to obtain additional feedback. The annotated proof steps are then used to generate classifiers for granularity, and to evaluate their performance using data mining tools (also concerning the question which features of the proof steps are most useful for the classification task).

6 DISCUSSION

Granularity is a challenging topic in artificial intelligence and education, both from a theoretical viewpoint (e.g. (Hobbs, 1985; Keet, 2008)) but also in several applications, for example in the computer-assisted teaching of programming skills (Mccalla et al., 1992), or in the modeling of biological information systems (Keet, 2008).

In this paper, we have sketched a flexible, adaptive approach for modeling and assessing proof step granularity. It is based on the collection of empirical data from the observed behavior of expert tutors, which is then modeled via artificial intelligence and data mining techniques. These models for granularity can be generated independently of whether the experts are able to introspect or justify their judgments. The learnt classifiers serve to imitate the mathematical practice of the experts (pertaining to granularity) when used within an intelligent tutoring system. An alternative approach would be to establish an explicit best practice of judging proof step granularity by openly engaging tutoring experts in the discussion of the involved cognitive dimensions. It remains debatable which of the two approaches is more adequate for building a granularity-informed proof tutoring system, and we consider our work and our system environment as a fruitful first step in both directions.

Future work will address the questions raised in the introduction. Among other things this is dependent on the successful completion of our ongoing experiments.

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INTEGRATION OF ONTOLOGY IN DISTANCE LEARNING SYSTEMS
Models, Methods and Applications

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Abstract: Semantic web technologies, including domain ontologies, can enhance possibilities and functionality of traditional Web systems. The problem is that these technologies are not fully adopted yet to bring benefits to final users. We analyse the oppurtunities to integrate domain ontologies into typical learning management systems in order to gain some automation or support from the system in frequent and time consuming jobs, which are performed by students and academic staff in ourdays systems. The main aim of our research is to propose a methodology for the development of the distance learning course domain ontology and its integration into the distance learning systems. In this paper, we present our research directions and proposed solutions. Furthermore, we pay here more attention to learning scenarios, which we design considering the proposed methodology and the particular learning manamement system – MOODLE – in mind.

1 INTRODUCTION

Semantic web technologies, including domain ontologies, can enhance possibilities and functionality of traditional Web. For example, Davis (2007) characterises the business value of semantic technologies in five critical areas:

- Development – automation in different development steps;
- Infrastructure – enablement and orchestration of core resources;
- Information – semantic interoperability of information and applications in real context;
- Knowledge – knowledge work automation and supporting knowledge workers;
- Behaviour – systems knows what they are doing.

Obviously, the technology itself provides only with increased possibilities. Therefore, methods, frameworks and tools are necessary for realising practically all mentioned aims. The problem is that there are no enough results in using these technologies, which brings benefits to final users.

Semantic web technologies are usefull in any knowledge intensive area. We restrict ourselves with e-learning domain, where Semantic web technologies – ontologies, agents, web services – are also employed and intensive researches are carried in this field (Alsultanny, 2006; Stojanovic *et al.*, 2001).

The topics of ontology engineering are comprehensively described in (Devedzic, 2002; Corcho *et al.*, 2007), including methods and methodologies for the development of ontologies, ontology development process and lifecycle, ontology tools and languages.

Several authors analyse and develop domain ontologies for specific topics in e-Learning (Sosnovsky & Gavrilova, 2006; Angelova *et al.*, 2004). Other papers deal with domain frameworks or recommendations for ontology development (Gavrilova *et al.*, 2005; Boyce & Pahl, 2007). After the analysis of scientific literature, we separate two types of approaches to the use of ontology in e-Learning system:

1) Ontology is used at development time. Automation and reuse are in the main focus (Ateveh & Lockemann, 2006; Karampiperis & Sampson, 2005; Valkeapää *et al.*, 2007). Here as *development* we consider the development of particular study courses or their elements. Also it would be very advantageous to actually use ontologies while designing and developing e-Learning systems, and later seeking for their interoperability. Such development process is called an ontology-driven development of information system, as in (Guarino,

1998). But we have not found any comprehensive research results in this field.

2) Ontology is used at run time. Users' support is in the main focus and ontology is understood mainly as shared knowledge source and the mean for achieving personalisation (see, for example, Angelova *et al.*, 2004).

In this paper, we present our research directions and proposed solutions for the development of the distance learning course domain ontology and scenarios for ontology application in the distance learning system.

2 RESEARCH PROBLEM

We have practical experience in designing and delivering distance study courses (DSC) for more than 6 years. Also one of our functions is to support academic staff in these processes. So the problems, which are formulated here, arise not only from scientific analysis but also from our social experience. Here we clearly state and analyse some problems, which we are seeking at least partially to solve. The purposes, which we are striving to achieve, are:

- ***Increasing effectiveness of workload.*** Not only the efficiency of the system, but also the efficiency of activities of its user, both lecturer and student is actually important. Students need different kinds of support: technical, administrative, subject oriented, motivational. In order to achieve good learning results, a significant amount of workload time of instructors is necessary. The ontology-based description of required knowledge is a prerequisite while seeking to shift a part of the student-instructor collaboration processes into the student-study material level. Therefore, some functions can be detached from an instructor and attached to a computer system. It is important to pick for transfer time-intensive, frequently repeated, maybe not complicated functions. In this way, efficiency will be increased on the organisational level, too. There is a misleading opinion that self-supporting studies usually happen effectively. For this type of studies people with very strong motivation are necessary. Despite of very large amount of information, it is difficult to find, what is useful. Therefore ontologies and software components, for example agents, allow us to present study material in a convenient way for a learner, avoiding information overload, adapting study material to the learning style of learner, readiness of a learner. In practice, learning scenarios can be generated and thus personalised learning implemented. This fact resounds modern ideas of individualised learning.
- ***Increasing of satisfaction***. Achievements of students depend on their satisfaction during gaining learning experience, too. Students meet modern web technologies in daily life; therefore, they also expect them in delivering modern curriculum.
- ***Adaptivity in dynamic context***. Adaptive systems are concerned as systems, which offer dynamically built and automatically performed personalisation. Learning materials perform changes in time. New learning objects come; some resources replace the other, some supplement. The cost of preparing DSC is conditional big in relation with DSC delivery. Therefore, we need DSC, which can be reused in different context.

Relevant problems are analysed in (Dignum & Dignum, 2003) and the objectives of knowledge management technologies, considering ontology modelling is one of them, are stated as follows:

- Assist people to generate and apply "just in time" and "just enough" knowledge, prevent information overload and stimulate sharing of relevant knowledge in a dynamic, collaborative environment.
- Preserve individual autonomy and contribute to the creation of an atmosphere of trust between participants.

Summarising, we can state that the same problems exist in different subject domains, not only in e-Learning, where users' work intensively with big amount of information. Therefore, supposed business value of spreading semantic web technologies, including ontologies, concerns better support for user in information-intensive environments, such as e-Learning systems.

Our selected problem domain is e-Learning, which, strictly speaking, covers participants and their performed activities. Our solution domain concerns ontology modelling/engineering and application. The goal, expressed abstractly, is to achieve better performance. Therefore, we begin our analysis from two directions:

1) Analysis of the problems in modern e-Learning environments, concerning data/information/knowledge resources used and processes, in which knowledge management appear.

The purpose of this part is extraction of possibilities for qualitative or quantitative change.

2) Analysis of technologies, tools, and methodologies, concerning ontology modelling/engineering; design of framework for change; design of scenarios for innovative use in e-Learning setting.

Our research object is integration of domain ontology into the e-Learning system. The objectives of our research are the following:

- to analyse and compare known approaches to ontology modelling/engineering related to the development and improvement of virtual learning environments (VLE);
- to analyse the ontology quality criteria and the ontology evaluation methods;
- to propose a methodology for the development of the distance learning course domain ontology and its integration into the distance learning systems;
- to propose an ontology quality evaluation model for the distance learning domain;
- to develop an experimental domain ontology for the distance learning course using the proposed methodology;
- to integrate the domain ontology into the existing VLE;
- to propose learning scenarios based on the developed ontology;
- to evaluate the quality of the developed domain ontology and its use.

Research hypothesis: we expect that extending LMS with domain ontology will increase tool functionality, provide more capabilities for effective learning and self-learning, and allow for rapid prototyping of DSC.

3 PROPOSED SOLUTIONS AND RESEARCH DIRECTIONS

3.1 What Have Been Done

3.1.1 Multi-layered Architecture of e-Learning System Proposed

The multi-layered architecture of the distance learning system, introduced by us in (Dzemydiene *et al.*, 2006), integrates components from the common LMS and extends it with intelligent components by the means of two architectural layers: 1) Intelligent layer – intelligent decision support components, which must act as a mediator between the core LMS elements and different types of user interfaces; 2) Deeper knowledge layer – domain, users', learning designs' ontologies, which can act as foundation for adaptive educational sequencing. Further, we restrict ourselves with domain ontology as a tool for reuse on the subject knowledge and a mean for automating some tasks. And differently from solutions, where semantically enriched systems are developed from scratch, as, for example, in our experiment (Tankeleviciene & Sakalauskas, 2008), we tend to use a great functionality of modern LMS.

3.1.2 Development of Domain Ontology Analysed

Development of domain ontology was analysed in (Dzemydiene & Tankeleviciene, 2008a). As ontology is "a conceptual specification that describes knowledge about a domain in a manner that is independent of epistemic states and state of affairs" (Guizzardi, 2007), it can be treated as a universal model of domain. Therefore, in the context of e-Learning, we can distinguish: 1) ***Domain level***, which concerns the domain knowledge. 2) ***Course level***, which concerns the practical implementation of e-Learning. The course consists of a set of learning resources, including both teaching/learning materials and activities. 3) ***Technological level***, which deals with learning objects (LO) and information objects. Such framework allows us also to distinguish between domain engineering and course engineering. Therefore reuse can be employed on a higher level.

In our approach we argue for:

1) Manual ontology development. Despite of the fact, that there are still much heuristics in the development of domain ontology manually, it remains still the best approach to the development of ontology of high quality. In the near future we have plans to experiment with semi-automatic methods for ontology (or its base - taxonomy) development, because this task is very time consuming.

2) Real schema-based ontology. The differences between schema-based ontology and topic-based ontology are explained in (Kiryakov, 2006). The author accentuates the possibility to formalise the domain while using a set-theoretical model and set theoretical operations. We choose schema-ontology for capturing subject domain knowledge, because: a) It better corresponds with our understanding of the concept of ontology; b) It deals with formal or semiformal representation, and it represents a top-down systematic approach; c) It better fits in our instructor-led e-Learning context.

3.1.3 Reasoning Over Ontology Elements Analysed

As ontologies are static knowledge resources, we need active components for performing the tasks. The concept, possibilities, types and implementations of reasoning over ontology were analysed in (Dzemydiene & Tankeleviciene, 2008b). Also in this paper the framework for conceptual linking of educational resources, based on reasoning over domain ontology elements, was proposed.

In our approach we argue for:

1) Query-based reasoning, because it is simpler and more efficient than logic-based reasoning. We choose hybrid information systems, where current web technologies and ontology engineering are combined.

2) The necessity to implement simpler reasoning mechanisms over domain ontology in order to support learner in simple tasks. We strive to achieve better trade-off between control and self-responsibility; therefore, conceptual linking of educational resources and displaying different ways of reaching the learning goal correspond to our pedagogical viewpoint.

3.2 Ways for Extending MOODLE with New Functionality

For our practical experiments MOODLE (http://www.moodle.org/) was chosen. MOODLE is a free Learning Management System (LMS) for offering DSC. The main part of DSC is usually composed from topics (see Fig. 1 in the middle). For each topic instructor can define resources and activities. In our MOODLE version (1.9.2+, last build 2008.09.17) there are the following types of resources: a) Label; b) Text page; c) Web page; d) Link to a file or a web site; e) Directory display; f) IMS content package.

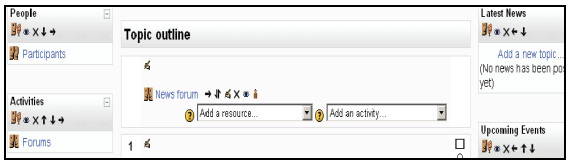

Figure 1: A part of MOODLE environment in the editing mode.

The same version by default offers the following activity types: a) Assignments; b) Chat; c) Choice; d) Database; e) Forum; f) Glossary; g) Lesson; h) Quiz; i) SCORM/AICC; j) Survey; k) Wiki.

The right and left hand sides of the DSC page (see Fig. 1) include blocks that display various information. Instructor can choose what blocks to display; some of the most popular blocks are: Latest News, Upcoming Events, Calendar, Participants.

All these elements – resources, activities and blocks – provide students with 1) transferring of knowledge in different forms and in different ways; 2) active participation in learning activities. The constructivist viewpoint towards learning especially emphasizes the importance of active participation in ones own development. For this purpose a great level of interactivity must be implemented. Here *interaction* means primarily the communication between the user and the system. Interactivity is one of the criteria or indicators showing quality of distance studies (Karoulis & Pombortsis, 2003). These authors emphasize interactivity with the instructional material, which is described as navigational fidelity, multimedia components, multiple kinds of exercises, facilitation of the active interaction, support for collaborative work and group dynamics. Students' support is formulated as other indicator and it concerns guidance and encouragement of the student both from the instructional material and from the communication channels, accessibility to the tutor, instructional organisation.

Since MOODLE is an open sourced system, there are quite many possibilities to extend its functionality. We can use third party plug-ins or develop them ourselves; also we can modify existing elements of a system. Basically modifiable elements are:

- Modules. They define new learning activities.
- Blocks. Usually they provide extra information or support for students.
- Inner elements of some module. For example, question types in Quiz module.

We have found very few efforts to integrate MOODLE and Semantic web technologies (Lukichev *et al.*, 2007; Diaconescu *et al.*, 2008).

3.3 Outline of Experiments

After analysis of semantic web technologies and particular LMS architecture, we have decided to proceed with experiments in the following areas:

1) ***Visualisation of domain structure***. A tag cloud as user interface design pattern is planned to be used. Protégé has plug-in ***Cloud Views*** (http://protegewiki.stanford.edu/index.php/Cloud_Views), which allows to visualise ontology as a tag cloud, but this plug-in don't support yet the export

of prepared tag cloud. Also we could use some tag clouds generator, but in this way visualisation of the domain will be pre-delivered as the DSC starts. Our idea is to support dynamical linking between domain ontology and its visual representation. We think ***Classes by usage*** is the best way to accentuate more important concepts (also we can calculate siblings, descendants, etc.).

2) ***Navigational support***. The scenario for providing navigational support is provided by us in (Dzemydiene & Tankeleviciene, 2008b). Briefly it consist from several steps: 1) Requested resource is displayed; 2) The position of the requested resource in the predefined by lecturer course structure is displayed; 3) Reasoning over domain ontology and mappings between ontology concepts and resources is conducted; 4) Links to resources of possible interest are generated and displayed. The problem in implementing this algorithm is related with the definition of current state, i.e., the position of the particular resource in overall course structure. The other problem concerns universality of semantical linking. We can't know in advance the possible intensions of such linking. Therefore, we restrict ourselves with main linking patterns: 1) Finding all child concepts; 2) Finding all siblings; 3) Finding all instances; etc.

For these first two scenarios, the standard MOODLE HTML block is planned to override. HTML block provides an HTML editor for formatting text. Also we can integrate images and other elements, for example, Flash moves. The differences in functionality is that the content of visualisation block is generated once, when student logs into DSC, and the content of navigational support block must be generated on every change of resource (*resource view* record in log file).

3) ***Semi-automatic generation of test questions and their answers***. The possibility to append new question type in Quiz module is foreseen. This module provides templates for editing questions and their answers. We are seeking to implement the support in development of questions by the means of suggesting ontology components, for example, labels of classes, and names of instances or relations. We plan to use the following question types: 1) Multiple choice – where one or more true answers are must be chosen; 2) Short answer – where people must type a word; 3) Matching – where relations between elements in two column must be found.

4 CONCLUSIONS AND FUTURE WORK

Semantic web technologies are rapidly evolutioning, therefore, it is a great demand for analysis of the latest achievements and striving to use them in existing solutions – information systems from different fields.

The approach to using domain ontology in the development and delivery of educational resources enables automating these processes, increasing adaptivity and personalisation. Scenarios for those tasks are foreseen. The first two scenarios for ontology usage are more oriented towards learner satisfaction and higher learning effectiveness, because they introduce learners to domain space and provide more possibilities for personal navigation. The third scenario is oriented towards automation of workload of academic staff. The main shortcoming of this approach is that it requires large efforts of humans at initial stage, and we will benefit from this approach only after its repeatable reuse, but, on the other hand, this problem concerns distance studies and e-Learning in general, too.

In order to evaluate the proposed methodology and designed learning scenarios, we shall implement and test these scenarios in a particular LMS.

Our future research work also will focus on the analysis and formulation of the detailed list of the semantical linking patterns, derivation of possible patterns of test questions from semantical linking patterns, and implementation of experimental tools for realisation of these patterns.

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POSTERS

DEMO PROGRAMS FOR NORMAL AND UNIFORM RANDOM VARIABLES TRANSFORMATION

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Keywords: Demo program, MATLAB, Linear transform, Nonlinear transform, Normal variables, Uniform variables.

Abstract: This paper presents MATLAB-based demo programs for transformation of normal and uniform random variables. Linear as well as nonlinear transforms are considered. It is demonstrated how the transform changes the corresponding probability density function. It is also shown how to use the transformation of given random variable to generate a new desired random variable. The programs can be used as a complement to theoretical classes or alone as a self-study tool.

1 INTRODUCTION

Computer-aided learning has become an important educational research activity in various engineering disciplines and there has been a growing interest in the development of educational software in all areas of study (Fernandez and Sanchez, 2004). As a result many computer packages have been developed to assist learning (Yann and Teng, 2003; Li and Lie, 2004).

It is known that random variable (r.v.) is generally considered as one of the most abstract and conceptually difficult areas in the engineering education and teaching of random variables is one of the subjects that requires more time for its understanding. Our experience shows that the use of demo programs gives students the visual and intuitive representation of the random variables which had traditionally been stated in terms of abstract mathematical description (Jovanovic, 1997; Jovanovic and Champac, 2000). Such software tools must have characteristics like repeatability, capacity to motivate students, interactivity, versatility, easy to use etc.

Presented in this paper are demo programs to teach the transform of uniform and normal random variables. The programs can be used as a complement to theoretical classes or alone as a self-study tool. The programs are interactive, i.e., the user chooses the parameters of the input variables and the corresponding transform.

Each program presents input and output variables and the desired transform as well as the estimated probability densities. The exact densities are also presented.

The rest of the paper is as follows. Next section is devoted to the linear and nonlinear transformations of uniform random variables, while Section 3 demonstrates the linear and nonlinear transforms of normal random variables.

2 UNIFORM VARIABLE

2.1 Demo for Linear Transform

In this program the linear transform (LT) $Y=aX+b$ of the uniform random variable X is discussed. The user chooses the range (R_1, R_2) of the uniform r.v. and the parameters of the linear transform a and b.

The program shows the output variable and the estimation of the input and output probability densities (PDS), thus demonstrating that the linear transform of the uniform r.v. results in an uniform r.v. As an illustration Fig.1 shows the result for R_1 = -1, R_2 = 4, a = 2, and b = 3. The estimation of the corresponding PDFs is given in Fig.2.

Figure 3 presents the corresponding uniform PDFs.

It is also demonstrated how this result is useful to generate the desired uniform r.v. from the given uniform r.v. For example, in MATLAB the file *rand*

generates the uniform r.v. in the interval (0, 1). To obtain uniform r.v. in the interval (R_{21}, R_{22}), we have to apply the linear transform with $a=R_{22}-R_{21}$, where $a=R_{22}-R_{21}$; $b=R_{21}$, to the uniform random variable generated by *rand*. Figure 4 illustrates the generation of the uniform r.v. in the interval (-3, 5).

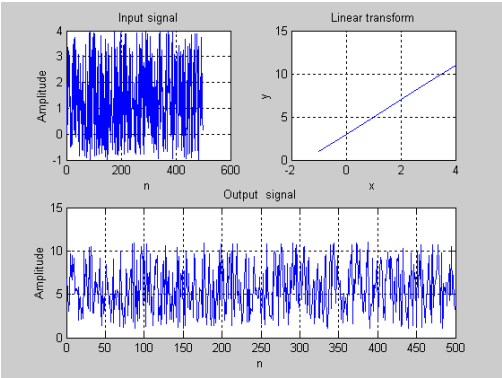

Figure 1: Linear transform of uniform r.v.

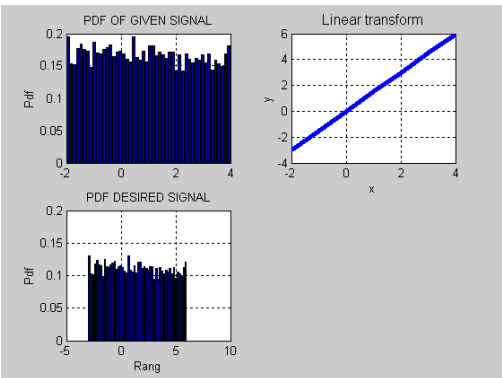

Figure 2: Estimated Input and Output Densities.

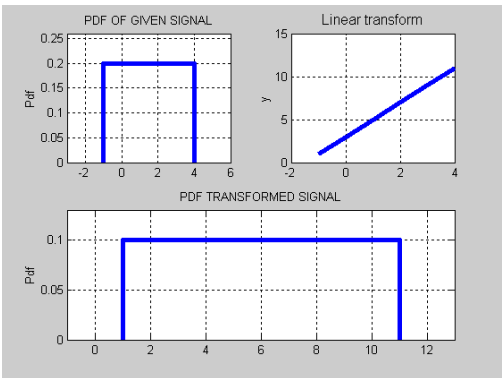

Figure 3: Input and Output Densities.

2.2 Demo for Nonlinear Transform

The Demo program for the absolute value of uniform r.v. illustrates that the transform does not change the type of the uniform r.v., as shown in example in Fig.5, where the input r.v. is uniform in the interval (-5, 5). The estimation of the input and output PDFs are given in Fig.6.

The following demo shows the transformations of the uniform r.v. X in the range (0, 1).

The demo illustrated in Figs 7 and 8 shows how to generate an exponential random variable by applying transform

$$Y = -\frac{1}{\lambda}\log(1-X), \tag{1}$$

to a uniform variable X.

Figure 9 illustrates the demo for the transformation of the uniform random variable X,

$$Y = \sqrt{-2\sigma^2 \ln X}\ . \tag{2}$$

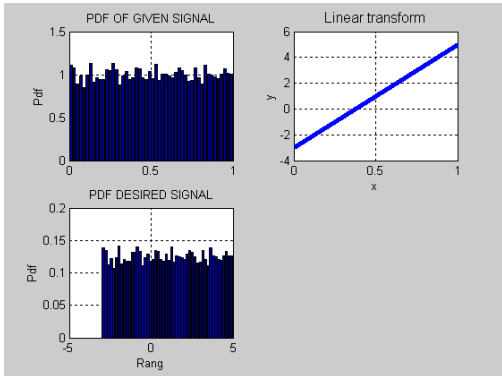

Figure 4: Generation of the desired uniform r.v.

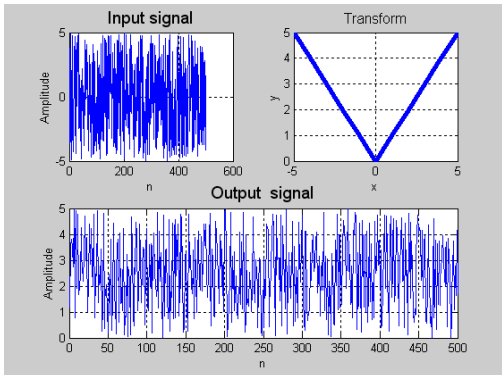

Figure 5: Absolute value of uniform r.v.

The resulting random variable is Rayleigh as shown in Fig.9.

3 NORMAL VARIABLE

3.1 Demo for Linear Transform

This program demonstrates that the linear transform of the normal r.v. gives again the normal r.v. User chooses the mean value and variance of the normal variable, as well as the parameters of the linear transform *a* and *b*. Figure 10 illustrates the demo for the mean value 2, variance 4, and *a*=3, *b*=4. The figure shows the estimation of the output PDF demonstrating that the output random variable is also the normal variable. The same is confirmed in Fig.11.

MATLAB file *randn* generates the normal r.v. with the zero mean value and the variance 1. The normal random variable with mean *m* and the variance σ^2 is obtained by applying the following transform

$$Y = \sigma X + m. \tag{3}$$

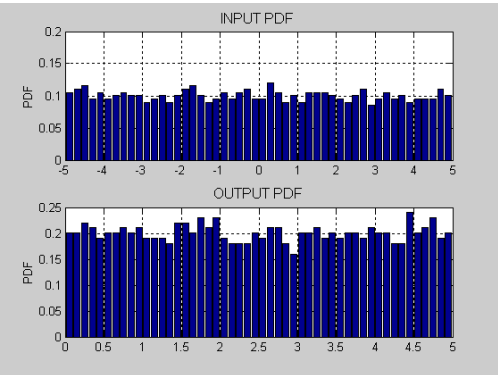

Figure 6: Estimation of the corresponding densities.

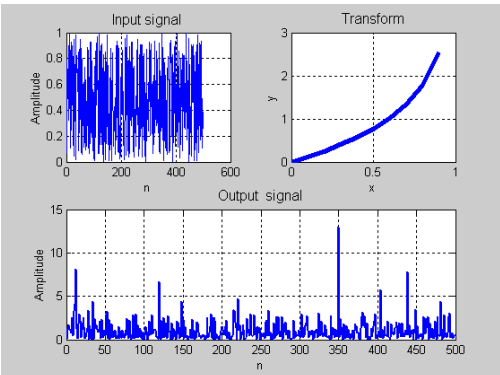

Figure 7: The generation of exponentional r.v.

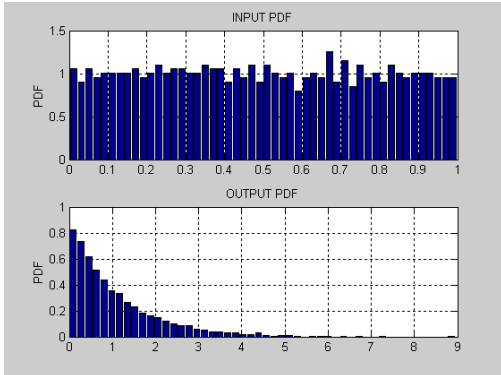

Figure 8: Estimation of the corresponding densities.

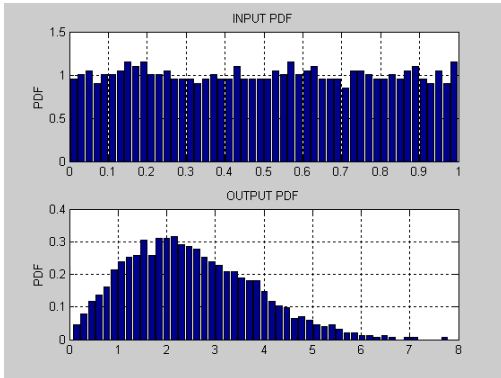

Figure 9: Estimation of the Rayleigh density.

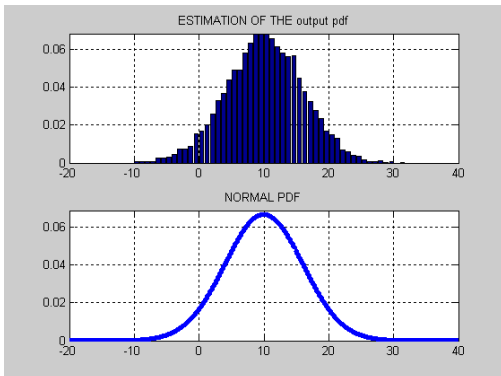

Figure 10: Estimation of the output density.

3.2 Demo for Nonlinear Transform

Figure 12 illustrates the absolute value of the normal r.v. with zero mean and the variance 4. The resulting random variable is the one-sided normal variable. The exponential transform

$$Y = e^X \tag{4}$$

of the normal variable is illustrated in Figs.13 and 14.

4 CONCLUSIONS

This paper describes the educational software for transformations of the uniform and normal random variables. The linear as well as nonlinear transforms are considered. It is also described how to use the transformations to generate different random variables.

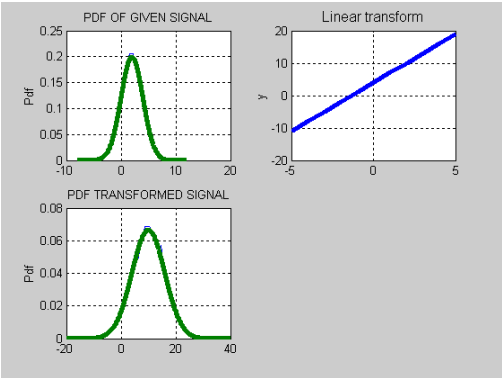

Figure 11: Input and output densities.

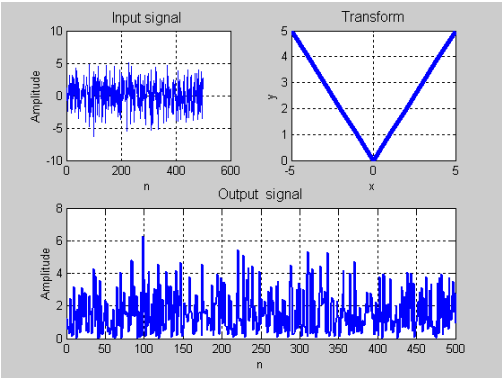

Figure 12: Absolute value of normal r.v.

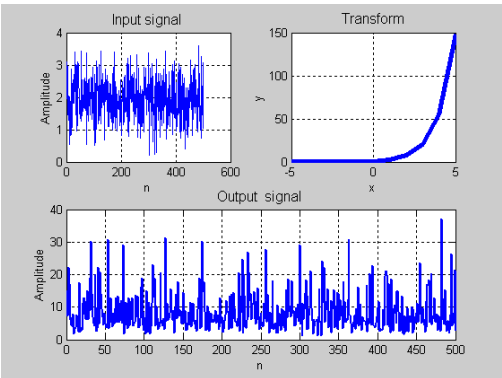

Figure 13: Exponential transform.

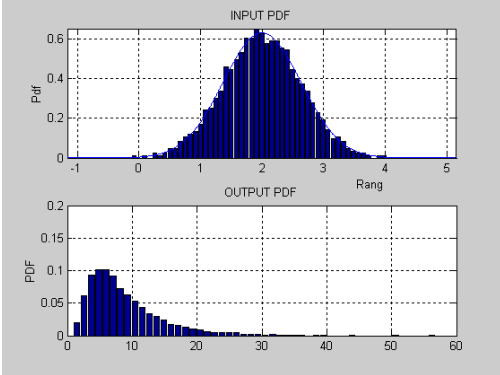

Figure 14: Estimation of the densities.

The programs are written in MATLAB, although any previous knowledge of MATLAB is not required. The programs can be used as a complement to theoretical classes or alone as a self-study tool for teaching basic course on random signals.

ACKNOWLEDGEMENTS

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LEARNING SUPPORT FOR ENGLISH COMPOSITION BY ASKING BACK QUESTIONS

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Keywords: Learning support for English composition, Asking back question, Realizable possibility, Suppositive expressions.

Abstract: There are several gaps between Japanese and English expressions, such as suppositive expressions. These gaps make it difficult for Japanese students to study English composition. For example, realizable possibilities are described clearly in English suppositive expressions, on the other hand, they are frequently omitted in Japanese suppositive expressions. As a result, when Japanese students translate Japanese suppositive expressions into English, they are often forced to reveal the realizable possibilities which are not described clearly in Japanese expressions. In this way, it is important to make students aware of realizable possibilities when they try to translate Japanese suppositive expressions into English. To solve this problem, in this paper, we propose a learning support method for English composition by using asking back questions. Our system asks users back and makes them aware of realizable possibility.

1 INTRODUCTION

It is difficult for Japanese students to study English composition because there are several gaps between Japanese and English expressions. Take realizable possibility in suppositive expressions for example. In English sentences, realizable possibilities are clearly expressed in suppositive expressions.

(ex 1) I'll call you when I get to Narita Airport.

(ex 2) If I get to Narita Airport, I'll call you.

(ex 1) shows that the speaker is sure to get to Narita Airport. On the other hand, (ex 2) shows that the speaker has a fifty-fifty chance of getting there. In contrast, in Japanese sentences, realizable possibilities are frequently omitted or expressed ambiguously.

(ex 3) *Narita kuko* (airport) *ni* (to) *tsui* (get) *tara* (when/if) *denwa* (call) *shimasu* (will).

In this sentence, the possibility of getting to Narita Airport is not expressed clearly. Both a man who is sure to get to Narita Airport and a man who has a fifty-fifty chance of getting there can speak (ex 3).

As a result, when Japanese students translate Japanese suppositive expressions into English, they are often forced to reveal realizable possibility because they are not described clearly in Japanese suppositive expressions (Figure 1).

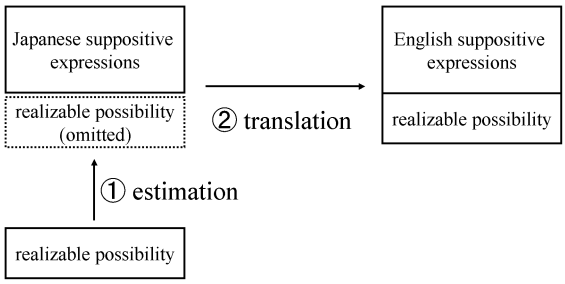

Figure 1: The translation process of Japanese suppositive expressions into English: 1. the estimation of realizable possibility, 2. translation.

A considerable number of studies have been made on English composition support by extracting English expressions from Web documents (Oshika 05) (Takeda 94) (Yamamoto 99) (EDP 07). In these studies, however, little attention has been given to the gaps between Japanese and English expressions. Suppose that a Japanese student wants to translate (ex 3), however, does not know that the realizable possibility is the key to translating Japanese suppositive expressions into English. If (ex 1) and (ex 2) are given as the translation examples of (ex 3) to the student, it is difficult for the student to determine which sentence is proper without the viewpoint of realizable possibil-

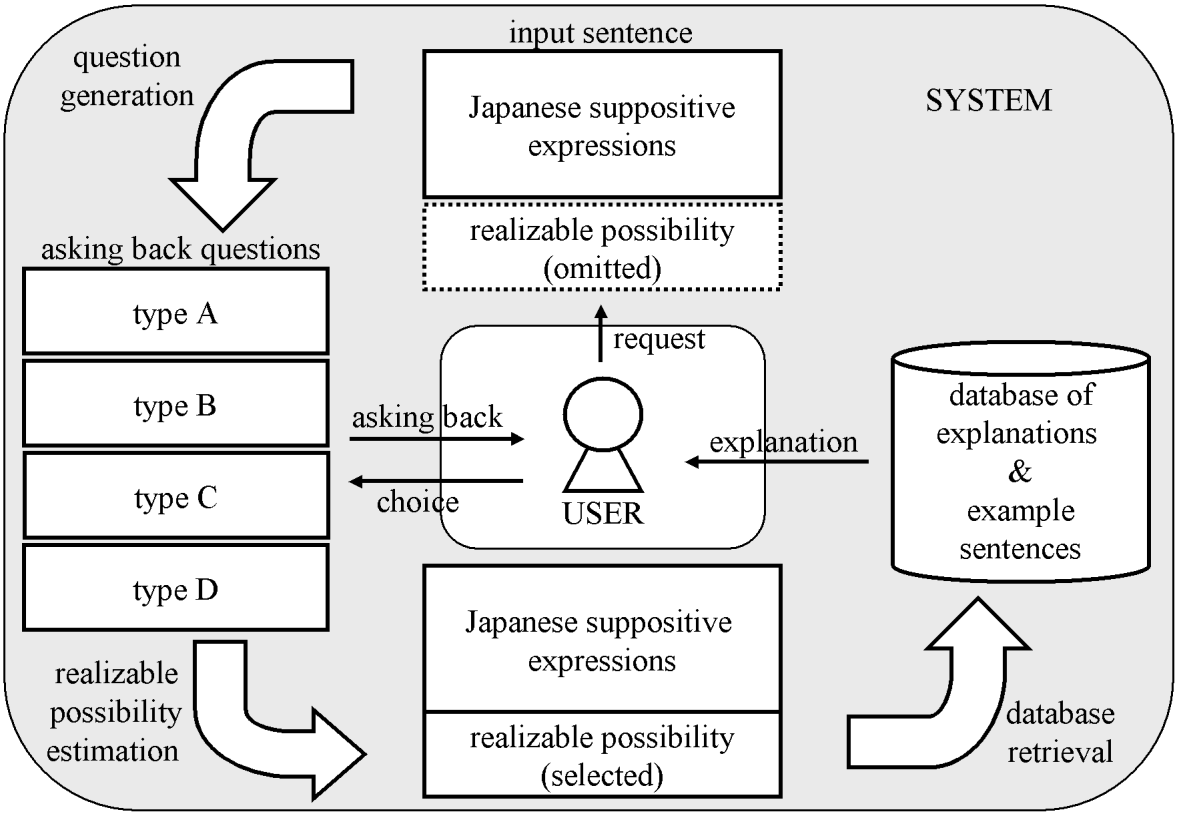

Figure 2: System overview.

ity. As a result, it is important to make students aware of the gaps, in this case, the realizable possibility.

To solve this problem, we propose a learning support method for English composition by asking back questions. Our system asks users back and make them aware of the gaps between Japanese and English expressions. There are several kinds of gaps between Japanese and English expressions. However, in this paper, we have concentrated on suppositive expressions because space is limited.

2 ASKING BACK QUESTIONS ABOUT POSSIBILITY

From the viewpoint of realizable possibility, English suppositive expressions can be classified into four types:

Type A expressions about general or habitual activities and the possibility is very strong

(ex 4) When you mix red and yellow, you get orange.

(ex 5) You always play baseball whenever the weather is nice.

Type B expressions about one-time activities and the possibility is very strong

(ex 6) You will play baseball when the weather is nice.

Type C expressions about one-time activities and the possibility is fifty-fifty

(ex 7) If the weather is nice, you will play baseball.

Type D expressions about one-time activities and the possibility is very weak

(ex 8) If the weather was nice, you would play baseball.

Because, in Japanese suppositive expressions, realizable possibilities are frequently omitted or expressed ambiguously, it is important to make Japanese students aware of the realizable possibilities.

To solve this problem, our system asks users back and make them aware of the gaps between Japanese and English expressions. Figure 2 shows the overview of our system. Our system applies morphologic anal-

ysis(Kurohashi 05) to an input sentence, obtains conditional clause (basic and original form) and consequence clause, generates four types of asking back questions according to the rules in Figure 3 and gives them to the user. Take (ex 9) for example.

(ex 9) *moshi* (when/if) *tenki* (weather) *ga haretara* (nice), *yakyu* (baseball) *ga dekiru* (will play).

From (ex 9), our system extracts "*moshi* (when/if) *tenki* (weather) *ga haretara* (nice), " as the conditional clause, on the other hand, "yakyu (baseball) ga dekiru (will play)" as the conclusion clause. Then, according to the rules in Figure 3, our system generates four types of asking back questions:

Asking back question (type A) [for general or habitual activities]

(ex 10) *tenki ga hareru toki ha, itsumo yakyu ga dekiru, desu ka?* (You think it always happens that you play baseball whenever the weather is nice, don't you?)

Asking back question (type B) [for very strong possibility]

(ex 11) *tenki ga hareru koto ha kakujitsu ni okoru node, moshi tenki ga harereba yakyu ga dekiru, desu ka?* (You think it is certainly that the weather will be nice and it certainly happens that you will play baseball, don't you?)

Asking back question (type C) [for fifty-fifty possibility]

(ex 12) *tenki ga hareru ka douka wakaranai ga, moshi tenki ga harereba yakyu ga dekiru, desu ka?* (You think it is fifty-fifty that the weather will be nice and are tentatively planning that you will play baseball, don't you?)

Asking back question (type D) [for very weak possibility]

(ex 13) *tenki ga hareru koto ha arie nai ga, moshi tenki ga harereba yakyu ga dekiru, desu ka?* (You think it is almost impossible that the weather will be nice, however, you are dreaming that you would play baseball, don't you?)

Then, the user answers the asking back questions, finds a gap between Japanese and English expressions, and translates the Japanese expression into English by using explanations and example sentences which are generated by our system and consistent with the selected possibility. For example, Figure 4 (a) shows the explanation and example sentences which our system gives to the user when he/she chooses very strong realizable possibility. On the other hand, Figure 4 (b) shows the explanation and example sentences which our system gives to the user when he/she chooses fifty-fifty realizable possibility.

(rule for type A) [for general or habitual activities]
[conditional clause (basic form)] *toki* (whenever) *ha itsumo* (always) [consequence clause] *desu ka* ? (You think it always happens that [consequence clause] whenever [condition clause], don't you?)

(rule for type B) [for very strong possibility]
[conditional clause (basic form)] *koto ha kakujitsu ni* (certainly) *okoru* (happen) *node* [conditional clause (original form)] [consequence clause] *desu ka* ? (You think it is certainly that [conditional clause] and it certainly happens that [consequence clause], don't you?)

(rule for type C) [for fifty-fifty possibility]
[conditional clause (basic form)] *ka douka wakaranai ga* (fifty-fifty) [conditional clause (original form)] [consequence clause] *desu ka* ? (You think it is fifty-fifty that [conditional clause] and are tentatively planning that [consequence clause], don't you?)

(rule for type D) [for very weak possibility]
[conditional clause (basic form)] *koto ha arie nai ga,* (impossible) [conditional clause (original form)] [consequence clause] *desu ka* ? (You think it is almost impossible that [conditional clause], however, you are dreaming that [consequence clause], don't you?)

Figure 3: Generation rules of Asking back question about realizable possibility.

Explanation You want to compose English suppositive expressions with very strong realizable possibilities. In such a case, you should not use if clause.
Japanese *Narita kuko ni tsui tara denwa shimasu*
English I'll call you when I get to Narita Airport.

(a) An explanation and example sentences for English suppositive expressions with very strong realizable possibilities.

Explanation You want to compose English suppositive expressions with fifty-fifty realizable possibilities. In such a case, you should use if clause.
Japanese *Narita kuko ni tsui tara denwa shimasu*
English If I get to Narita Airport, I'll call you.

(b) An explanation and example sentences for English suppositive expressions with fifty-fifty realizable possibilities.

Figure 4: Explanations and example sentences which are consistent with user's selected realizable possibility.

3 EXPERIMENTAL RESULTS

We examined whether nine Japanese students understood realizable possibility which was consistent with the given situation. In this experiments, we gave the following Japanese suppositive sentences

(input 1) *962 do* (degrees centigrade) *made* (to) *kanetsushi* (heat) *tara* (when/if), *gin* (silver) *ha tokeru* (melt)

(input 2) *shigoto* (job) *ga owat* (over) *tara* (when/if), *renraku shimasu* (get in touch)

(input 3) *ano ki* (the tree) *wo kiritaoshi* (cut down) *tara* (when/if), *motto* (more) *nagame* (view) *ga yoku naru darou* (be good).

and some situations of each input sentence (Figure 5) to the students. Then, our system gave asking back questions to the students and we examined whether the students understood realizable possibility which was consistent with the given situations. Table 1 shows the experimental results. In Table 1, underlined numbers show the numbers of students who select asking back questions which, we first thought, were consistent with the given situations. As shown in Table 1, students' answers were almost the same as our answers, except in situation 1-2 and 3-3.

In situation 1-2, we first thought that type C asking back question was consistent with situation 1-2. However, four students selected type D asking back question because they thought that their friends were not specialists and it is impossible to heat silver above 900 degrees Celsius. On the other hand, in situation 3-3, five students selected type D asking back question which, we first thought, were consistent with situation 3-3. The reason why these five students thought the possibility was very weak was that they thought they could not cut down the tree in someone else's garden. In contrast, three students selected type C asking back question. The reason why these three students thought the possibility was fifty-fifty was that they thought the tree would fall down naturally or somebody would cut it down. In both cases, students' answers were divided and some students found the possibility which was not consistent with what we expected, however, consistent with what they thought. It shows the effectiveness of our method.

situation 1-1	You are a science teacher. You will tell the nature of silver to your students.
situation 1-2	You will give some advices to your friend who intends to performing experiments.

(a) situations for input 1

situation 2-1	There are prospects of finishing your task.
situation 2-2	There are little prospects of finishing your task.
situation 2-3	There are no prospects of finishing your task.

(b) situations for input 2

situation 3-1	You are rebuilding your house and have already decided to cut down the tree.
situation 3-2	You are rebuilding your house and now discussing whether you cut down the tree.
situation 3-3	You are taking a walk and watch the tree in someone else's garden.

(c) situations for input 3

Figure 5: Situations for input 1, 2, and 3.

Table 1: Experimental Results.

asking back question	situation							
	1-1	1-2	2-1	2-2	2-3	3-1	3-2	3-3
type A	6	0	1	0	0	0	1	1
type B	2	0	8	1	0	9	0	0
type C	1	5	0	8	2	0	8	3
type D	0	4	0	0	7	0	0	5

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INFORMATION EXTRACTION FOR SUPPORTING A LEARNER'S EFFORTS TO RECOGNIZE WHAT THE LEARNER DID NOT UNDERSTAND

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Keywords: Learning support system, Question making support, Q&A site, Information extraction, Support vector machine.

Abstract: Asking a question is an essential method of learning. Especially, when problems in learner's question are pointed out, the learner has a chance to recognize what he/she did not understand. As a result, we intend to develop a learning support system which points problems in learner's questions and give the learner a chance to recognize what he/she did not understand. In this study, we propose a method of extarcting information from questions and their answers posted to Q&A sites for supporting a learner.

1 INTRODUCTION

Asking a question is an essential method of learning. Especially, when problems in learner's question are pointed out, the learner has a chance to recognize what he/she did not understand. For example,

(Qst 1) *kinou yometa webpage ni access dekimasen. dou shitara ii deshouka?* (I cannot access a webpage which I could read yesterday. What should I do?)

(Ans 1) *URL wo misetekudasai.* (Show URL.)

In this case, the questioner could not obtain an solution, however, he/she had a chance to understand the relation between webpage and URL. In this way, it is important for a learner to ask a question and receive indications of problems in the quesiton. As a result, we intend to develop a learning support system which points problems in learner's questions and give the learner a chance to recognize what he/she did not understand. In order to develop this learning support system, it is necessary to investigate

- a method of analyzing learner's question and pointing out problems what the learner did not understand, and
- a method of extarcting information from questions and their answers posted to Q&A sites [1] for supporting a learner.

[1] Q&A sites is websites where users answer to each other's questions.

In this study, we are concerned with information extraction from questions and answers posted to Q&A sites.

The point is that our approach differs from question answer (Dumais 02), (Kiyota 02), query expansion, (Matsuike 05), (Xu 96) and writing support systems (Hayashi 91), (Yamazaki 99).

By using the following examples, we discuss information for supporting learner to recognize what he/she did not understand and make better questions.

(Qst 2) *PC wo kidou deki masen. dou shitara ii deshouka?* (I cannot start my PC. What should I do?)

(Ans 2–1) *OS ha nan desu ka? chanto shitsumon shinai to, kotae raremasen.* (Which OS? I cannot make an answer unless you ask a question properly.)

(Ans 2–2) *kidou disk wo tsukaeba, saikidou dekimasu.* (You can start your PC by using boot disk.)

In (Ans 2–1), the answerer pointed out that the questioner did not describe important information (OS type). The questioner had a chance to recognize that information about OS type should be add to his/her question. By the way, the questioner probably knew such OS matters. If the questioner had got a clue as to which information should be described in his/her question, he/she would have made such a question:

(Qst 2–a) *windows XP no PC wo kidou dekimasen. dou shitara ii deshouka?* (I cannot start my win-

dows XP PC. What should I do?)

By the way, information which a questioner did not know might be also important to give a learning chance to the questioner when it is easy to confirm. For example, even a questioner who did not know the utilization of a booting disk can find that there is a way of dealing with his/her problem by using it when he read (Ans 2–2). However, if he/she had no booting disk, the solution described in (Ans 2–2) was useless. It is not difficult to confirm whether he/she have a booting disk, and if he/she had no booting disk, he/she would have made such a question:

(Qst 2–b) *PC wo kidou deki masen. dou shitara ii deshouka? kidou disk ha motte imasen.* (I cannot start my windows Vista PC. What should I do? I have no booting disk.)

As shown, information easy to confirm is also important to recognize what he/she did not understand. Information easy to confirm could be instruments, environments, conditions, or solutions themselves.

In this study, we propose a method of extracting information for supporting a learner to recognize what he/she did not understand, in other wards,

- clues as to which information should be described in his/her question, and
- information which a questioner does not know but is easy to confirm

from questions and answers posted on Q&A sites by using support vector machine (SVM) (Kudoh 00). The point is that information extracted by our method differs from information extracted for developing knowledge of Q&A systems, (Watanabe 08), (Lin 02). In this study, we used questions and answers posted on Yahoo! chiebukuro which was published by Yahoo! Japan via National Institute of Informatics.

2 INFORMATION FOR SUPPORTING A LEARNER TO RECOGNIZE WHAT HE/SHE DID NOT UNDERSTAND

In this study, we propose a method of extracting information for supporting a learner to recognize what he/she did not understand from questions and their answers posted on the Q&A site. Specifically, we use support vector machine (SVM) and extract the following kinds of sentences:

- important sentences from questions, and
- sentences which include information for supporting a learner to recognize what he/she did not understand from answers.

We used the data of Yahoo! chiebukuro for developing experimental data and investigating features for SVM. The data of Yahoo! chiebukuro was published by Yahoo! Japan via National Institute of Informatics in 2007 [2]. This data consists of about 3.11 million questions and 13.47 million answers which were posted on Yahoo! chiebukuro from April/2004 to October/2005. The answers were classified into two types: best answer and normal answer. In this study, from about 470 thousand answers which were posted on "PC and peripheral equipments" category, we extracted 2251 answers (1058 best and 1193 normal answers) which consists of less than four sentences. This is because, we think, it is easier to extract information for supporting a learner to recognize what he/she did not understand from these short answers than longer answers.

Table 1 shows the results of this investigation. We show below some examples of questions and their answers which consist of less than four sentences.

(Qst 3) *gazou no tokoro ga zenbu □ ◯ △ (aka, midori, ao) no kigou ni natte shimaun desu kedo, virus deshouka ?* (Is it virus?: Symbols □ ◯ △ (red, green, blue) were displayed instead of an image)
mata dou shitara naose masuka? (And, what should I do?)

(Ans 3) *net jyou no gazou to iu koto deshouka?* (An image on the network?)
kono te no shitsumon wo suru toki ha saiteigen OS no jyouhou kurai ha irenaito kotaere masen. (You must describe at least OS information when you make such a kind of question, or I cannot make an answer.)

(Ans 3), was a normal answer of (Qst 3). In this case, we determined that the important sentence of (Qst 3) is the first sentence (Is it virus?: Symbols □ ◯ △ (red, green, blue) were displayed instead of an image). Also, we determined that the first sentence (An image on the network?) and the second sentence (You must describe at least OS information when you make such a kind of question, or I cannot make an answer.) include clues as to which information should be described in the question. In (Ans 3), the answerer pointed out that the questioner did not describe important information (OS type), and made no solution.

(Qst 4) *kinkyu nanode, oshiete kudasai.* (It is urgent, help me.)

[2] http://research.nii.ac.jp/tdc/chiebukuro.html

Table 1: Results of the investigation of questions and their answers posted on Yahoo! chiebukuro (category: PC and peripheral equipments). A target sentence (type I) means a sentence including clues as to which information should be described in his/her question. On the other hand, a target sentence (type II) means a sentence including information which a questioner does not know but is easy to confirm.

text type	# of text	# of sentence	# of important sentence	# of target sentence (type I)	# of target sentence (type II)
question	2219	6216	2893	—	—
answer (best)	1058	2116	—	214	649
answer (normal)	1193	2160	—	232	332

ima sugu print shinakya ikenai mono ga arimasu. (A matter should be printed as soon as possible.)

2ji made desu. (by two o'clock.)

demo, color ink 2 shoku ga nakute koukan suruyou message ga demasu. (However, I received a message: due to out of ink, change the two colors of ink)

mou sukoshi motsudarouto omotte itanode kaioki ha shite imasen. (I have no spare ink because I thought ink was enough.)

insatsu ha shirokuro desu. (I want to print the matter in monochrome.)

nantoka color ink 2 shoku wo koukan sezuni insatsu suru urawaza wo shitteiru kata imasenka? (Do any of you know how to print it without exchanging the two colors of ink?)

printer no kishu ha epson no PM-A850 desu. (My printer is epson PM-A850.)

ink ha kuro to, color ink 5 shoku ni cartridge ga wakareteimasu. (There are black and five color ink cartridges.)

(Ans 4) *printer no property ni "monochrome insatsu" tte naidesuka?* (Do you have "monochrome print" in the property of the printer?)

areba, sore wo shiji suru toka. (If you have, turn it on.)

(Ans 4) was the best answer of (Qst 4). In this case, we determined that the important sentence of (Qst 4) is the seventh sentence (Do any of you know how to print it without exchanging the two colors of ink?). Also, we determined that the first sentence of (Ans 4) (Do you have "monochrome print" in the property of the printer?) includes information which a questioner does not know but is easy to confirm.

3 FEATURES USED IN MACHINE LEARNING ON YAHOO! CHIEBUKURO

In this study, we made experiments on questions and their answers posted on Yahoo! chiebukuro to extract by using support vector machine (SVM).

- important sentences from questions, and
- sentences including information for supporting a learner to recognize what he/she did not understand from answers.

Figure 1 shows feature $S1 \sim S16$ used in machine learning (SVM) on Yahoo! chiebukuro. $S1 \sim S4$ were extracted from the target sentence of the extracting process based on SVM. On the other hand, $S6 \sim S8$ were extracted from sentences other than the target sentence. $S1 \sim S8$ were used in extracting sentences from questions and answers. On the other hand, $S9 \sim S16$ were only used in extracting sentences from answers. $S9 \sim S11$ were extracted from questions, $S12 \sim S14$ were extracted from the important sentences in questions, and $S15$ and $S16$ were extracted from questions and their answers. These features were based on the results of the investigation in section 2. In the experiments, we used JUMAN for the morphological analysis (JUMAN 05).

4 EXPERIMENTAL RESULTS

In this section, we show the results of the following experiments by using SVM and effective features in extracting information for supporting a learner to recognize what he/she did not understand.

Table 2: Results and effective features in Exp. 1, 2 and 3.

Exp.	effective features	accuracy	F-measure
Exp. 1	$S1, S2, S3, S4, S5, S6$	86.04%	0.8443
Exp. 2	$S1, S4, S5, S9, S12, S15, S16$	91.65%	0.4773
Exp. 3	$S1, S4, S5, S9, S12, S16$	86.04%	0.6503

$S1$	word unigrams of the target sentence
$S2$	word bigrams of the target sentence
$S3$	word trigrams of the target sentence
$S4$	number of sentence of the question/answer and sentence number of the target sentence
$S5$	number of words of the question/answer
$S6$	word unigrams of the non-target sentences and relative position to the target sentence (before/after)
$S7$	word bigrams of the non-target sentences and relative position to the target sentence (before/after)
$S8$	word trigrams of the non-target sentences and relative position to the target sentence (before/after)
$S9$	word unigrams of the question
$S10$	word bigrams of the question
$S11$	word trigrams of the question
$S12$	word unigrams of the important sentence in the question
$S13$	word bigrams of the important sentence in the question
$S14$	word trigrams of the important sentence in the question
$S15$	nouns which are found both in the question and its answer
$S16$	number of nouns which are found both in the question and its answer

Figure 1: The features used in machine learning (SVM) on Yahoo! chiebukuro.

Exp. 1 extract important sentences from questions posted on a Q&A site

Exp. 2 extract sentences including clues as to which information should be described in a question from answers posted on a Q&A site

Exp. 3 extract sentence including information which a questioner does not know but is easy to confirm from answers posted on a Q&A site

We conducted Exp. 1, 2, and 3 using TinySVM (Kudoh 00) with polynomial kernel ($d = 2, c = 1$). In this experiments, we used 2219 questions and their 2251 answer in Table 1 as the experimental data.

All experimental results were obtained with 10-fold cross-validation. To calculate the accuracy and F-measure, the experimental data was manually tagged in the preparation of the experiments.

Table 2 shows the results and effective features in Exp. 1, 2, and 3.

Finally, we discuss the features which were not designated as effective features in Exp. 2 and 3. Both in Exp. 2 and 3, $S6, S7$, and $S8$ were not designated as effective features. These features were based on word n-grams in the non-target sentences of SVM extraction process. It shows that sentences including information for supporting a learner to recognize what he/she did not understand can be extracted, not by using non-target sentences of SVM extraction process. Furthermore, it may show that although the user only read sentences which include information for supporting a learner to recognize and never read other sentences, he/she can understand and use it.

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COMMON SOFTWARE ENGINEERING COURSE
Experiences from Different Countries

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Keywords: Joint Course, Software Engineering, Team assignments.

Abstract: A joint common course has been created as a result of a project of the "Stability Pact of South-Eastern Europe" and DAAD. It has been conducted in Novi Sad, Serbia, with graduate students, and in Tirana, Albania, with master students by teachers from Berlin and Novi Sad. In this paper, similar methods used in each of these courses, and outcomes reached by students are presented and compared with the achievements within the "original" course, conducted at the Humboldt University in Berlin.

1 PRELIMINARIES

With support of DAAD and the "Stability Pact of South-Eastern Europe", a joint project was established in 1999. Idea was to build and evolve common courses in several fields of computer science, starting with "Software Engineering".

The project consists of participants from 15 universities, from 9 countries: Germany, Serbia, FYR Macedonia, Bulgaria, as core members, and Croatia, Bosnia and Herzegovina, Romania, Albania, and Montenegro as associate members (Bothe, 2003; Bothe, 2005; Budimac, 2008; Zdravkova, 2003). The main goals of the project were:

- "Software Engineering" is included into universities' curricula of all participating countries;
- Agreement on a joint course was performed, with creation of teaching, examination, and assessment material;
- Founding of e-Learning facilities was completed;

Goals are performed through cooperation in development of teaching materials, and production of a distributed, Internet-based, multilingual university course. Joint course originated from one conducted at the Humboldt University in Berlin. It covers more than 85% of the elementary lessons suggested in "Curricular guidelines for undergraduate programs in computing" (ACM 2001, SWEBOK 2001).

2 STRUCTURE OF THE COURSE

The course is conducted at several participating universities as a whole, or in part:

- At Humboldt University in Berlin, it's been conducted for a decade, for undergraduate students;
- At the University of Novi Sad, Faculty of Science, course has been conducted:
  - for postgraduate CS students, for 2 years,
  - for undergraduate CS students, for 4 years.
- At the University of Beograd, Serbia, Timisoara, Romania, Plovdiv, Bulgaria, and Skopje, FYR Macedonia, course has been conducted in different ways and durations in the last several years;
- At the Polytechnics University of Tirana, a 7-day crash-course has been conducted for 2 years.

The course consists of 28 topics covering introductory notions of software engineering.

The second essential component of the course is usage two of complex case-studies.

The third component of the course is team assignments. An assignment pool was created, and lecturers are free to choose from it. From 5 to 20 teams was created per year, sizing from 3 to 5 students. During the school year, assignments are given to teams, with a deadline of 2-3 weeks to solve it. A minimum number of points required to qualify for the final exam is 50%, yet how those influence the final grade is not the same. In Germany, number of points does not influence the final grade. In Serbia, and Albania, points gained for the assignments directly influence the final grade.

3 ASSIGNMENTS AND ACHIEVEMENTS

For the first time during the school year 2004/05 an identical complete course, with the same case studies, and the same assignments for students was held in Berlin and in Novi Sad. Later on, the same course was conducted in a different style in Tirana, but with the same general structure.

A pool of nine assignments has been created.

- Assignment 1: Review of "(preliminary) requirements specification".
- Assignment 2: Application of a function-point method on a given requirements specification.
- Assignment 3: Review of a product model resulted after structured analysis.
- Assignment 4: Development of a use-case diagram and class diagram for a given problem.
- Assignment 5: Definition of a formal specification for several given operations.
- Assignment 6: Review of a solution of the fourth assignment of a different team.
- Assignment 7: Measuring a quality of software.
- Assignment 8: Specification of a regression test.
- Assignment 9: Creation of a classification tree.

The following procedure for assignments is applied: Teams are given specific tasks and have to produce results in a given time. Later, one exercise class is organized where the most provoking solution is presented by the members of the team submitting it.

For solving of the assignments, students are divided into teams, according to their own choice. This approach has several advantages (Bielikova 2004). The first is simplicity from the managerial point of view. Second is the fact that the opportunity to sign up for a team of their choice creates an additional personal relationship within team.

There are at least two disadvantages to this approach. First, the team quality can (and usually does) vary significantly. The second drawback is that occasionally, members of the groups have complaints on the other members. While students are informed that they are allowed to "fire" their colleague from the team, this is much more difficult when team members are mutual friends.

Not all of the assignments are performed each year. Especially, the length of the course influences the choice of assignments for the course in Tirana. Another important point is the fact that the "correct solution" which is presented to students is created in cooperation, based on the combined experience of lecturers from Berlin and Novi Sad.

4 RESULTS FOR ASSIGNMENTS

Results gained at different universities, for the assignments are presented here. Number of students grows every year, yet percentage of gained points for assignments shows regular behaviour. For students from Novi Sad results are given in Table 1.

- Percentage of gained points for the first year is significantly different than during the following years. Reason for this probably is connected to the non-experience of lecturers.
- The worst results are usually gained for the assignment number 2 (the function-point method). The assignment is quite straightforward, yet it seems that it has some hidden difficulties.

Table 1: Assignment points for Novi Sad students of Computer Science.

Novi Sad	Nr of Students	Average Points Assgn 1	Average Points Assgn 2	Average Points Assgn 3	Average Points Assgn 4	Average Points Assgn 5	Average Points Assgn 6	Average Points Assgn 7	Total Points Assgn
2004	45	81,11%	66,67%	63,78%	73,11%	75,78%	88,61%	68,52%	74,05%
2005	54	73,89%	74,53%	80,38%	79,90%	80,68%	94,32%	95,45%	81,75%
2006	60	81,67%	75,42%	88,00%	75,56%	80,67%		95,00%	81,85%
2007	66	77,73%	75,99%	85,76%	77,42%	78,30%	94,38%	91,67%	82,18%
Average		78,60%	73,15%	79,48%	76,50%	78,86%	92,43%	87,66%	79,96%

Table 2: Assignment points for Tirana master students.

	Nr of Students	Average Points Assgn 1	Average Points Assgn 2	Average Points Assgn 5	Average Points Assgn 7	Total Points Assgn
Tirana 2007	17	78,24%	80,59%	80,00%	98,24%	84,26%
Tirana 2008	15	69,30%	74,00%	76,70%	95,30%	78,83%
Tirana 2008 II	15	66,00%	78,70%	80,70%	92,70%	79,53%
Average		71,18%	77,76%	79,13%	95,41%	80,87%

- Assignment number 6 (review of a solution of another teams' assignment) has the highest average percentage of points, which is expected, since it represents mostly the ability of a team to defend their own opinion.
- The best results and the highest number of points are gained for the assignment 7 (measuring of the quality of software). First, it is straightforward and relatively simple task. Second, this is the last assignment, when students are experienced of what they have to do to solve their task.
- The assignment 4 (creation of use-case and class diagrams), asking for the highest level of "creative" work, has the second worst results. The main point here is the lack of experience with the real-life work, no practical abilities and skills.
- Average total points achieved by students are sufficient for them to approach the rest of the exam. Even more, it is close to 80% of points.

At the Polytechnic University of Tirana, in spring of 2007, a 7-day crash-course for the students of master studies was conducted by professor from Berlin and assistant from Novi Sad. Again in 2008, course was conducted again, this time with 15 students from the first year, and 15 students from the final year of master studies.

These students had to solve 4 assignments: 1 (review of requirements specifications), 2 (function-point method), 5 (definition of formal specification), and 7 (measuring of the quality of software). The first one they solved before the course started, to be introduced to the requirements specification. Other three had to be solved after the course, 2 weeks per each assignment. Results are presented in Table 2.

Results are quite comparable to the results of Novi Sad students. If we disregard the first year, percentages for the same assignments in Novi Sad are 77.76%, 75.31%, 79.88% and 94.04%. The difference is not high, since students from Tirana were studying in non-mother tongue, preventing them to achieve better results as master students.

How does all this compare to Berlin students? For Berlin, statistics is given in Table 3. One thing that influenced those results is the fact that during 2007, assistant was changed in Berlin. Notice that in Novi Sad, Tirana, and Berlin (during the first two years) average percentage of points is around 80-82%, yet, inexperienced assistants had different results: 74% in Novi Sad, or 87% in Berlin.

5 THEORETICAL TESTS

The second part of the exam was tests with theory. The particular structure is different, but general form is the same. A repository of around 400 questions is created. There were 2 tests in Albania, or 3-4 in Serbia, yet in total they sum up to 60 points for tests, added to 40 points for assignments. For students from Germany, the second part of the exam is performed orally. Table 4. presents Serbian students' results achieved in tests.

Students from Tirana had only two tests, both were performed "on the distance" by a local professor, and at the same time. This is different than in Novi Sad, where tests are scheduled throughout the school year. Test results are presented in Table 5. Number of points is much lower than for Novi Sad students. The only reasonable explanation is a usage of English, non-mother language. Additional problem was the fact that the test was performed on the distance. So, problems with questions, even the lingual ones, could not be solved.

Table 3: Assignment points for Berlin students.

Berlin	Nr of Students	Average Points Assgn 1	Average Points Assgn 2	Average Points Assgn 3	Average Points Assgn 4	Average Points Assgn 5	Average Points Assgn 7	Total Points Assgn
2003	52	88,57%	78,41%	75,00%	72,27%	65,00%	86,73%	77,14%
2005	85	86,88%	80,63%	86,25%	74,67%	75,63%	78,00%	80,34%
2007	64	87,14%	87,62%	87,62%	87,62%	81,00%	91,90%	87,15%
Average		87,53%	82,22%	82,96%	78,19%	73,88%	85,54%	81,54%

Table 4: Test points for Novi Sad students of Computer Science.

Novi Sad	Average Points Test 1	Average Points Test 2	Average Points Test 3	Average Points Test 4	Total Points Tests
2005	68,07%	66,09%	66,92%	63,95%	66,25%
2006	70,41%	71,35%	67,54%	70,89%	70,05%
2007	68,63%	70,00%	54,01%	53,33%	61,49%
Average	69,03%	69,14%	62,82%	62,72%	65,93%

Table 5: Test points for Tirana master students.

	Nr of Students	Average Points Test 1	Average Points Test 2	Total Points Tests
Tirana 2007	17	58,33%	50,33%	54,33%
Tirana 2008	15	64,23%	56,43%	60,33%
Tirana 2008 II	15	67,33%	52,00%	59,67%
Average		63,30%	52,92%	58,11%

6 CONCLUSIONS

Results of the project were very successful, first of all for students:

- Students are enabled to learn according to contemporary contents, principles and standards;
- Course compatibility, both general and particular, is achieved;
- Experiences, methods, and learning activities and styles of lecturers from several different countries are adopted;

There are a lot of similarities with the results gained for the assignments. The final grade for each of conducted courses is on the average between 8,20 and 8,29 for all countries.

Considering the method of passing the exam and results for assignments and tests general conclusions are drawn out:

- Students belonging to higher years are: (slightly) more serious; get (slightly) higher number of points for the assignments and for tests; pass the exam in (slightly) larger percentage.
- Comparable groups of students from different countries have similar results: they use the common material; are confronted with the same methodology and didactics; meet the similar style, techniques of presentation and exam
- Good results with the application of common course material and techniques are a consequence of exchange of experiences and opinions of Project participants.

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A NEW APPROACH TO TEACHING AND LEARNING STRUCTURAL ANALYSIS

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Keywords: Structural analysis, Computer software, Virtual experiment.

Abstract: After the 9/11 incident, many structural educators became aware of the importance of inculcating in their students a clear understanding of local and global structural behaviour to develop basic knowledge about the progressive collapse of structures. The authors of this paper have addressed the issue by training students through 'virtual' experiments in a self-learning environment with the help of a newly developed software application, iSA (Instant Structural Analysis). One of the outstanding features of this application is that it allows students to instantly observe the changes in structural behaviour that are induced by changes in loading conditions, structural geometry, support conditions and member properties. This paper not only discusses the need to modify traditional teaching methods in the education of the new generation of structural engineers, but also presents some of the features of iSA that serve as handy tools in the teaching and learning of structural analysis.

1 INTRODUCTION

Since the catastrophic collapse of the World Trade Centre (WTC) towers on September 11, 2001, it has become more apparent that understanding the progressive failure or collapse of structural systems is of paramount importance. Many educators and researchers have realised the importance of this, developing different types of educational packages. Al-Ansari & Senouci (1999) and Codeno-Rosete (2007) decided to employ commercial software such as Microsoft Excel, Mathcad and Scilab (http://www.scilab.org) in developing education packages to facilitate the teaching of structural analysis and design. With the help of rapidly developing information technology, many researchers have developed applications related to structural education that can be accessed through the Internet. Yuan and Teng (2002), Jiang et al. (2002), and Brretto et al. (2003) have applied client-side technologies such as HTML, Java and Flash in developing web-applications for students to carry out simple structural analysis or structural laboratories by using web-browsers without having to install the application in their local computers. One of the most outstanding advantages of this type of client-side technology is that students can always gain access to the latest version of the software from the website. Elgamal et al. (2005) made use of both client-side and server-side technologies in developing the Webshaker system, which allows students to remotely control a shaking table in the laboratory through a web-browser. Common to the abovementioned packages is their ability to enable students to easily test structures under various support conditions, material and cross-sectional properties, and loading conditions.

A new approach to teaching structural analysis and design is the use of instant structural analysis software (Beer & Pilz, 1999) that is capable of stimulating rapid experimental learning as well as capable of being used as a creative design tool.

An easy-to-use instant structural analysis software application with full graphical user interface (GUI) has been developed for 2D structures – iSA (Instant Structural Analysis). iSA serves as a handy tool for teachers and engineers alike to learn about structural analysis and design. It

gives instant graphical results that accurately simulate structural responses, thus promoting self-learning and creativity. This paper introduces several features of iSA and their importance in enhancing student learning and the understanding of structural analysis.

2 ISA (INSTANT STRUCTURAL ANALYSIS) AND ITS BASIC FEATURES

iSA (http://www.bc.cityu.edu.hk/isa) is a user-friendly, yet powerful, 2D structural analysis package that supports modelling with a 'drawing' GUI or the use of template wizards (so-called 'structure generators') to generate structurally complicated models in minutes. Because its purpose is to provide an environment for students to simulate different structures under various loading conditions, iSA is easy-to-learn and easy-to-operate. In general, it takes only a few minutes for students to finish the computer model of a structure in iSA. According to the experience of the authors, it takes only two hours for Year 2 undergraduate structural engineering students (with knowledge of the matrix stiffness method) to evolve from beginners to experts in the use of this software.

iSA can be used for the analysis of trusses, continuous beams and frames with different types of pinned joints. Comprehensive databases of materials and standard sections are available. This feature is very important for students using iSA in learning structural design, as they can easily 'try' different sections on the structure and instantly obtain a new set of analysis results to determine whether the design is feasible. Apart from standard sections, users can define their own material and cross-sections. Analysis is automatically completed once the structural system and the loading conditions are defined, and the analysis results can be instantly presented to the user. After changes to the structural geometry, support condition, member properties, etc., the new analysis results can again be instantly presented. This ability to provide instant results makes it very suitable for carrying out 'virtual testing' (Kayvani, 2007). For example, students can remove some members, apply several hinges or change the boundary condition of the structural system to simulate the situation of a terrorist attack, and then observe the effects on the structure (e.g., what is the change in load distribution? What is the change in deformation? Is the structure still stable under the second-order analysis?). This kind of 'virtual testing' is very efficient in helping students to develop their structural engineering sense and to understand the concept of progressive collapse.

Furthermore, iSA supports not only first-order but also second-order static analysis, dynamic modal analysis, stability analysis and moving load analysis. It is not only a versatile tool for the teaching and learning of the subject, but is also a handy tool for practising engineers in structural analysis and design.

2.1 Material and Cross-sectional Properties

iSA provides a GUI that allows users to modify the material and cross-sectional properties easily (see Figure 1).

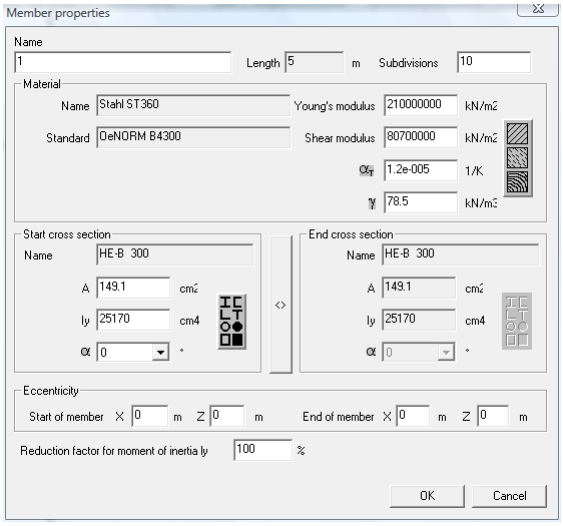

Figure 1: GUI for modifying the material and cross-sectional properties of members.

A series of commonly used materials, such as steel, concrete and aluminium are available in the system's material database (see Figure 2). A comprehensive database of cross-sections is also available for different standards, such as universal beams and columns. iSA supports both prismatic and non-prismatic members. By clicking the '<>' button (see Figure 1), users can define a different section as the 'end cross section'. iSA assumes that the inverse of the second moment of area varies linearly along the member.

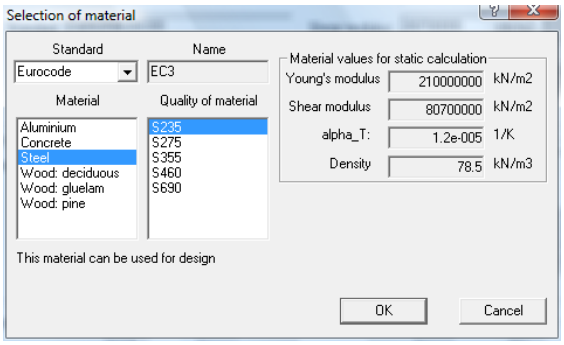

Figure 2: GUI for selecting a material from the database.

2.2 Support Conditions

iSA's GUI allows users to modify the support conditions easily. In the 'Constrained DOFs' area shown in Figure 3, users can define the support as a pin, a roller or a built-in support at any angle from the horizontal. They are also allowed to use springs to model the semi-rigid behaviour of the support.

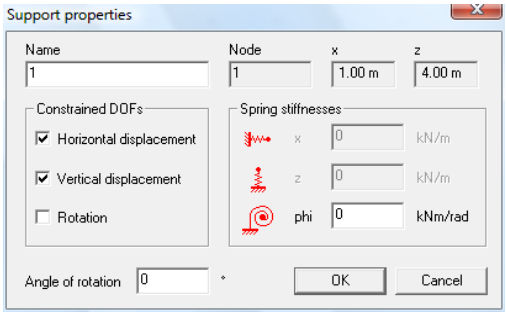

Figure 3: GUI for defining the support condition.

3 ADVANCED FEATURES

In addition to basic first-order static analysis, other types of analyses are available in iSA, such as second-order analysis, dynamic modal analysis, stability analysis and moving load analysis. Owing to the limited space, only some of these are introduced in the following sections.

3.1 Dynamic Modal Analysis

Once the structure is defined in iSA, the system stiffness and mass matrices are automatically generated. When users press the dynamic modal analysis button (at the toolbar), iSA solves the eigenvalue problem of the system stiffness and mass matrices and calculates the natural frequencies and mode shapes of the structure.

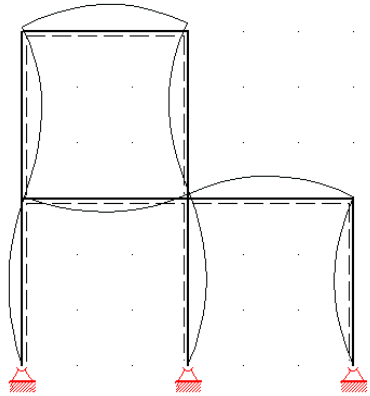

Figure 4: GUI showing the third mode of vibration of a simple frame structure.

The first mode natural frequency and mode shape is then instantly displayed in the drawing area on top of the original structure. Users can easily display the shapes of other modes through the GUI. Figure 4 shows a GUI that displays the third vibration mode of a steel frame. An animation of the mode shape is also available for students to gain a physical sense of the modes of a structural system.

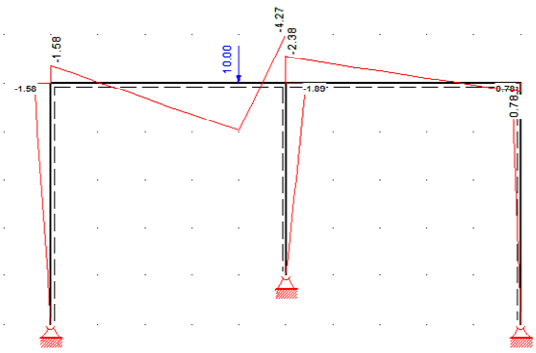

Figure 5: The bending moment diagram for one of the automatically generated moving load case.

3.2 Moving Load Analysis

Moving load analysis provides a fast and convenient feature for users to easily study the effect of a moving load on the structural system. After defining the movable load and the member on which the load is moving, a series of load cases are automatically generated under a pre-defined load case group. Figure 5 shows the bending moment diagram of the structure. In addition to the bending moment diagram, the shear force and axial force diagrams, together with their envelopes, are also available. When the structural geometry, the member

properties or the support conditions are changed, all of the analysis results are updated automatically, and the results are instantly presented through the GUI.

3.3 Teaching Progressive Collapse

The concept of progressive collapse can be introduced to students by using iSA with suitable guidance. A simple steel portal frame, as shown in Figure 6, is employed to illustrate this idea.

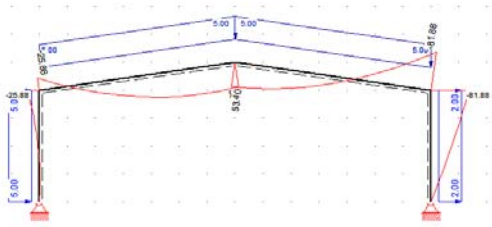

Figure 6: A portal frame to demonstrate the idea of progressive collapse.

Under the action of both the vertical and the horizontal distributed loads (as shown in Figure 6), it is clear from the results that the maximum bending moment is 81.88 kNm at the top right corner of the frame (see Figure 7).

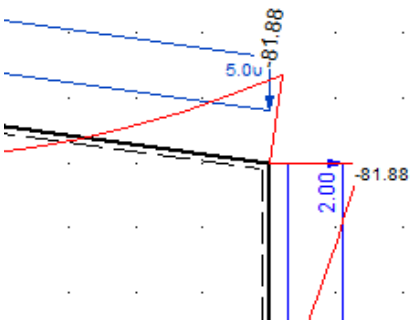

Figure 7: The maximum bending moment at the top right corner of the frame.

For demonstration purposes, 81.88 kNm is assumed to be the maximum plastic moment. Thus, a plastic hinge is formed at the top right corner of the frame. This plastic hinge can be easily modelled in iSA by first adding a full hinge at the joint and then applying appropriate moments at the ends of the members that connect the hinge. In this example, a full hinge is added to the joint at the top right corner of the frame. Then, member end moments of magnitude of 81.88 kNm and -81.88 kNm are applied at the ends of the two members that connect the full hinge, as shown in Figure 8. Note that the bending moment diagrams in Figure 7 and Figure 8 are the same, but there is a plastic hinge on the structure in Figure 8.

Users can now continue to increase the applied load on the frame. To demonstrate, only the vertical distributed load is increased. Figure 9 shows a situation in which the vertical load is increased to 6 kN/m. It is clear from the iSA result that the maximum bending moment of the structural system is on the top left member of the portal frame.

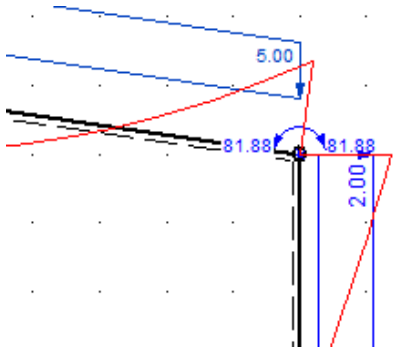

Figure 8: A plastic hinge is modelled at the top right corner of the portal frame.

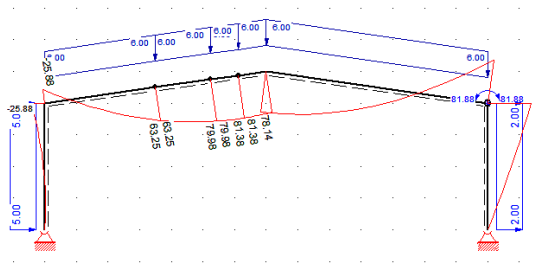

Figure 9: The applied load is further increased after the formation of the plastic hinge.

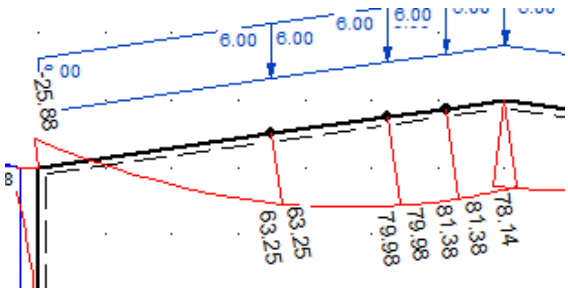

Figure 10: Additional nodes are added to locate the maximum bending moment on the top left member of the frame.

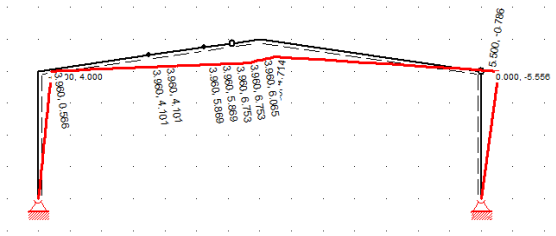

Figure 11: The additional plastic hinge makes the structure unstable, and it collapses.

To determine that location approximately, additional nodes are added on the member, as shown in Figure 10. It must be pointed out that there are many ways to identify the location and magnitude of the maximum bending moment (or axial force or shear force) on a member, and the introduction of additional nodes is only one of them. It is assumed that a plastic hinge is formed at the location of the maximum moment. When the user applies a full hinge at that location, iSA immediately shows that the structure is kinematically unstable, as shown in Figure 11. By repeating this exercise with suitable guidance from the teaching staff, students will be able to build up a sense of progressive collapse of structural systems.

4 CONCLUSIONS

The notion of having an adequate 'safety factor' in itself is not enough. Indeed, it could even give us a false sense of security. We need to emphasise to our students the importance of understanding physical, holistic structural behaviour such as the equilibrium of whole structures, the effects of compatibility, the effects of a lack of fit, etc. We need to equip our students with the fundamental and essential skills they need to be able to check and verify computer-generated results manually. We need to adopt easy-to-use structural analysis software that can provide and stimulate rapid experimental learning through the investigation of 'what if?' scenarios, that can be used to check computer-generated results to reflect on 'whether it really makes physical sense', and that can also be used as a creative design tool. We need to revise our curricula to phase out or reduce the use of old-fashioned manual calculation techniques and, instead, increase our emphasis on practical aspects and on a physical/holistic understanding of structural behaviour.

To prevent a catastrophic collapse, such as that which occurred on 9/11, we need to understand how a structure will behave and respond under all possible loadings, including that from a terrorist attack. Therefore, we should design every structure so that:

1. It will not fail catastrophically if a part or parts of the structure are damaged or destroyed;
2. It will be able to re-distribute the load when parts of the structure have failed; and
3. It will have a high degree of redundancy and be able to provide alternative load paths to avoid sudden collapse.

iSA, a user-friendly 2D structural analysis program with an easy-to-use GUI, has been described here. This software is a handy tool for instructor teaching and student learning in structural analysis (e.g., the matrix stiffness method, second-order analysis, dynamic modal analysis, plastic analysis, stability analysis, moving load analysis, etc.). As the analysis results are presented instantly, this is an efficient and rapid self-learning tool with which students can build up their confidence, engineering sense and understanding of structural behaviour.

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USING SEMANTIC TECHNOLOGIES AND CASE BASED REASONING TO SUPPORT COURSE CURRICULUM DESIGN TASKS

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Keywords: CBR, Ontologies, Course Design, Knowledge Based Systems.

Abstract: This paper presents a novel approach to Course Curriculum Design (CCD) where Semantic Technologies and Case Based Reasoning (CBR) techniques are used to assure *(i)* a better understanding of the course being designed and *(ii)* an efficient use of the available resources. Our work focuses on re-utilization of previously modelled information (courses, tasks, evaluations, etc.) in order to maximize the efficiency of the Course Design process while at the same time embedding implicit and experential knowledge of the course designers. Our approach is presented through an easy to follow architecture that can be adapted to course curriculum regulations of most European and American models. As a test case, we present an implementation for a Spanish technician-level telecommunications course, to demonstrate the benefits of our proposal.

1 INTRODUCTION

A good teaching process should provide the student with the highest possible quality. It can be argued that such quality, is strongly related to the best use of the available resources, the proper design of the subjects and evaluations, and generally, in the design of the courses and course components which are part of the education process (Högskoleverket, 2008).

For the aforementioned reason, the importance of course/curriculum design is gaining interest for teachers, education centres and researchers.

It has been reported, that in the present situation (Rubio Oca, 2006) many curriculum designs do not met requeriments, due to different factors, e.g. the evolution of technical tools used when the original design took place. This fact can lead to problems in technical adaptation. In many cases the lack of effective adaptation to the actual situation in curriculum plans generates a situation where students are not sufficiently qualified for industry, implying longer adaptation times when they become workers.

Typically, a course design starts with the definition of competences. In other words, the objectives that must be met at the end of the course cycle. Diamond (Diamond, 1998) points that educators need to clearly identify goals prior to any kind of course assessment. In our case, those goals are indistinguishable to what we understand as a

competence evaluation. Based on the competences the course designer builds the content, and later, the evaluations, producing an output for the students to follow (a process known as CCD).

Whitin our scope, we have found that CCD presents several challenges, the following being the most interesting from a computational perspective:

- Course Curriculum Designers have differing points of view, which lead to a non-homogenized, case curriculum.
- The re-use of knowledge and prior user experiences is not included in the approach.
- Every country has its own course design legislation. Successful experiences in one country cannot be easily applied to another.

For these reasons, a computerized system that aids the competences based CCD is required. We address this need by presenting a novel approach in where Semantic techniques are combined with a Case Based Reasoning (CBR) schema in order to enhance the precision of the system.

This paper is structured as follows: In chapter 2, we present an overview of related concepts. In chapter 3, we introduce our proposed schema using Semantic technologies and CBR. In chapter 4, we describe a case study, briefly explaining key points. Finally in chapter 5, we draw conclusions and suggest future work.

2 RELATED CONCEPTS

In this chapter, we introduce some concepts relevant to our work. Our intention is not to provide a comprehensive description of the topics involved, but to give a short overview. An interested reader is invited to review (Fallon and Brown, 2003), (Noy and McGuiness, 2001), (Aamodt and Plaza, 1994).

2.1 Educational Contents Modelling

e-Learning is defined as “any learning, training or education that is facilitated by the use of well-known and proven computer technologies, specifically networks based on Internet technology” (Fallon and Brown, 2003).

An important part of the e-Learning process involves the educational platform. The actual situation involves propriety design platforms with their own contents, making interoperability and interaction between models in use by different institutions a difficult and considerable task. The re-use of previous content presents further difficulty and expense. To rectify this situation, metadata-based educational standards have been developed.

We believe that important information can be rendered invalid, or not to be taken into account. Such information is not directly stored in databases, and is closely approximated to what we understand as ‘user experience’.

2.2 Semantic Technologies

In this work, we use ontology modelling for its inference capabilities and to support our architecture from a knowledge engineering point of view.

There are many possible definitions to describe what ontology is. In the Computer Science domain, the widely accepted definition states that “an ontology, is the explicit specification of a conceptualization” (Gruber, 1995), or in other words an ontology is a description of the concepts and relationships in a domain of study.

The main characteristic of an ontology based solution is its capacity to semantically infer newly derived information. Such information is not explicitly specified by the user and in order to obtain it modern inference engines and reasoners, like Racer or Pellet (Sirin et al., 2007), are used.

2.3 Case Based Reasoning

CBR is a problem solving technique based on two tenets: (*i*) the world is regular, so similar problems have similar solutions, and (*ii*) types of problems an agent encounters tend to reoccur (Leake, 1996).

CBR does not use generalized rules as a knowledge source, but a memory of stored cases recording specific prior episodes (Leake, 1996). New solutions are generated by retrieving the most relevant cases from memory and adapting them to fit new situations.

We believe that by mixing CBR and Semantic technologies the strong points of both techniques can be leveraged to the users advantage.

3 PROPOSED SCHEMA

In this work we propose an open and extensible architecture that combines Semantic and CBR techniques to enhance the CCD process.

Our architecture is divided in five layers (see Figure 1): (*i*) the *User Layer*, (*ii*) the *Knowledge Layer*, (*iii*) the *Experience Layer*, (*iv*) the *Information Layer* and (*v*) the *Data Layer*.

From bottom up, the fist layer is the *Data Layer*. This layer contains the data repositories that define the different CCD conforming elements (e.g. objectives, competences, courses, etc). The components of the *Data Layer* are not necessarily standardized; they are just bits of data that can be used for a CCD.

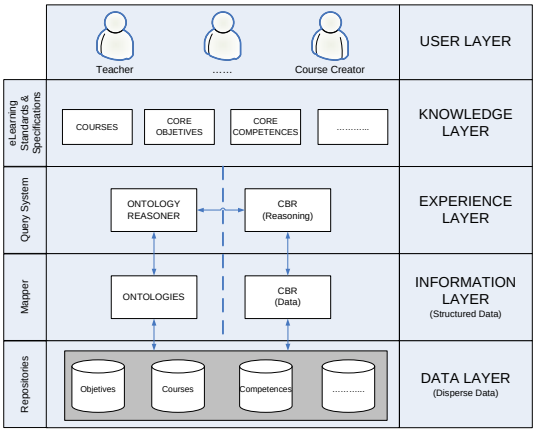

Figure 1: Architecture.

The *Information Layer* (above) contains two parts, (*i*) the ontologies and (*ii*) the CBRs.

The ontologies are constructed using a domain model that can be fed from the *Data Layer*. This means that these domain ontologies build their individuals upon the data available in the first layer.

The CBRs are the second component of this layer and they are a set of Case Systems (rules) that use the data of the first layer as a feed.

It is interesting to note that the available data is not necessarily used in both components and moreover that some data collected is resultless (revealing an opportunity for data model reduction). At this level it can be argued that the data has become usable information.

To convert the data into information a mapping tool is needed. Such a mapping tool is implemented based on the requirements of the domain model and the CBR and it must be implemented inside both components in a semi-automatic framework where possible.

The information produced enters the *Experience Layer* through a query system. Such a system performs a series of queries over the ontologies and the CBRs.

At the ontology level, the answers to the queries are obtained using an ontology reasoner.

At the CBR level, the traditional CBR cycle acts as the reasoner (based on rule logics and a statistical analysis). Both the CBR and the ontology reasoner are use to share information in a cyclic process. When the information is processed it can be argued that experience is obtained.

In the *Knowledge Layer*, the elements that constitute the curricular plans are modelled, using e-Learning standards.

Finally, in the *User Layer* several user types (e.g. course creator, the teacher, etc.) are used to adapt the system to particular cases.

4 CASE STUDY

Our case study is an application of the presented architecture following the Spanish Ministry of Education and Science (MEC) guidelines for vocational education.

The domain was modelled based on the unit-project composition of courses, following the recommendations of our R&D project partner who is a recognized expert in the field of CCD in Spain.

To explain the functionality of the prototype, it must be mentioned that we implemented a use case where the Course Designer user creates a course for a non-existing competence .

The first task is to create a new competence using the stored previous experiences (elements contained in the *Information Layer*). For such purposes, the user introduces the master guides of the new competence that they are interested in. Following these guides, the system launches a CBR process on the data repositories containing the competences. By doing so, they obtain a set of similar competences stored in the repositories, which are at this point in the *Experience Layer*. Those competences will help them in new competence generation. If necessary, it is possible to launch a new CBR process changing the guidelines. When finished, the new competence (that is now in the *Knowledge Layer*) is saved (to the repositories of the *Data Layer*) and becomes a part of the stored cases.

Once the new competence is created, the user can decide if they want to assign a collection of courses for the created competence, or finalize the process and return to the competence creation task.

If the chosen option is to assign courses, an ontology reasoner infers which are the most relevant courses of the new competence based on a semantic reasoning process performed over the stored courses (these courses are in the *Information Layer*). With this collection of suggested courses (and individual units and projects, all of which are in the *Experience Layer*), the user is able to design the new course. At this point, the user can launch more CBR processes

to obtain new complete courses, or to obtain new individual units and projects. The results obtained are added to the course creation *Experience Layer*.

When the course contents are defined (in the *Knowledge Layer*), it is necessary to establish a common objective for the competence and the course. The system shows the available objectives (again from the *Information Layer*), and the user chooses an available objective or creates a completely new one. After this assignment, the new course including its objective is stored in the repositories of the *Data Layer*.

Finally, the user chooses between assigning other course to the same competence or to end the process.

The *User Layer* filters the content displayed depending on user type. In this use case, there is only a user type, so there is not explicit implementation of the layer.

4.1 Implementation Issues

The core language used to implement the prototype was Java, using Swing and AWT libraries for Graphical Interfaces. Competence, Course, Project and Unit repositories were created and managed with mySQL databases. The set of ontologies that model the domain were written in OWL-DL, using the Protégé ontology editor. For the query system, we used Protégé OWL API (Knublauch, 2006), and the chosen reasoner was Pellet (Sirin et al., 2007). For the CBR implementation, we used jColibri2 (Díaz-Agudo et al., 2007), developed by the GAIA group at Complutense University of Madrid.

5 CONCLUSIONS AND FUTURE WORK

In this work, we presented an architecture to address some common problems encountered in CCD. Specifically we focused on the re-use of available information. Our approach uses a mix of Semantic and CBR techniques in order to enhance a real world, factual industry problem. A case study implementation of our architecture was presented for using the design of a mid-level vocational education course that complies with the Spanish normative as a demonstration sample.

As future work we intend to extend our implementation in two different directions, one being related to the collaborative aspect of our work (e.g. many users modifying the same resources at the same time). The other direction we wish to explore will focus on the possibility of enhancing the system with experience in using SOEKS techniques (Sanin et al., 2007) used in other domains with positive results (Toro et al., 2007).

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GETTING ECLIPSE INTO THE CLASSROOM

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Keywords: Eclipse, Teaching, Java, Open Source.

Abstract: In this paper, I describe an approach to integrating Eclipse into the classroom for the purpose of having students develop assignments using the Java, Scheme and Prolog programming languages. The approach attempts to overcome three problems. 1) Students wanting to learn about Eclipse have no idea where to start. 2) Educators wanting to teach Eclipse do not have available the breadth of material required to introduce students to it. 3) In most institutions, there is no room in the existing curricula to dedicate courses for explicitly teaching Eclipse.

1 INTRODUCTION

In a survey conducted in November 2006 by BZ Media (BZ Media, 2006), 66.3% of SD Times subscribers surveyed reported that developers within their organizations used Eclipse (Eclipse, 2008). Their primary reasons for choosing Eclipse were its low cost (free) and that it is open source. The major uses of Eclipse reported were for its Java Development tools, followed by its J2EE Standard tools, and then its Web Standard tools. These results are particularly significant to those in computer science (CS) education. It illustrates industry's continued move towards open source software and Eclipse. There are many reasons for this move, but at zero cost and better quality, commercial offerings are having a difficult time competing in the space. Given the move, it is important for CS educators to discuss the merits of open source software with their students and provide them with education on significant open source offerings, such as Eclipse. The need is clear: students need to know how to use Eclipse to be competitive in today's corporate software market and CS educators need to teach students about Eclipse. Industry is demanding it.

While Eclipse has established a large and vibrant ecosystem of technology vendors, start-ups, universities, research institutions and individuals, the availability of focused and organized educational material on Eclipse is lacking. This situation has created at least three problems.

The first one is students wanting to learn about Eclipse have no idea where to start. The second problem is CS educators wanting to teach Eclipse do not have available the breadth of material required to introduce students to Eclipse. The third, and perhaps the largest problem, is that in most CS institutions there is no room in their existing curricula to dedicate courses for explicitly teaching Eclipse.

I believe the simple solution to the last problem is to have Eclipse used as a common tool for developing various course concepts, rather than it being the course concept itself. The benefit is that students will learn about Eclipse as a side-effect of developing their assignments. A second benefit is that they will be able to use their Eclipse knowledge to work productively in industry. A final benefit is that by helping students to learn about Eclipse, CS educators will better understand the joint needs of their students and the companies they will work for using Eclipse.

At the recent ITISCE conference, I had a few CS educators tell me Eclipse was overly complex. While this is a debatable point, my answer is that even though Eclipse can be used as an integrated development environment (IDE) suitable for commercial development, portions of it can be made easier to use and tailored towards first year students.

My implementation of the solution to the last problem noted above and to the complexity issue has been to develop plug-ins for Eclipse that enable students to create Java, Scheme, and Prolog assignments all within the same environment. The plug-ins add new functionality to Eclipse that, while not suitable for commercial development, provides CS educators and their students with a single

development environment for teaching and applying object-oriented, functional and logic programming concepts. The plug-ins add only the functionality required to develop language concepts, not the full blown capabilities of an industrial strength IDE.

In the background section we look at implementations of different open source and commercial IDEs. The approach section discusses how we have integrated the three different languages into Eclipse and how students interact with them to develop their assignments. The final chapter provides a summary.

2 BACKGROUND

Scaled down versions of Eclipse for Java development have been done in the past. One such version was produced by the GILD (Gild, 2008) project. However, it is no longer supported, with its last release done on January 3, 2006, and intended for use with Eclipse version 3.1. Another version is Penumbra. It is plug-in developed at Purdue University for use in their introductory programming classes. It was intended to ease the transition to the use of the full-featured functionality of Eclipse. Penumbra presents an Eclipse perspective that hides all but the basic actions of Eclipse's existing Java perspective, while packaging elements of other perspectives (e.g., the CVS perspective) into simpler actions that ease the downloading and turn-in of programming assignments, and adding new code views inspired by other environments for introductory programmers. Although neither version seems to be currently supported, they provide direction as to what a light version of Eclipse for Java development might look like. And, while not Eclipse based, BlueJ (BlueJ 2008) can also provide another view of an IDE for teaching object-orientation to beginners.

Only one Eclipse based Scheme development environment exists: The SchemeWay (SchemeWay, 2008) project. It provides a set of Eclipse plugins for the Scheme programming language and features a powerful, fully extendible S-expression-based editor that integrates seamlessly with any Scheme interpreter. However, this environment does not come with the source code and it is not targeted at first year students. While not Eclipse based, DRScheme (DRScheme 2008) provides an environment that provides an integrated programming environment designed specifically with the needs of beginners in mind.

One free Eclipse plug-in for Prolog exists created by an undergraduate student named Juliana Barby Simão (Simão, 2004). However, it was completed in 2004 and was not continued, even though it was reported that the project would continue duing 2004 as a graduate project. Not Eclipse based, JLog (JLog 2008) is an implementation of a Prolog interpreter, written in Java. It includes a built-in source editor, query panels, online help, animation primitives, and a GUI debugger. It could be easily wrapped within an Eclipse UI, providing Prolog for Eclipse users. The only difficulty with this idea is that JLog is under the GPL license.

Whether for Java, Scheme or Prolog development, the idea is to provide first year students with Eclipse-based light IDE. By doing so, the belief is that as students become more experienced with the light versions and the language IDE, they can and will want to transition to the full versions of the IDE. Having students wanting and using the different light versions of Eclipse should also impact faculty making them more likely to include material on the Eclipse Platform in their lectures in order to help students use these environments. Where do they get the material? From the LCMS outlined in the first part of the approach.

3 APPROACH

Central to our approach is the notion of community. We wanted to develop a community of users and a community of developers providing new features and languages to our IDE for education (IDE4EDU). To meet these goals the first decision made was to make the IDE open source. The implication is that whatever software we use and whatever software we develop, it must be open source. Since Eclipse is at the heart of the implementation, the implication is that, like Eclipse, the code will ship under the Eclipse Public License (EPL 2008). Using this license ensures that users are free to download and use the IDE without needing to pay any fees to anyone and developers are free to view, modify and add to the source code. The second decision made was to create a community project for the IDE. We have created an Eclipse Summer of Code project at the Eclipse Foundation (IDE4EDU, 2008). This subproject is part of the Eclipse Technology family. Creating this project ensures that the source code will have a home location, that key members of the project are identified, and that there is a community site for others to access to become involved with the

project. This project site also ensures that users have a common place to visit to get software updates and new versions of the IDE.

Rather than having different versions of the IDE for each language, another central part of our approach is to have all languages integrated into one IDE. The reason for this is simple: there is only one installation. Educators save class time, by only needing to describe the install process once, and students save time by only going through the download and installation process once. That said, the installation is very easy: download one zip file, unzip the file's contents to a location of choice, click on the identified IDE executable, and you are done.

Taking this approach also provides a common environment for students to work with different programming languages. While there are certainly many differences between the Java, Scheme, and Prolog programming languages, students always work within the confines of the Eclipse workbench, providing common actions to the edit, compile/interpret, and execution loop.

The following sections describe how each of the three languages are integrated into Eclipse, what other open source software was used in the process and the key features that are provided for students working on assignments using the various languages.

3.1 Java Lite

While Eclipse has been used extensively for Java development, as I mentioned, I have heard people say many times, "it is too complex for first year students". While part of me believes that we should expect students to deal with a certain amount of complexity, I can agree with the argument that when students are learning a language for the first time, many things that you would want for commercial development are not required by students developing their assignments.

The Java Lite integration into Eclipse simplifies the approach for student developing Java assignments. At a minimum, students need to create a project, create a class and run their code. Optionally, they can also create a Java package. If they don't create a package, all of the source code goes into the default package. And, to get to this functionality they have to navigate to the Java-Lite Eclipse perspective. That's it. What follows are these steps in more detail, provided to illustrate that the level of complexity is something that I believe we can expect first year students to be able to manage.

After downloading and installing the IDE4EDU from its project web site, the next step is to start it up by clicking on the IDE4EDU application icon. This will bring up the Eclipse workbench.

Selecting the menu Window -> Open Perspective -> Other…-> Java Lite opens the Java-Lite Perspective, shown in Figure 1. From now on, when a student starts up IDE4EDU they will go directly to the Java-Lite Perspective. This is a feature of Eclipse, always returning to the point where it was last closed from.

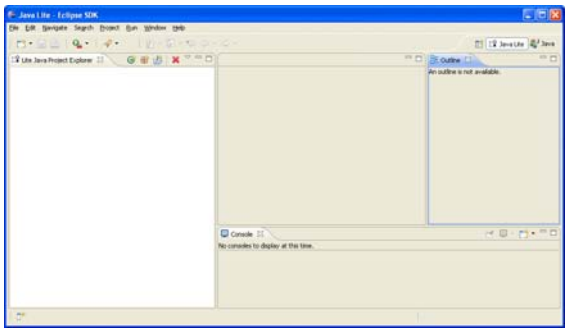

Figure 1: Java Lite Perspective.

The perspective has four distinct areas. The left area contains a Java Lite Project Explore view where students create their projects, packages, and classes. The right area provides an Outline view of the selected class's methods and variables. The bottom area is the Console view. The middle/top area is where the selected class is viewed and edited.

First students need to create a new project. In the JavaLite Package Explorer. From either the context menu or the JavaLite Package Explore toolbar menu, they select New Java Project, as shown in Figure 2. After entering the project name, as in assignment-1, students can create a new class. Using corresponding selection from the context menu or the toolbar, as shown in Figure 3, they fill in the class name as shown in Figure 4.

As a course progresses and students become more Java aware, they can select interfaces and a different superclass. However, to start with the defaults are all that is required. Closing the wizard opens the editor on the class, which has the default constructor and main method templates already written. After completing the code, selecting the class and running it as a Java application, the corresponding output will appear in the Console view, as shown in Figure 5.

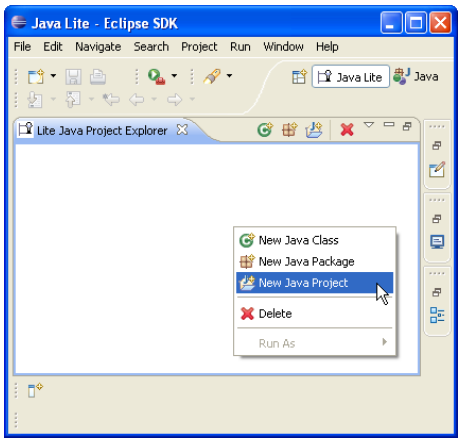

Figure 2: New Project.

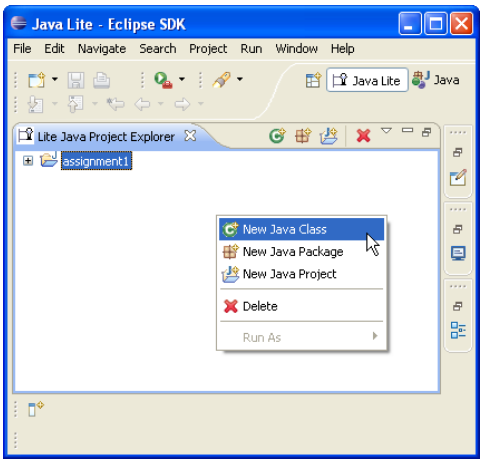

Figure 3: New Class Menu.

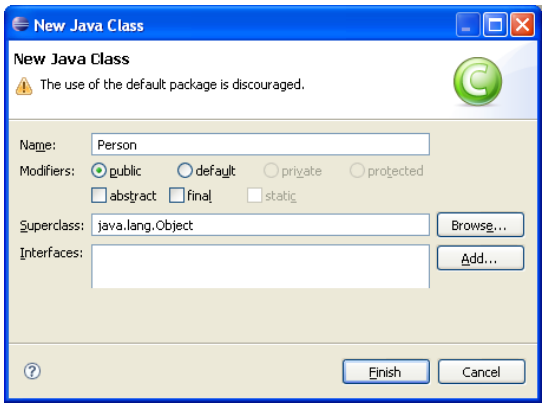

Figure 4: New Class Wizard.

Students can select their project and export it as a zip file. Given many schools have electronic submission of assignments, having an assignment in a single zip file makes assignment submission simple, and easy for teaching assistants to unzip, view, test, and mark the assignments.

As students progress in their Object-Oriented programming course, they can always switch from the Java Lite Perspective to the Eclipse's Java Perspective, giving them all of the features the Java perspective provides to developers, such as a debugger.

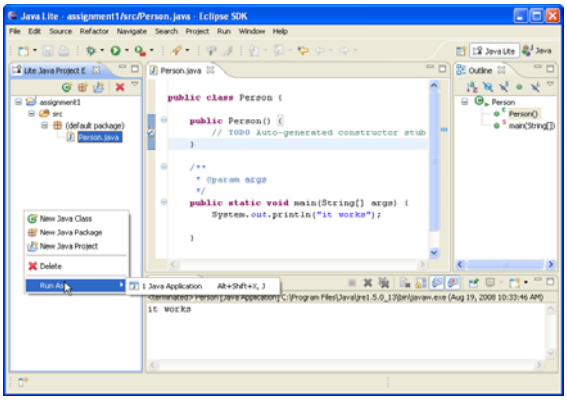

Figure 5: Editor and Consol Execution.

3.2 Scheme Lite

The integration of Scheme development into Eclipse is centered on any file created in Eclipse with the .scm extension. Since Eclipse does not have a Scheme interpreter included with it, the approach also embeds the Second Interpreter of Scheme Code (SISC, 2008) into Eclipse.

As with the Java-Lite integration, students must first create a project. In the Scheme integration, any project will do, even a Java project. However, it is suggested that students start with building a General Eclipse project, by selecting File -> New -> Other…-> General -> Project from the toolbar menu of any perspective and enter their assignment name, such as Assignment 2, as the project name. Next student select File -> New -> File to create the Scheme file, ending with the .scm extension. These actions result in what is shown in Figure 6.

The left area in Figure 6 contains the view with the project and Scheme file. The middle/top area contains a multi-tabbed editor. The editor lets students enter their Scheme code and then by switching tabs they can evaluate it. The other areas of the workbench contain views relevant to the corresponding perspective students are working in.

The editor has syntax highlighting and by clicking before or after any bracket they are shown the corresponding open or closing bracket, as shown in Figure 7. Selecting the evaluation tab, brings students to where they can evaluate the code in their

editor and other selected code, as shown in Figure 8. Hitting the Load Editor Contents button evaluates the code from the editor. Entering code in the Input and Eval area and selecting Eval Selection evaluates the corresponding code. Actions for clearing the console and resetting the Scheme environment are also available.

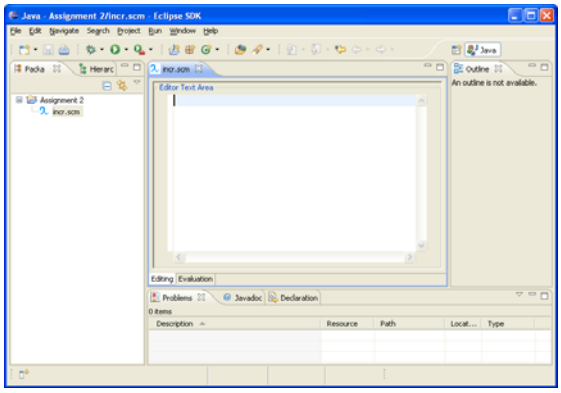

Figure 6: Scheme Multi-Tabbed Editor.

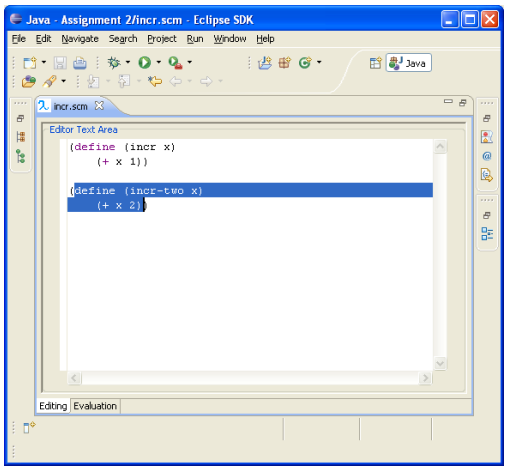

Figure 7: Scheme Edit and Evaluator.

While not full featured, students can work on the Scheme assignments along side their Java assignments using our Scheme integration into Eclipse. Exporting projects as zip files is also available.

3.3 Prolog Lite

The integration of Prolog development into Eclipse is centered on any file created in Eclipse with the .plog extension. Since Eclipse does not have a Prolog interpreter included with it, the approach also embeds JLog - Prolog in Java (JLog, 2008) into Eclipse.

As with the Java-Lite and Scheme-Lite integrations, students must first create a project. As in the Scheme integration, any type of project will do. Next, students select File -> New -> File to create the prolog file ending with the .plog extension. These actions result in the multi-tabbed editor shown in Figure 9.

The left area of Figure 9 contains the view with the project and prolog file. The middle/top area contains a multi-tabbed editor. The editor lets students enter their Prolog code, consult it, and then by switching tabs execute queries. The other areas of the workbench contain views relevant to the corresponding perspective students are working in.

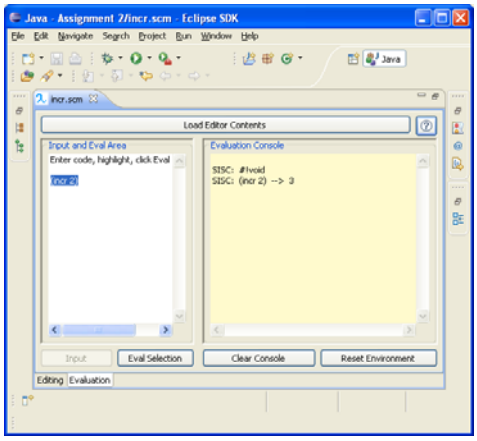

Figure 8: Evaluator.

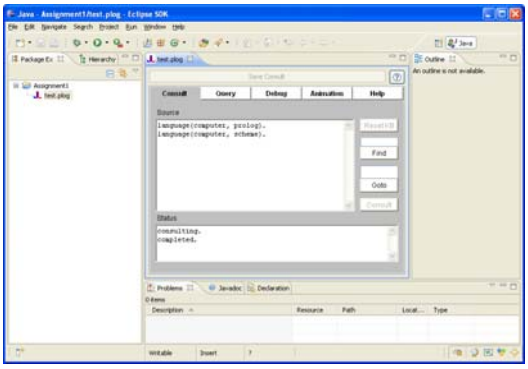

Figure 9: Prolog Multi-Tabbed Editor.

Selecting the Query tab, brings students to where they can run queries on the code they have consulted, as shown in Figure 10. Hitting the Consult button on the Consult page consults the code in the editor. Other Prolog related actions are also available.

While not full featured, students are able to perform the basic operations of consulting and querying Prolog code. Debugging is also possible and exporting projects as ZIP files is available.

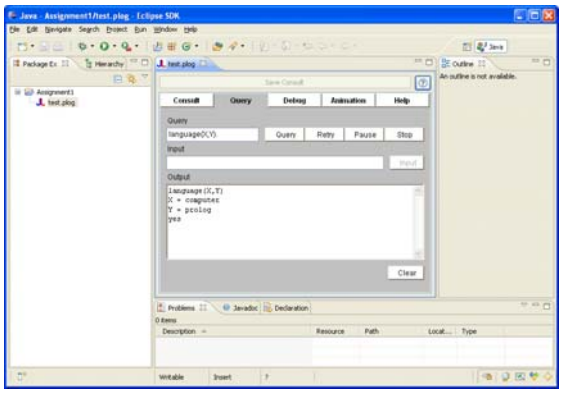

Figure 10: Query.

4 SUMMARY

While there is no room in CS curriculums to dedicate courses for explicitly teaching Eclipse, there is a need for students entering the workforce or going on co-op work terms to know how to use it. Our solution is to use Eclipse as a tool in the classroom for helping students learn how to program in Java, Scheme and Prolog. At Carleton University we use the combined IDE4EDU in our first year object-oriented programming courses and subsequent courses requiring Java. We also use the Scheme-Lite and Prolog-Lite integration in our third year Programming Paradigms course that teaches student Functional and Logic Programming concepts.

The three main features of the combined integration are important to us. First, students need only learn, and faculty need only teach how to download and install a single environment. Second, this is a community effort rather than a home-grown project. The intent is for the community to produce a plan and continue the growth of the combined integration. While there will always be project leads and committers, the goal is to encourage all interested parties to contribute to the project. Since it is important that others contribute to the project, having the project licensed under an Open Source License means everyone will have equal access source code providing them every opportunity to become involved and make improvements.

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A TILED DISPLAY SYSTEM FOR IMMERSIVE EDUCATION

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Keywords: Virtual Education, Virtual Reality, Virtual Training, CAVE, Tiled Display.

Abstract: Virtual reality systems may be used as a new educational tool because a user can be provided immersive sensation as he/she experiences a real object. A tiled display is one of the virtual reality systems which generates high-quality images and guarantees wide view angle using multiple projectors. In this work, we present a tiled display system which has high resolution screen (its resolution is 4096 x 1536 and its effective resolution is 3200x1200). We apply a seamless technique to this system in order to remove joint lines and to improve the quality of images. Furthermore, we implement educational contents for experiencing a CMOS manufacturing process based on the proposed tiled display system.

1 INTRODUCTION

Even though many education systems provide a wide range of benefits for students, the education systems have some problems to be solved before accepting. One of these problems is that many systems do not provide immersion and the sense of reality to users. Virtual reality technology allows users to experience the same sensation as if they watch and feel real objects. Therefore, the education system based on the virtual reality technology can be a solution for immersive training because VR systems enable users to experience phenomena in virtual environment which are difficult to illustrate in real world. Furthermore, users can learn how to operate a machine or a target device in virtual world.

Virtual reality technology in its early stage has been focused on displaying and rendering the shape of a target object on 2D monitors or limited screens. These systems are not suitable for the following cases: 1) where visual contents are important; 2) where high resolution display is necessary; and 3) where a wide field of view is required. For these cases, researchers have developed tiled display systems (Hereld et al., 1999; Yang et al., 2001; Chen et al., 2001; Krishnaprasad et al., 2004) which can generate high resolution images and can fill up users' field of view with the images.

This paper proposes a tiled display system where a high resolution image generates by binding images obtained from multiple low resolution projectors. Furthermore, we implement the educational contents on the proposed tile display system.

2 SCREEN

One of the most important factors in virtual reality is to convey the sense of reality to users. The sense of the reality means that a user feels or experiences an object in virtual world as the object exists in real world. The one of the conditions to increase the sense of the reality is to fill a user's field of view (FOV) with high resolution virtual images. Humans have an almost 180° forward-facing field of view (FOV) and 120° an effective FOV (Authur, 2000).

There are four major screens for expressing virtual environment: (1) a wall type, (2) a cylindrical type, (3) a dome type, and (4) a CAVE type. Since the advantage of a tiled display system is to share a virtual environment among users, we decided to choose a cylindrical type screen which provides a wide FOV. However, when virtual images are

projected on the cylindrical screen, it is necessary consider a complex calibration method for generating continuous images. Another problem is that the position of a target object is hard to compute and to present on the cylindrical type screen.

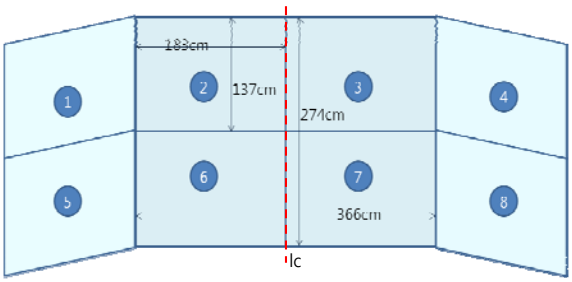

Figure 1: The shape and the size of the proposed screen.

Therefore, in this work, we implemented a folded type screen which brings into relief the advantage and supplements the disadvantage of the cylindrical screen as shown in Figure 1. Since each sub-screen in the folded type is flat, the proposed tiled display system is not only easy to establish, to maintain, and to repair but also easy to calibrate. In Figure 1, each part (①~⑧) is a projection area. In this symmetric screen, the angle of refraction between the left sub-screen (①, ⑤) and the middle sub-screen (④, ⑧) is 120°. If the distance between a user and the screen is 1 meter, the field of view becomes about 160°.

3 SYSTEM ARCHITECTURE

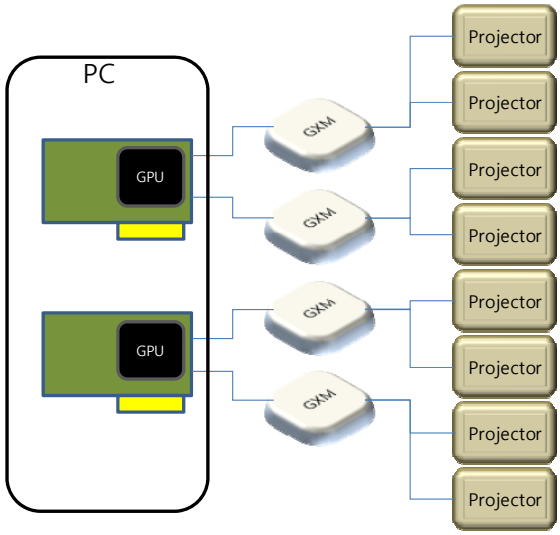

Figure 2: Hardware system architecture.

Figure 2 shows the hardware configuration of the proposed system. The system was implemented with a single PC and 2000 ANSI DLP projectors whose resolution is 1024 x 768. Two graphic cards were included in the single PC and each graphic card has two graphic output ports. Each graphic output port has a Graphics eXpansion Modules(GXM) which can connect two visual displays. Therefore, our system generates high resolution image by connecting eight projection areas with a single PC as shown in Figures 2 and 3.

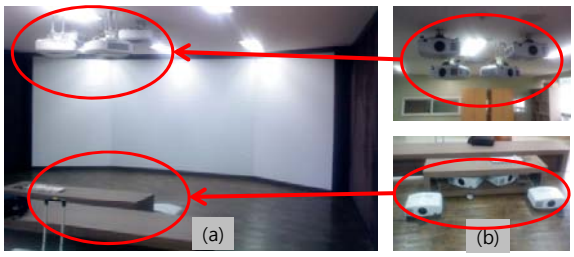

Figure 3: (a) Screen, (b) arrangement of projectors.

4 CALIBRATION

The graphic simulations were carried out by a program written in Visual C++ with direct X. As mentioned above, we used 8 projectors to create huge and high resolution images. Since projectors can be moved or rotated by a small amount of disturbance (for example, certain vibration, small impact, and/or etc.), we overlapped the portions which the projectors undertook as shown in Figure 4. However, this installation causes an image to distort. For compensating this distortion, we conducted geometric calibration.

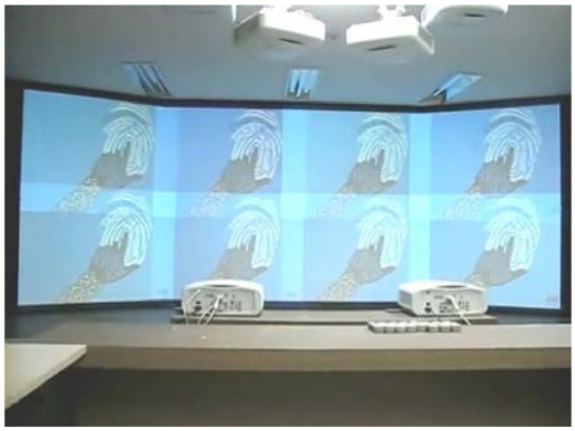

Figure 4: Overlapped Projection.

Figure 5 shows an example of geometric calibration procedure when four projectors employed in a tiled display. Figures 5(a) and 5(b) show the images before and after the geometric calibration, respectively. Consider the situation where four projection sub-images are overlapped and distorted according to the arrangement of projectors as shown in Figure 5(a). These overlapped and distorted sub-images need to be adjusted to the compensated region (bold rectangle portions (Figure 5(b)) through the calibration method.

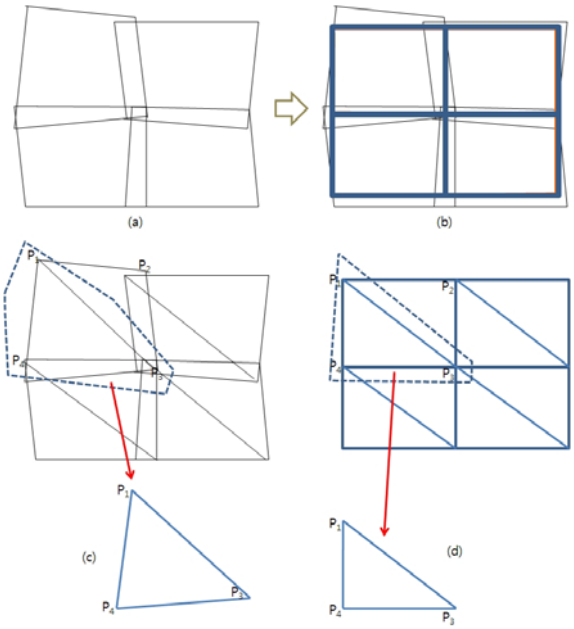

Figure 5: Geometric Calibration.

$$P_1 = (x_1,y_1),\quad P_2 = (x_2,y_2),\quad P_3 = (x_3, y_3) \qquad (1.a)$$

$$P'_1 = (s_1,t_1),\quad P'_2 = (s_2,t_2),\quad P'_3 = (s_3, t_3) \qquad (1.b)$$

$$M = \begin{bmatrix} m11 & m12 & m13 \\ m21 & m22 & m23 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} s1 & s2 & s3 \\ t1 & t2 & t3 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} x1 & x2 & x3 \\ y1 & y2 & y3 \\ 0 & 0 & 1 \end{bmatrix}^{-1} \qquad (1.c)$$

For compensation, original projection portions and the calibrated projection portions are divided into triangles, respectively as shown in Figures 5(c) and 5(d). After that we computed transformation matrix from the triangle 1 (P_1,P_3, P_4) to triangle 2 (P'_1,P'_3, P'_4) using equation 1. In Figures 5(c) and 5(d), let's define the coordinate values of P_1, P_3, P_4 as (x_1,y_1), (x_3,y_3), and (x_4,y_4), respectively. We also define the coordinate values of P'_1, P'_3, P'_4 as (s_1,t_1), (s_3,t_3), and (s_4,t_4), respectively. Figures 6(a) and 6(b) show the results before and after the calibration method, respectively.

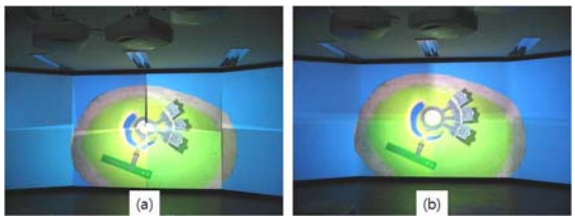

Figure 6: (a) before and (b) after calibration.

5 VIRTUAL ENVIRONMENT FOR EDUCATION

In the proposed tiled display system, we implemented a virtual silicon island (VSI) where users can learn semiconductor manufacturing processes. Users arrived at the VSI and walked in one of the buildings where they can study the semi-conductor manufacturing process.

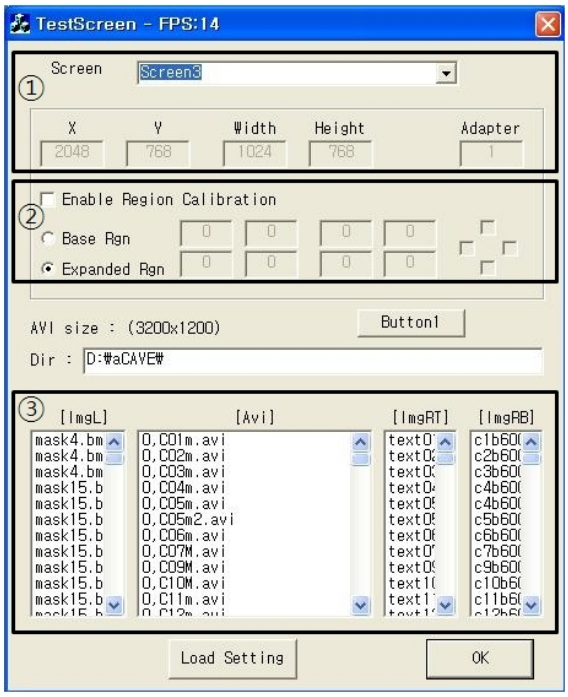

Figure 7: VSI authoring tool.

We developed a VSI authoring tool in order to easily create, edit, and play semiconductor contents. A user can insert or delete the semiconductor manufacturing components through the VSI authoring tool. As shown in Figure 7, the VSI authoring tool consists of a screen control part(①), a calibration part(②), and a contents control part(③). The screen control part allows a user to determine

the size of images. The calibration part adjusts the overlapped and the projective regions. In the contents control part, multimedia objects based on movie clips are displayed. Once multimedia contents are registered in the contents control part, a user can control and play them on the huge screen by just clicking a mouse or pressing a keyboard. Figure 8 shows the semiconductor education contents based on the proposed tiled display system.

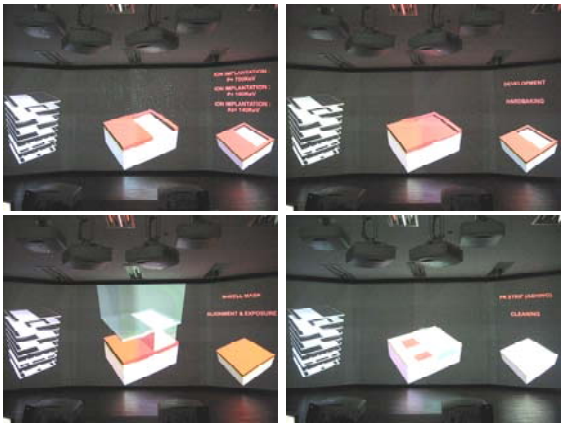

Figure 8: Semiconductor educational contents.

6 CONCLUSIONS

A virtual reality system provides the sense of reality and becomes a more user-friendly interface than the other systems. In this work, we developed the tiled display system for educating semiconductor manufacturing processes. Moreover, we conducted calibration in order to compensate the distorted image and to increase the sense of reality.

We are currently considering natural interaction for effective lecture with the proposed platform. Even though, the proposed system does not include natural interaction (for example, gesture recognition), it has the potential of an immersive education platform as an effective tutor.

ACKNOWLEDGEMENTS

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BUILDING THE EUROPEAN HIGHER EDUCATION AREA
A Subject in Information Systems Security

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Keywords: European Higher Education Area, Computer Security, Syllabus, Evaluation, Course Design.

Abstract: This article describes the "Security in Information Systems" subject that is currently imparted at the University of A Coruña as part of its Master in Computer Sciences. This subject is organized as a response to the requirements of the European Higher Education Area (EHEA) and of extreme importance to future computer experts, since security is such a delicate and essential part of any information system. Special care has been given to the development of this subject, which requires continuous and timely updating.

1 INTRODUCTION

Our information society is, to a great extent, based on the idea that basic rights such as privacy, confidentiality, access to information, and authentification are not to be violated. In the world of information systems, security is particularly crucial because its advances take place at such a fast rate. Security requirements change with each new development, and since more and more information becomes accessible, security checks become increasingly exacting. As such, technological advances are catalysers that work in two directions: on the one hand they provide access to more and new information (entailing more security controls), on the other hand they allow for the implantation of more refined security mechanisms (which provide secure access to new information types).

The proposed subject is designed to provide students with the basic concepts and techniques for the protection of information systems. This knowledge is presented from a physical, logical, administrative, and legal point of view, and allows our future experts to understand and solve risks that threaten information systems in the present and in the future.

2 GLOBAL DESCRIPTION AND OBJECTIVES OF THE SUBJECT

Among the first basic concepts that are imparted is the evolution of several cryptographic algorithms (Ramió, 1998; Lucena, 2008). The enormous surge in electronic information exchange systems (electronic mail, web pages, e-commerce, digital signature, etc.), has increased the importance of first-level training on secure and reliable security infrastructures, with a strong focus on protocols, configuration, etc. (Stallings, 2006).

Operating Systems (Garfinkel et al., 2003) are also extremely dependent on security: they constitute the core of any computerized device and are the favourite target for computer attacks, so their vulnerabilities and possible defence strategies are especially interesting.

In general terms, this subject focuses on the weaknesses of Information Systems from both a physical (communications networks) and logical (operating systems, communications protocols, configurations, etc.) point of view, and broadly covers the following areas:

- Cryptography
- Cryptoanalysis
- Public-key cryptosystems
- Private-key cryptosystems
- Vulnerabilities in Information Systems
- Security in Operating Systems

- Security in Networks

These subjects provide students with extensive knowledge on basic security concepts, applicable to a wide range of fields, and allow them to manage and administrate the security aspects of information systems. The main purposes of this subject are the following:

- Become familiar with the security process
- Identify the risks for information systems
- Know the security mechanisms with which to equip an information system
- Understand the fundamental concepts of cryptography
- Understand the nature, definition, and application of a security policy

After completing this subject, the student will have of a series of competences with which to manage and administrate the security of information systems. These competences can be divided into three large groups:

- Competences related to conceptual capacity:
  - Summarize the foundations of cryptosystems
  - Know the legal aspects of information systems security
  - Define the risks and vulnerabilities of an information system
  - Analyse new advances in security and their repercussions
- Competences related to procedural capacities:
  - Use security tools
  - Organize the security of an information system
  - Express clearly and effectively the need for security measures and their implantation, advantages, and disadvantages
- Competences related to behavioural capacities:
  - Assume the existence of vulnerabilities in information systems and minimize them
  - Assess a system's security in a critical and objective manner
  - Collaborate with other professionals (such as system administrators, networks, databases, applications, etc.) in launching and maintaining security measures.

These competences will allow students to carry out their work in the systems security field. They will be able to design, implant, and evaluate the security mechanisms, the incident detection mechanisms, and the security policy of an information system.

3 TEACHING METHODOLOGY

The subject is based on three elements: theoretical classes, practical classes, and practical exercises. During the theoretical classes, the fundamental concepts of the subject are introduced so as to allow the student to study the proposed matter in depth. At this point, the teaching staff plays an essential role, but the students are also encouraged to participate actively and this participation will be evaluated.

Students receive the teaching material and a selection of bibliographical references, which enable them to prepare the classes in advance or focus on any given aspect. They may be exposed to written tests based on brief theoretical questions or on solving small problems, in order to check their level of assimilation of the concepts that were explained during class or analysed individually. These tests have a duration of approximately 30 minutes and are corrected and commented in class.

The practical classes are dedicated partly to the application of the exposed theoretical concepts to a practical case. During these classes, the students play a more relevant role; the professor merely presents the case and provides an individualized (or generalized, if relevant) support in case of doubt.

The practical sessions take place individually (or in groups of two persons), except for one of the classes which requires 2 or 3 sessions with groups of 4 to 6 persons. This particular class consists in a collaborative learning experience in which the group works on a previously indicated and structured theme (e.g. the application of security policy to a concrete case). The group indicates one person responsible for each part of the work; the persons responsible for the same part work together and explain what they do to the rest of their group, so that in the end all the components of one group have acquired knowledge on all the parts. In order to stimulate the explanation of concepts between the members of one group, a written test takes place after the work and the obtained result is common to the entire group, i.e. the average of the results of the individual members. This method enhances the interest of each student in making a fellow student understand the part for which he/she is responsible.

The practical classes can be complemented with seminaries that develop a subject related to the objective of the subject.

Finally, the practical exercise is carried out by groups of 2 to 4 persons and either chosen from a list proposed by the professor or directly proposed by the students. The proposed exercises have to be related to one of the subjects of the subject and seek

to expand it. They are followed-up continuously during obligatory tutorials and finally exposed, as part of the theoretical classes, for a duration of 30 minutes. Time is given for questions and comments, and the content of these exercises is considered part of the subject material.

4 PROGRAMME

4.1 Theoretical Programme

The classes are within one semester, with four classes each week. The programme is divided into 5 large sections of very different nature. The subjects are the following:

- SECTION 1: Basic notions
  1.- Basics of the Security Theory
  2.- Physical and logical Security

- SECTION 2: Cryptography
  3.- Classical Cryptographic Systems
  4.- Private-key cryptographic systems
  5.- Public-key cryptographic systems
  6.- Digital signature

- SECTION 3: Security in Operative Systems
  7.- Security in Linux systems
  8.- Security in Windows systems

- SECTION 4: Security in Networks
  9.- Communciations Networks: Introduction
  10.- Security elements in communications networks: firewalls, , proxy
  11.- Vulnerabilities and Security on the Internet: WWW, electronic mail

- SECTION 5: Advanced Concepts
  12.- Steganography, visual cryptography
  13.- Forensic analysis

4.2 Practical Programme

For a correct and adequate follow-up of the theoretical programme, a practical programme is imparted that consists of a series of practices:

- Security Policies
- Classical Cryptography and Cryptoanalysis
- Security configuration and intruder detection in operative systems
- PGP
- Security configuration and intruder detection in web servers
- Forensic Analysis

5 EVALUATION

The evaluation process of this subject is continuous and consists of several sections: assimilation of theoretical concepts, execution of practices, and exposition of exercises that are evaluated according to the weighting criteria mentioned in Table 1.

Table 1: Weighting criteria for the evaluation of the subject.

Aspect	Criteria	Instrument	Weight
Attendance and Participation	▪ Active participation in theoretical and practical classes. ▪ Participation and output tutorials	▪ Observation and teacher's notes	10%
Concepts	▪ Command of theoretical and operative notions	▪ Final theoretical exam	40%
Continuous assimilation of concepts	▪ Assimilation and compression of theoretical and operative notions	▪ Partial exams	10%
Monitored Practical Exercise	▪ Output of tutorials ▪ Quality of work ▪ Clarity of exposition	▪ Observation and teacher's notes	25%
Elaboration Practical Classes and Exercices	▪ Output and elaboration of exercise during practical classes	▪ Observation and teacher's notes ▪ Presentation exercises and practical classes	15%

In order for students to pass this subject, the sum of their qualifications in the above sections must be at least 5, and the results of the theoretical exam, the practical exercises, and the exposition of the work must each reach at least 40% of the highest mark.

The practical exercises will be retained for one year. The students who have already passed these during the previous year may repeat them but are not required to do so.

6 EXPERIENCE

This subject has been very well received by the student population, who was particularly interested in the "Hacking techniques in web applications" seminar that was organized in collaboration with Microsoft.

The monitored works have in many cases exceeded the required level, the students themselves being the ones who proposed additions or improvements to the initial proposal. We have even been obliged to organize additional classes so as to make room for all the expositions and subsequent debates and rounds of questions.

7 CONCLUSIONS

Good notions on security in information systems is an essential element in the training of any computer professional. Our subject is structured in a way that allows students to easily assimilate the programme but at the same time requires the highest level of participation (by means of practical classes and exercises). We believe that this can do nothing but stimulate their interest and implication in the subject.

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SERIOUS GAMING, MANAGEMENT AND LEARNING
An Agent Based Perspective

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Keywords: Business game, Knowledge transmission, Enterprise management.

Abstract: We present the construction and experimental application of a web based system for teaching topics of Business Administration. The same concepts can be easily extended to other formative areas, and used to transfer knowledge (learning by doing). The system realizes a cooperative behaviour of human agents (learners) who interactively take decisions for a simulated profit oriented enterprise. The technical design is based on System Dynamics and Artificial Agent modelling. An agent based framework is applied to the model in the form of virtual tutoring system for learners; the cognitive agents learn through a trial and error technique. After the trial period, they can be used as a decision support system for the human learners.

1 INTRODUCTION

Business Games (BG) can be considered role playing games, characterized by a managerial context. The players usually face some situations typical for enterprise management and must take various core decisions, mainly about marketing, logistics, production, research and development politics and so on. A very interesting feature of business games is that they can be employed as a teaching instrument and for training; the students/trainee can learn some important concepts about enterprise management, by trying them on the field, instead of just studying them on books. This is regarded as "learning by doing" concept. The main didactic goals for BGs are to refine the decision capacities of the learners when facing situations of uncertainty, and above all their ability to take managerial decisions when there is a trade-off between risk and profit. Besides, through a BG, some advanced managerial techniques can be reached, and so can be the interaction among the different enterprise functions.

The BG presented in this work is built on the System Dynamics methodology (Forrester, 1961) and following the specifications given in Bussolin (1979); this means that the mechanisms of the game are based on finite differences equations and curves defining the main parameters of the game itself.

The innovative part is constituted by an agent based framework applied in the form of virtual tutoring system for learners; the intelligent agents learn by trial and error, based on Reinforcement Learning paradigms, by practicing the system. After this trial period, they form a model of the cause/effect relations among the decisions and the observed results and can then be used as a decision support system for human learners, during the game.

2 MODEL STRUCTURE

The model is built using a structure based on the theory of System Dynamics. The model itself is considered as an *artifact* (Simon, 1996), i.e.: an interface between the internal structure (implemented in Java) and the external environment, i.e.: the physical one, in which the system itself is used by the learners. There are six main subsystems, mutually connected, in the simulated enterprise: production, finance, implants, research and development, marketing and sales. Some of these subsystems are divided into other subsystems, if needed (e.g.: national sales and sales to the rest of the World). The model is a dynamic system and the temporal walkthrough in the system has been converted into a set of differential equations and laws that can generate the walkthrough itself. This description consists into a constant relation between

the system status in a generic time T and the status after a brief time interval "delta T" (DT). Two are the main variable types in the model: the stock type and the flow type (or rate). The latter are used to recalculate the former after each DT. Many of these flows are generated by the "actions" of the learners, i.e.: their decisions, in order to modify the states of the system. Not all the states are modified by external actions, though.

There exist some inner actions and regulations that act as "internal implicit decisions" performed by the system, used to normalize the levels. The choice of the configuration and balance among the external decisions and implicit decisions identifies the nature and type of knowledge that has to be transferred to the learner in a direct or indirect way.

The external decisions are those that make it possible for the individual learners to know the object of their studies, since it is directly "acted upon" by them. This kind of actions are simply referred to as "decisions", since they can be carried on by the learners. The other kind of decisions are those that make it possible to keep the system "alive" even when the learners (for a lack of knowledge) has not been able to lead the system.

The enterprise, here seen as a complex system, is part of a bigger external environment with which it continuously interacts. This is configured by some other sub-systems, like the banking system (able to supply the financial means for the developing of new technologies, new products and the enterprise itself), the market system (where the demand is generated in the form of orders for the enterprise), the technology system (that determines what kinds of technologies are available at a certain time step), the suppliers system and customers system (respectively simulating those sides) and the workforce system (determining the average wages, the work supply on the market and so on). The equations in the model are in the form of:

$$SFi = SSi + (RIi - ROi) * DT \qquad (1)$$

Where *SFi* at the first member is the *i-th* Stock Variable at the end of a DT, while the *SSi* on the right is the same variable at the beginning of the DT. *RIi* and *ROi* are respectively the Input Rate and Output Rate relative to the *i-th* stock variable.

The variation is then depicted as a difference among the Input and Output rates during the considered DT; this is summed to the previous stock value, to calculate the new one. The algebraic difference among the two rates is then to be weighted by the time in which that rates applied.

The units of measurement in the system derive from the above equation. The time is measured in months and the stocks are measured in units. The rates are then units/month and DT is again measured in months. DT is a very brief time period; for simplicity, in the model it's set to 1/100 of a month.

3 COGNITIVE AGENTS

Reactive agents don't own an internal representation of the environment and react to the stimuli coming from it, by retrieving wired behaviours similar to reflexes without maintaining any internal state.

Cognitive agents' behaviour, on the contrary, is goal-directed and reason-based; i.e. is "intentional".

Basing on the final goal, the agent chooses its action (or set of actions) according to its beliefs (knowledge) of the world. At a higher level, cognitive agents can choose a specific goal from a set of achievable ones. Cognitive agents' behaviour can be seen as a two steps process: 1) goal selection and 2) action selection to reach the selected goal.

The action selection problem at time *t+1*, along with the goal selection, at a macro level, are central topics, when the agents must learn how the models works, by experimenting on it and being able to act as a decision support system for human users.

So, in the following, by action selection we do not strictly mean the problem of choosing which action to take at a micro level (agent level), but also which one, among the possible goals, to select.

In order to decide which actions to perform, the utility for each of them must be evaluated; specific Reinforcement Learning (RL) algorithms are used, which transform quantitative data (the *payoff*) in behavioural patterns for the agents. An agent endowed with some RL algorithm, when in a particular state of the world (x), performs an action (a) and gets a payoff (r), calculated by a reward function based on the consequences of the action itself. Through a trial & error mechanism the agent learns what are the actions that maximize this numerical value and computes an internal table, linking actions to states. It's straightforward that in the presented model the macro-goals are multiple and typical of enterprise management (e.g.: maximizing the profit, improving the implants, expanding the research & development and so on).

Besides, the actions to be performed to achieve any of these goals are in the form on a vector, containing the decisions affecting each part of the enterprise and the relative strategies.

4 ENTERPRISE MANAGEMENT

The model supplies the user (and the agents) with a set of generated reports, typical of Management and enterprise analysis. The users, by reading and analyzing them, can track down the influence of the single decision – or even better the aggregate effects coming from two or more decisions – on the synthetic results, representing the monthly performance of the whole enterprise.

According to the traditional use of the above quoted modelling, the design of a whatever economic system being simulated provides a discussion of its results "at the end" of simulation, and the traditional transfer of knowledge suffer from the paradigm of "*coeteris paribus*" i.e. teaching is concerned with the behaviour of just given variables at a time, while keeping the remaining ones "still". On the contrary, in the presented approach, the learner (or better, the team of learners) "drives" the whole system by his own decisions during the decision making process, learns through the interaction and the process of "role playing" within the group, and at the end of each month gets a set of reports, that will constitute the basis for the decisions to be taken during the following one.

The users, by reading and analyzing them, have to track down the influence of the single decision – or even better the aggregate effects coming from two or more decisions – on the synthetic results, representing the monthly performance of the whole enterprise.

While the model has been originally conceived as a teaching platform, in Universities and schools for transmitting such concepts as "double-entry accounting", and the way in which the decisions taken in a real enterprise affect the synthetic results, at the end of each period (month), it can be employed also as a simulator for managing purposes. After tuning it basing on a certain enterprise, it can be used as a what-if analysis tool, i.e.: a simulator in which certain changes can be done, in order to see how the system reacts to them, before doing them in the real world.

The cognitive agents can help both when the system is used as a teaching platform in schools, and when it's used as a real simulator. In fact, in the first case, the agents can correct the common mistakes of the students, by learning a correct policy (or, better, a correct set of action for a given managing strategy) and aid the students when they need to keep their decision. For an example, it's possible to think about a simulated enterprise, in which the R&D department is particularly weak, while the income is high, but the products are getting old and – possibly, will turn obsolete in few months. Unskilled students, that of course are not used to manage real enterprise, will probably get excited by the good and steady incomes, and will likely not invest in the R&D department. In few months, the competitors will have better products on the market and suddenly the enterprise will drastically diminish the sold quantities. Unfortunately, it will be too late to start an R&D campaign, since that'll likely require several months (or even year) to develop a new competitive product from scratch.

A cognitive agent, when turned on, by means of a dynamic hint could inform the students that their product is in the maturity phase of its life cycle, and that soon it'll face a probable decline. If, that notwithstanding, the students still do not invest in R&D, then the agent will suggest this as a possible strategy to prevent a forthcoming decline for the product, that will lead to a likely drastic reduction in the sales and will directly point to R&D as a way to overcome this in advance, by developing new products or improving the old ones.

When used a dynamic real-time simulator for what-if analysis, the agent has a different task; since we can aspect that users are, in this case, experienced managers, the agent could help them in finding the cause-effect relations basing on historical data. For example, when the system is tuned on a real enterprise, and empirically validated on its raw data, it could be used to conduct a scenario analysis. If we consider, for instance, the introduction of a new machinery in a manufacturing enterprise, then the system will keep track of its costs (variable and fixed) and all the interactions it could have with the rest of the environment (e.g.: required labour force, energy, training and so on).

Though, without an intelligent system acting as a supervisor, many of these relations will result in black boxes, exactly as it happens in the real world. An intelligent agent could supply step-by-step explanations for that, by monitoring all the data flow, through statistical and data-mining techniques. Besides acting as a decision support system for human learners experiencing with the model, artificial agents can be used to supervise the decision taken by learners, in order to interpret them in a cognitive way.

For example, in the previously mentioned enterprise accounting model, some users could immediately pursue an high profit, while others could be concerned first with the expansion of their enterprise on new markets. Others could choose to improve industrial plants, while others could want to

differentiate production and invest on research & development and marketing. All these decisions are complex, since they are determined by the combination of many different variables.

Sometimes the learners won't even realize that they are pursuing a strategy instead of another one, and they often won't foresee what the selected strategy could bring.

5 REACTIVE AGENTS

The agents can also constitute some parts of the model itself (Remondino, 2003); in the considered enterprise accounting model, some reactive agents can form the supply chain, or the warehouses, or even the competitors operating on the same market.

When dealing with reactive agents, the action selection problem is to be found at a macro (aggregate) level, i.e.: population level. If reactive agents are the competitors of human learners in the simulated world, they could have a fixed rule of behaviour over time. Some evolutionary algorithms could be embedded in the agents, so that the best players on the market could merge, to form some other artificial players with an even better behaviour. In this way it's possible to start with a population of agents with a random behaviour, facing the standard decisions in the model, and select – through the various "generations" – the best ones.

So it's not the single agent that selects his behaviour by updating its own policy (that remains the same, being the agent a reactive one), but the population that evolves over time, through the mechanism of reproduction and mutation. This is an approach often used when the rules of the environment are given and the main task is to observe some emerging aggregate behaviour arising from simple entities, i.e.: reactive agents.

Since these agents does not feature a goal based – pro-active – behaviour, the way they act tends to be deeply dependent on the choices made by the designer. In order to design flexible systems, the aggregate behaviour (at population level, i.e.: macro level) can be made self-adaptive through the implementation of an evolutionary algorithm (EA). In this case the agents will have a wired random behaviour at the beginning, and evolve according to the environment in which they act, through a selection mechanism.

6 CONCLUSIONS

A cognitive business game has been presented in this paper, used to form learners in the Universities and schools. The structure of the model is built on the theory of System Dynamics. The inner structure of the model has been briefly described in the paper, along with the main sub-systems tied to form the whole. The users of the system must take decisions at each time step, after which the system calculates the corresponding results, showing them according to the principles of double-entry accounting. Cognitive agent based paradigms are then described as a development for the system itself. The agent based framework constitutes a form of virtual tutorship for the learners. The agents act as a decision support system for the decisions to be taken, and can explain some cause/effect relations.

The agents themselves learn how the model work by practicing it, through some reinforcement learning techniques, and are then able to assist the learners in the decision process. A brief description about how reactive agent can be used as a part of the model itself is also described.

ACKNOWLEDGEMENTS

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A GESTURAL INTERFACE FOR ORCHESTRAL CONDUCTING EDUCATION

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Keywords: Computer-based conducting system, Drill and practice, Gestural interface, Pedagogy, Visual representation.

Abstract: Over the past few years, a number of computer-based orchestral conducting systems have been designed and implemented. However, only a few of them have been developed to help a user learn and practice musical conducting gestures. This paper is intended to address research related to this area. It utilizes an infrared baton and an acceleration sensor to track the standard conducting gestures. The infrared baton is similar to a conducting baton and has little influence on the conducting. A drill and practice instructional strategy has been applied in this gestural interface. Five options are implemented. Once an option is chosen, users must conduct according to the supported conducting gestures. While a student is conducting, his/her gestures are identified and followed by the system using an accurate and relatively simple process. The conducting is interpreted using a few visual items that clearly show a conducting gesture and reveal its quality. In addition, aural representation informs students of beats or errors when eyes are busy.

1 INTRODUCTION

Since the 1980s, various computer-based conducting systems have been developed (Nintendo, 2006) (Satoshi, 1998) to allow a student to conduct a piece of music using a digital system. Most of these systems focus on the act of conducting instead of gestures or education. Visual representation as a straightforward interpretation for a gesture has only been implemented in one system (Guy, 1999). The research described here is intended to present a gestural interface that is designed and implemented for pedagogy. It presents both visual and aural representations for students.

2 RELATED RESEARCH

2.1 Instructional Strategies

As computer and electronic instruments spread, computer-based musical systems have been a supplement to traditional teaching approaches (e.g. printed music notation). Several instructional strategies, such as programmed learning and drill and practice, have been used. A system supporting programmed learning presents some questions and gives feedback to students' answer according to expected one. Drill and practice let students do some pre-designed activities repeatedly. (Brandao, 1999)

2.2 Visual Representation of Musical Parameters

Although it is natural for music education systems to provide aural responses, since music is based on hearing, aural responses can interfere with music being used as an exercise or target. Therefore, visual representation is also supported in many music education systems. It is important to note, however, that visual feedback can interfere with the learning of visual aspects of music in the same way.

In an example of visual feedback, *pianoFORTE* (Stephen, 1995), a system for piano education, utilizes different colors and shapes on the original score to show the difference between the performance of teachers and students.

2.3 Computer-based Conducting Systems

A few current conducting systems have a pedagogical purpose. For example, *Wireless sensor interface and gesture follower* (Frederic, 2007) was

designed to find problems in a student's gesture compared to a teacher's gesture.

Various sensors have been used in computer-based conducting systems. Acceleration sensors (Satoshi, 1998) can be equipped on baton-like devices, which may change the weight and balance of the controller. Cameras (Paul, 2004) capturing the front view of a conductor can show a 2-dimensional trajectory of a conductor's motions. Infrared sensors (Guy, 1999) only track the movement of infrared light sources thus avoiding the influence of background or other confounding visual objects. In addition, other sensors, such as the Wii Remote (Nintendo, 2006), have been used for conducting.

3 INSTRUCTIONAL STRATEGIES

The gestural interface presented in this paper is designed for learning and practicing conducting gestures. Currently, drill and practice has been used. Once an option (there are five options in all.) is chosen, students can repeat a certain conducting gesture to practice it. The feedback from the system lets students know the accuracy of the gestures.

4 DESIGN AND IMPLEMENTATION

This gestural interface has five aspects: tracking, analysis, recognition, following, and response.

The implementation is on an iMac personal computer using Max/MSP, Jitter, and Java. Once the system is run, a main window (Figure 1) is shown on the screen. It displays the menu, the conducting window, and the information related to tempo and dynamics. The visual feedback is also displayed on this main window.

For the right hand, there are two modes: the option selection mode and the conducting mode. The “Menu” bar is used to go back to the menu area (option selection mode). In the menu, if students stay on an option, for example 2-Beat, for a period of time, the focus will be moved back to the conducting window (the conducting mode). An infrared baton is used as both a mouse and an infrared light source. Thus, a lot time is saved on the switch between system manipulation and conducting.

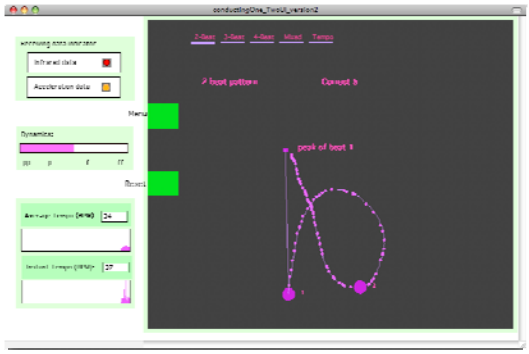

Figure 1: A snapshot of the main window.

4.1 Gestures

When conducting, the movements of both the right hand and the left hand are located in a chest-high virtual rectangle named the conducting window.

For the right hand, this gestural interface focuses on expressive legato gestures (continuous, curved) as shown in Figure 2 (Joseph, 2000) (Brock, 1989). It can be extended to support other beat patterns.

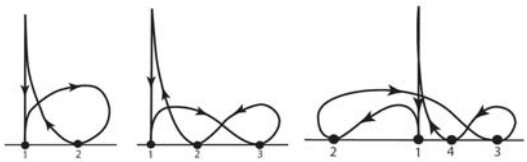

Figure 2: 2-beat pattern, 3-beat pattern, and 4-beat pattern.

For the left hand, the gestures to show dynamics are supported. When the left hand is held with the palm facing up, it means louder. The palm facing out means softer playing.

4.2 Gesture Tracking

The system described in this paper uses an infrared sensor because it has higher sensitivity and less computation time compared to systems using a video camera, and data captured by an infrared sensor is easier for visualization compared to those collected by an acceleration sensor.

The infrared baton (Figure 3) used in this gestural interface consists of a conducting baton, an infrared LED (110 degrees viewing angle), a button, and a battery. During conducting, a student holds the infrared baton in the right hand like holding a real conducting baton and presses the baton using his/her thumb. Thus, it is not difficult for a student to learn to use. A Wii Remote (Figure 4) is employed as an infrared camera in front of a student. An acceleration

sensor named WiTilt v2.5 (Figure 4) is applied to capture the movement of the left hand.

Figure 3: The infrared baton.

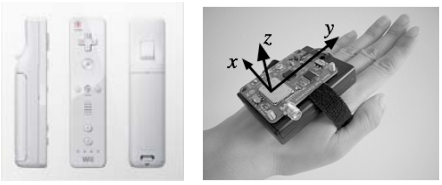

Figure 4: Wii Remote (from (Wii, 2008)) and WiTilt v2.5.

4.3 Gesture Analysis

The features for the right hand consist of coordinates and beats. Coordinates of the tip of a baton at each time are used to generate beats, fundamental components of a beat pattern. Figure 2 shows that a beat always occurs at the vertical minimum of a movement. A beat detection algorithm is developed to detect the peaks and troughs of a trajectory.

The results of gesture analysis are displayed as shown in Figure 1. All coordinates are small dots. A trough (beat) is represented with a larger dot. Thus, it is easy for a student to visually differentiate one feature from another. A curve connects these dots and represents the trajectory of the movement. The result is a quantitative interpretation which shows students exactly what their gesture looked like, and can be compared to a reference gesture from a teacher or textbook.

For the left hand, 3-dimensional acceleration data are features and will be used directly in gesture recognition/following.

4.4 Gesture Recognition

4.4.1 Task-target Gestures

The first gesture recognition is able to tell whether a beat pattern is conducted correctly or not on the basis of an assumption that the beat pattern is known beforehand. It is reasonable because the conductor and performers in an orchestra have the score that indicates the time signature. Currently, it only supports 2-beat, 3-beat, and 4-beat per measure. It is not difficult to extend to other patterns.

Initially, the downbeat is detected as a downward motion based on horizontal coordinate comparison and represented visually by a vertical line. Subsequent beats are then detected according to their coordinate position relative to the downbeat. The recognized result is displayed on the upper left side of the conducting window as shown in Figure 1.

The accuracy of this recognition depends on the downbeat identification and the quality of other beats. If the student performs the gesture correctly, the system recognizes it and rewards the student.

4.4.2 Free-form Conducting Gestures

The second recognition is a more general one, allowing the student to conduct any beat pattern. The downbeat is detected first, as for the task-target gestures, and then the number of beats is accumulated until the next downbeat is found. The amount of beats reveals the beat pattern performed. Figure 5 shows an example of 12-beat patterns.

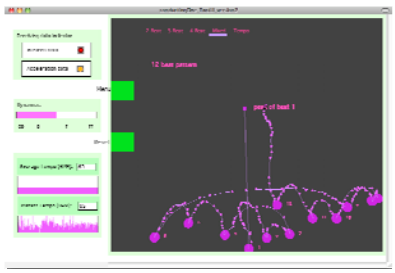

Figure 5: An example of 12-beat pattern.

The downbeat of a subsequent gesture affects the recognition accuracy because an incorrect downbeat does not stop the beat counter. As a result, the number of beats increases until a beat is identified as a downbeat.

4.5 Gesture Following

4.5.1 Tempo Tracking

Tempo tracking reveals the speed of conducting, enabling a student to practice consistent timing. Each time a beat occurs, the value of the tempo will be calculated using beats per minute (BPM). Both average and instant values are supported. The average value is a moving average and estimated based on the past 10 beats. Therefore, it can follow the changes, especially the significant changes, in tempo quickly and also show the speed trend of conducting clearly. The instant value is intended to show current speed of conducting.

There are two representations for the value of the tempo (Figure 5). The numerical tempo value is a value at a certain time. The diagram clearly shows

the changes of the tempo in terms of remaining steady, the increase, and the decrease.

An experiment was performed to demonstrate the accuracy of the tempo tracking system. Individuals were asked to conduct a piece at a specific tempo measured in real time. Results are shown in Table 1.

Table 1: Comparison between the calculated average tempo and the real average tempo.

Amount (2-beat)	Calculated tempo by the system (BPM)	Real tempo by a stopwatch (BPM)
15	115.38	115.68
30	99.45	100.19
45	128.27	128.85

4.5.2 Dynamics Tracking

Dynamics tracking is for the left hand and done on the basis of 3-dimensional accelerometer values measuring tilt. As the orientation of the left hand changes, the tilt values change corresponding to the intended change in dynamics. A particular hand position equates to a specific dynamic, and the recognized result is shown using a slider, which is a conventional visual representation for the volume and easy to understand for students.

4.6 Response

In this gestural interface, visual and aural feedback are presented once a gesture is recognized.

Visual representation is intended to present a more direct interpretation to gestures and can be compared to that of a teacher's or a diagram on a textbook. It may be easier for students to adjust and improve their gestures.

Aural representation consists of playing a certain tone corresponding to the recognition of a certain beat. For example, C4 will be played when the downbeat is found. This kind of aural representation gives students the feedback they need while conducting, but does not require them to keep their eyes on the screen. Correct gestures and errors are identified this way. This aural representation also allows professionals and instructors to use the system as they conduct a real orchestra.

5 CONCLUSIONS

This gestural interface aims to help conducting students learn and practice conducting gestures. The Wii Remote is not expensive and easy to acquire. Students do not need to spend time learning how to manipulate the whole system because real conducting gestures are employed with an infrared baton, which is similar to a real baton. Both visual and aural representations are presented to students. The process of gesture recognition and following is simple, fast, and accurate.

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A DESIGN OF COMPLEMENTARY COMMUNITY CURRENCIES FOR EDUCATION

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Keywords: Complementary Community Currencies, Wits, Rewarding, Education Community.

Abstract: This paper proposes a design for complementary community currencies for education communities to boost cooperation of the more advanced students with the less advanced ones. Its design follows two goals: motivating students to learn by doing extra homework (effort) and share knowledge with younger students (tutoring), and shifting the role of teachers towards a more supervisory, tutoring and dynamic tasks. The hypothesis, following a Brazilian example, is that colleges may accept as payment for their tuitions not only conventional legal currencies, but also educational complementary currencies. The traditional grants policies based on personal effort will be paid with bunnies, and modern community tutoring effort will be paid with knowls. The bunnies and knowls will be obtained as a reward of doing homework and providing help for homework, respectively, and as an expected result, students will have more solid knowledge background at all levels resulting from their boosted personal and community effort.

1 INTRODUCTION

Education has challenging problems beyond the well known ones of funding and methodology. The lack of motivation of the younger generations raises high up above them; students see no relevance in what is done in the school except for "good grades meaning good colleges". Several on-line communities try to deal with this problem presenting initiatives that resulted for example in high interaction and outstanding results in complex mathematical problems, involving pre-college students. The drawback is that these communities are not connected to each another. Thus, it is conceivable to connect them with expectation of boosting teachers' role of helping their students to learn and make academic progress.

Another problem is that teachers, burden with heave teaching load, rarely participate in innovation forums, do not take into account the modern student incentivization tools (for example, on-line games), and as the result, they have no time to address the problem of students seeing no relevance for their lives in what is done in school.

The current state of the art solutions attempt to increase the intrinsic motivation of students. Some solutions today are related to paying students for their academic progress, with either legal currency or complementary community currency that can be used towards college or university tuition. Other approaches are also increasing the intrinsic motivation of students by creating a strong sense of elitist community, like on-line communities. There are many other approaches, but we will keep focus on those, will discuss their pros and cons and will propose improvements to them.

The key fact is that the best students are some sort of *insiders*, who know the subject and also know how to motivate less advanced and/or younger students. Last, but not least, the universities, by allowing students to pay tuition with complementary community currencies, are promoting the *good will* as well as recruiting *good students.* At the same time the University will help with social services in the educational community and will benefit the students

who share their knowledge. Universities may hope also that the state will reimbursement them for the lost tuition income as some sort of a tax-payers' payback based on the public benefit of the scheme.

2 PREVIOUS WORK

Some precedent systems paying for sharing education have been already proposed. According to (O'Brien, 2008), the Baltimore schools Superintendent, Andres Alonso, unveiled a controversial proposal to improve city schools: pay students to perform. It's a simple idea that has generated quite a bit of controversy from purists who cringe at the thought of paying students to learn and from realists who believe there simply must be a more effective way to spend $1 million in a failing school system. Yet despite moral and practical objections, this approach does have a record of success abroad. What's more, there may be a way to tweak Mr. Alonso's plan so that it reinforces - rather than undermines - the value of learning and enables the city to earn a greater return on its investment.

Paying people to do what they should be doing, such as working hard in school, may seem like absurd policy, but this approach, as claimed by (Lietaer, 2006) is proving to be an effective tool for fighting poverty in the developing world. "Conditional cash transfer" programs, as they are known in the international development community, have increased health and education outcomes for impoverished families around the globe, from Brazil and Argentina to Mozambique, Cambodia and Pakistan. Perhaps the best-known such program, Mexico's *Progresa*, pays parents cash in return for forfeiting the wages their child could earn and instead keeping him or her in school. Not surprisingly, children of families enrolled in *Progresa* are much more likely to stay in school and acquire the skills they need for the high-wage jobs that can lift an entire family out of poverty.

Progresa's success inspired New York Mayor Michael R. Bloomberg to implement the first conditional cash transfer program in US. Launched last year, Mr. Bloomberg's Opportunity NYC is a privately funded demonstration project that offers cash payments to low-income workers who meet certain benchmarks, such as opening a bank account or meeting with teachers to discuss a report card. Early feedback from the program suggests that these transfers aren't simply a cash bonus; for many, they serve to replace the wages lost when a parent leaves work to meet with his or her child's teacher.

Mr. Alonso's proposal to pay students to perform draws ire from those who believe our instant-gratification culture has infiltrated every corner of society; no longer are students compelled to learn for learning's sake, or to achieve in the hope of securing a better future. The critique that these payments for passing send the wrong message to students is potent enough for Baltimore to reconsider how it structures and frames its program.

In our opinion, first, the city should split the payment by handing one part directly to the student and deposit the rest into a restricted savings account that can be used only to pay for higher education or skills training. The straight payment would give the city the instant results it seeks, while directing the savings to an account in the child's name would reinforce the expectation that passing the state assessment test is just one step in the journey to achieving a postsecondary credential and, with it, a better life. As a bonus, such a solution helps provide these students - those who work hard to achieve – with the financial boost they need to continue their education.

The program is thus transformed from a bribe for kids to past tests to a vehicle for students to chart a path to higher education through building academic skills and earning their college scholarship.

According to (O'Brien, 2008), the Bloomberg's claim was: "We've reached a breakthrough agreement establishing a new program that will reward excellent performance by individuals and by entire schools." Mayor Bloomberg also said: "We are rewarding our teachers who prove that they are the most successful in helping students make academic progress".

We claim that this approach has another problem resulting from the use of legal currencies that are not appropriate for certain types of communities like education-centered ones, since these communities may have other values.

For example, online communities blossom around specific subjects. Some examples are the art of problem solving www.artofproblemsolving.com, the Interactive Mathematics Miscellany and Puzzles, www.cut-the-knot.org, and the Maths Forum @ Drexel mathforum.org. They represent different approaches to attracting highly motivated high level students that love maths and enjoy exchanging solutions. These communities have strong community sense. From our point of view, they are disconnected from the less advanced students, who do not benefit from this excellent collective source of knowledge. This paper is an attempt to provide a framework for connecting these communities with regular students and teachers.

In some sense there is a solution: it is the *saber* of Bernard Lietaer (Lietaer, 2006). This is an alternative rewarding system that helps students to achieve access

to colleges and at the same time incentivize the advanced students to teach the beginners. The main social goal of *saber* project is to multiply the number of students that can afford to obtain a college-level education in Brazil. The additional goals are having a direct impact on the entire primary and secondary school learning potential, as well as improving the cross-generational and social awareness of the kids that will go to college. To avoid stagnation, they apply a 20% yearly inflation (or tax) on accumulated sabers, so that advanced students have an incentive to have a plan to be in college at a certain year. The discount rate applied for the tuition is 1 saber = 1 riai (the official currency in Brazil).

Finally, and far from being educational applications, there are the question-answer communities like yahoo answer, were the rewarding is based on simple points, but has attracted the attention of several hundreds of thousand users with about 70.000 questions posted every day. The question – answer approach may fit well with educational communities, and part of their incentivization schemas may adapt to them. In the on-line communities, people look for status, raising high in the ranking system, with predefined reward tables sorted according to their activity. Apparently, it is something that they enjoy (Howe, 2008). A problem that these communities have is that most of the most active users love to help, but do not like or need to be helped, making the points in their accounts not too useful.

3 GOAL

The challenge is to find a way to connect students and teachers so that collectively they act more intelligently than any individuals or groups have ever done before.

The goal is to incentivize students and teachers with intrinsic motivations, by a strong sense of community. This will be done by designing a special currency, whose unit will be called *Wit* and will be issued under highly controlled conditions as explained below. Its face value would be nominally the same as the legal currency of countries in which they are earner (i.e., Euros, Dollars, etc), and would be redeemable either for paying tuition for higher education programs in participating universities or for other benefits inside the educational community. The **balance** among the convertible value of the new currency **is the key for achieving the motivation** of students and teachers. This would be a paper currency (although electronic accounts can be kept where they will accumulate), with all the security precautions against fraud used for printing conventional national currency.

The proper design of the Complementary Community Concurrencies (CCC) is critical, since as (Krohn and Snyder, 2008) states, eighty-five percent of the local paper currency systems (a type of CCC) initiated in the United States since 1991 have become inactive. This is discussed in the following section.

4 A PROPOSAL OF COMPLEMENTARY COMMUNITY CURRENCIES FOR EDUCATION

Following (Carrillo et al., 2007), we proposed to introduce a new general class of currency called *wits*. The name intends to invoke the meaning of "things that make sense". Any student that makes things that make sense to somebody else in his/her educational community will be rewarded with *wits*. The reward can be granted either for progress towards obtaining higher grades or for involvement with the community in the form of helping other students. The payment can be issued by the students' parents or by public authorities. Teachers simply help students to advance themselves according to their goals. The redemption of their wits into *real* things may vary from exchanging them for tuition for colleges to exchanging for money or even for attaining certain roles in their communities. The rewarding will be always done from a meritocratic point of view. The educational community self-control will apply, so any fakes will be fixed inside the community itself.

Accordingly, we propose two different kinds of *wits*, as complementary currencies inside the educational communities:

- **Bunnies**, the first type of *wit*, will be a measure of individual progress as long as students succeed doing exercises. The bunnies may be also credited to parents when they are helping teaching their children and, when necessary call for help. They will be used by the students at the end of the term to redeem age-specific rewards of any type, according to the desires of students under the constraints set up by parents. The rewards are subject to achieving certain goals agreed by the parents and the educational community. Students start with zero Bunnies at every term. Bunnies are lost whenever a student quits the educational community though they might be given to other students at any given moment, or can be divided at the end of the term among the best students.

- **Knowls,** the second type of *wit*, is the currency that is assigned every term to students to reward tutors, advanced students or even other parents for their efforts to help students do and understand their homework. Knowls are assigned as a loan to every student that joins the community, which means that any student can use them to reward any other student or tutor for their help. The knowls are redeemable primarily for college grants, though, other usages may apply. For example converting knowls into bunnies may be allowed at the exchange rate yet to be determined. Before redeeming knowls for tuitions or bunnies, the loans have to be paid back.

These types of wits can be divisible by 100 to facilities precise pricing. We expect that the prices for personal progress and community contributions will be self-regulated by the educational community itself, by sort of an invisible hand.

4.1 Educational Viability of Bunnies and Knowls

There are some examples (Threadless, iStockPhoto, Fotózz, etc.) that led us to believe that our learning community will benefit from crowd-sourcing, by taking advantage of the over-education of middle class making our interests more diverse than our business cards would have us to believe (Howe, 2008). A confluence of factors contributed to a sudden creative abundance for teaching. An exponential rise in education has coincided with the emergence of the greatest mechanism of distributing knowledge the world has ever seen, the Internet. But this diversely talented, highly skilled workforce must toil away in a labor market that requires ever greater degrees of specialization. This leaves people feeling overeducated and under-fulfilled, with job satisfactions rates reaching all-time lows. Thus, the ones who can teach can be advanced students, as well professionals interested in sharing their specific knowledge, housewives with high degrees but no paid jobs, and others.

Motivations in the communities fall into extrinsic and intrinsic categories. We can think of extrinsic motivation as consisting of carrots (a financial reward) and sticks (a scolding from your boss). Intrinsic motivations, on the other hand, consist of such factors as creative fulfillment, a belief in the project, the sense of community obligations, or the opportunity to enhance one's reputation in that community.

People are inspired to contribute to crowd-sourcing endeavors for similar motivations, though financial incentives also play a role, especially when the contributors hail from developing countries. However, people derive enormous pleasure from cultivating their tales and from passion on what they have taught others. Collaboration, in the context of crowd-sourcing, has its own reward (Howe, 2008).

Fotózz (see Table 1. for some basic facts), an educational community in the field of photography, has rewarding schemes with some similarities to the concepts proposed in this paper. In Fotózz, there are over 40.000 users very motivated to learn and highly active in posting photos and writing reviews, so that users learn by doing. A participant sees others' photos and reviews, so that she understands deeply herself her own progress in photographic abilities. This community has a credit system quite similar to the complementary community currency proposed here, where every user receives some credits for every review made. A participant can use earned credits for publishing new photos, showing his progress or experimental work. If a user runs out of credits, then she cannot publish any picture until she reviews a sufficient number of other authors' photos. This is a powerful 'carrot' incentive.

Table 1: Features of Fotózz and Wikipedia communities.

Fótozz	**Data obtained Oct 30, 2008 from Oct 1, 2003**
43.181	users
147.813	active photos
1.646.372	reviews (hungarian)
0,43%	of the total population of Hungary
3,4	photos per user
38,1	reviews per user
Wikipedia (data obtained from en.WikiChecker by Oct 30, 2008)	
8.176.196	users
75.000	editors (hihgly active users)
2.606.566	articles (english)
260.875.565	edits
0,20%	of the total population in english
0,3	articles per user
31,9	edits per user - Note that edits are of lower magnitude
16,0	reviewed edits per user (estimation)

The cumulative mass of credits of the whole community steadily grows with the level community activity. Also the quality of the photos of the whole community steadily grows, despite a steady flow of people joining or quitting it. Fotózz shows a stable process of teaching done by advanced users to the benefit of beginners that love learning. Interestingly, this community is by far more active than the Wikipedia committee is. Just as a matter of comparison with the most known educational community today, we provide interesting statistics for Fotózz and Wikipedia in Table 2. As shown there, Fotózz members contribute 10 times more entries than the wikipedians do mainly because of

the different nature of entries on those sites. What it is relevant is that they are twice as many Fotózz members as there are wikipedians, measured by the ratio of active users to their linguistic base (Hungarian and English), as well as twice the number of entries per user. This means that Fotózz community is highly attractive and by far much more active than the wikipedian community.

The learning community may work equally well as the Fotózz community does, imposing a set of social norms of behavior on their constituents, offering rewards in the form of enhance reputation, and conforming to those norms or excelling at skills that the community considers valuable.

The users of Fotózz love learning, and they learn a lot by doing, sharing, and reviewing until they reach the time they feel they must quit the community to follow perhaps a professional career with the high credits and skills that they accomplished during their community residence. This virtuous process may also arise in an educational community that uses educational complementary currencies.

Table 2: Comparison of Fotózz and Wikipedia communities.

Ratios	Fótozz	Wikipedia	Fótozz /Wikipedia
Users/population	0,43%	0,20%	210%
Publications per user	3,4	0,3	1074%
Reviews per user	38,1	16,0	239%
Reviews per user (rough)	38,1	31,9	119%

4.2 About the Currency Redemption and the Exchange of Knowls and Bunnies

Colleges in the USA and other countries may decide to accept students pay with knowls to gain students with strong community services and solid knowledge demonstrated by their teaching. This already happened in Brazil, with the *saber* complementary currency (Lietaer, 2006), where every family receives 200 *saberes* per newborn child in order to pay his/her education. The final redemption, at the moment of paying a college tuition is 1 saber = 1 riai (legal currency in Brazil).

Other colleges may accept students paying with bunnies that demonstrate high personal effort and solid working background of the payers.

Some colleges may accept both currencies, what might set, as a matter of fact, the conversion rate between bunnies and knowls. From this point of view, conversions between bunnies and knowls should be allowed inside the community under certain conversion rates.

5 FUTURE WORK

This is a concept of yet another application of knowledge backed complementary community currencies (wits), in the roadmap to citation auctions (de la Rosa and Szymanski, 2007). We are looking for many uses of wits (Carrillo et al., 2007) in preparation to their general introduction not only in the Internet 2.0 communities but also in other knowledge intensive communities. We expect to build up communities that love teaching and learning by doing, where users generate, review and distribute the contents.

In future work, we will test the concept in on-line educational communities, initially in those devoted to helping students to do their homework, as well as helping parent to help their children to do the homework. Examples of such communities are Notemari.ro in Romania, a New York State educational community like GoodGrades.us, as well as a charter school.

ACKNOWLEDGEMENTS

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TECHNOLOGIES INTEGRATED LEARNING IN THE PRIMARY SCHOOL

Some Aspects of Forming Reflection and Assessment Skills to Young Pupils

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Keywords: Reflection, Critical thinking, Evaluation, Constructivism, Project-based learning.

Abstract: The information society we are living in is looking for new ways to help the new generation in the process of forming skills and knowledge about the use of new technologies. One of the main accents is on the abilities of forming skills for reflection, critical thinking, evaluation and self-evaluation. To form and create successful personalities who will manage to develop their talent and to implement their abilities in complex way, a systematic and purposeful education has to be proposed. Earlier the education process starts, more real the desired results will be obtained. The paper considers the constructivism's ideas of reforming the learning process. A model of technologies integrated learning in the Primary school that was approbated in the pedagogical practice is described. A way of forming skills for reflection and assessment – skills so important for one to have really successful realization in life – is proposed.

1 INTRODUCTION

The informational revolution leads to changes in all sectors of the social life. Society's changes necessitate one person's changes – the way of thinking, the quality and the content of knowledge, the behavior. The process of permanent expansion of new, powerful and modern technologies requires people to have skills to work with them. The development of the informational technologies and their implementation reveals new opportunities for the educational system. In the same time, this development brings before the educational system new challenges.

For a person to be successful in future, should start his/her education at early age. But, how one would do this? Which one is the new educational paradigm that will guarantee competitive personalities?

The paper makes an attempt to show some possibilities of forming skills of reflection, evaluation and self-evaluation during technologies integrated learning in the Primary school, based on some constructivism ideas. Some practical experience is presented.

2 THEORETICAL ANALYSYS

During the last few years psychologists, pedagogues and teachers turn their attention to the ideas of the constructivism and put them in the center as a new educational paradigm.

The constructivism has a long story. It is related to names of Lev Vigotski, Jean Piaget and John Dewey to numerous varieties of the pedagogical theory. The constructivism studies the learning theories (how the person assimilates knowledge and skills) and the characteristics of the knowledge itself (epistemology).

D. Jonassen defends the idea that the education should be realized in an environment that resembles different aspects of real society. Within traditional model of learning the students obtain separated portions of knowledge that they can't use as unity. He suggests the accent to be put on the construction instead on reproduction of knowledge; students to be involved in authentic, real problems and activities, i.e. content instead of abstract learning; the educational environment to be based on real situations; the self-reflection and the rationalization of the experience should be stimulated; the joint efforts during knowledge construction to be

supported instead of basing it on competitive rivalry among students (Jonassen, 1997).

The student is an active subject during the learning process. He/She learns by action. The student is put in the center; it is assumed that he/she is a creator, an acting subject that gains knowledge through his/her personal experience. In this way the knowledge acquires value and motivates the person to form skills that will help him/her to manage in real-life situations. The learning process, based on the constructivism's model helps in forming a lot of qualities and skills of the students like tolerance, critical thinking and self-evaluation and so on. That's why the problem of first significance, according the constructivism theory is the development of critical thinking (Cluster, 2001).

The critical thing is a skill to one to make a decision to what to believe and to what – to not believe **(**Norris, 1985**).**

The aim of critical thinking is the achievement of understanding, evaluation of view points and solving problems. Since all three things involve the asking of questions, we can say that critical thinking is the questioning or inquiry we engage in when we seek to understand, evaluate, or resolve (Maiorana, 1992).

The **critical thinking** develops mental processes, connected to the perception and the processing of information and forms valuable standpoints. "Habits of thinking" that contribute more exact and precise perception and rationalization of knowledge are formed though critical thinking. The critical thinking assumes reflection skills.

The term reflection is used in order to describe the processes of thinking. The reflection is an action. By it people go through the experience, think over it, and estimate it.

The main points of reflection are described in four classical theoretical accents. According Dewey the reflection is thinking about "myself" as an individual and about "my function" as an individual. The reflection is seeking of strong and weak features of a person (Dewey, 1933). For Kolb learning is described as process of learning by doing. According the Kolb's cycle the model of learning suggests that a participant has a Concrete Experience, followed by Reflective Observation, then the formation of Abstract Conceptualizations before finally conducting Active Experimentation to test out the newly developed principles (Kolb, 1984). Schon distinguishes between 'reflection-in-action' and 'reflection-on-action' (Schon, 1983). Habermas studies the use of reflection as one of the process that human being adopt in the generation of particular forms of knowledge. He describes the process of construction of new knowledge, and new theories (Habermas, 1971).

Generalizing describer theories Moon states that the reflection "is a mental process with purpose and/or outcome that is applied to relatively complicated or unstructured ideas for which there is not an obvious solution" (Moon, 1999).

The following kinds of reflection are differentiated:

- Intellectual reflection – thinking about thinking;
- Personal reflection – self-knowledge of a subject;
- Dialogic reflection – self-knowledge by and through dialogue with others;
- Praxeological reflection – self-knowledge through one's actions and creations.

The intellectual reflection is divided to intellectual reflection in learning (learning reflection) and intellectual reflection in science.

Strong criteria about the stage of the critical thinking in young pupils are not formulated. Concerning mental development the following criteria are used: skills to operate with abstract terms; logical thinking; working mentally.

The formation of critical thinking and reflection skills are precondition for forming skills for evaluation and self-evaluation. The estimation in the Primary school is based on personality-oriented approach. The self-control also has its place and role in the Primary school.

3 MODEL FOR TECHNOLOGY INTEGRATED LEARNING IN THE PRIMARY SCHOOL

Following theoretical formulations and principles, we have developed and approbated a model for technology integrated learning in Primary school.

The experimental work was launched in 2005. The approbation successfully passed during the school years 2006-2007 and 2007-2008. Two schools from Bourgas – the fourth largest city in Bulgaria, were involved. Eight teachers and 225 students – 50 students from first grade, 75 from second grade, 55 from third grade and 45 students from fourth grade – worked on different educational projects.

The work within the Model is based on school projects that cover topics of the curriculum and provide activities requiring the use of information technologies. Team work and interdisciplinary

approach are used. The assessment is a crucial element of the model. The assessment is carried out on the basis of criteria and indexes. The developed system provides: Estimation that the teacher gives to each team and to each student individually; Estimation that the student gives him/herself; Estimation that a student gives to his/her teammates.

Theoretical basis for the development of the project is the project-based learning. The modification of project-based learning for the Primary school is indicated with the term project-oriented learning. From first go fourth grade step by step the transition from situational to project-oriented education is realized.

Main focus of the work on the project is the use of information technologies by the students. An important accent in the Model is the development of skills of children to present their work. Students work on teams into the computer lab. They usually have two assignments – one on computer and one accompanying task that do not require work on the computer (Papancheva, 2006).

4 FORMATION OF REFLEXIVE AND CRITICAL THINKING SKILLS, AND SKILLS OF EVALUATION AND SELF-ASSESSMENT

The formation of reflexive skills, critical thinking, skills of assessment and self-assessment in the proposed methodology is based on theoretical analysis considered shortly here. All these skills should be considered as a unity even so they have their specificity as well. Encouraging acts of reflection of small pupils goes along with the overall learning activity. The formation of reflexive skills is aimed at the four mentioned types.

In the first grade the students are given the opportunity to record their opinions about three randomly selected children from the class. The requirement for writing only positive qualities and skills is being set to the children. So far students have studied and played together, but have not been provoked to peer at their classmates. The work on this task supports the formation of skills of critical attitude of the thought.

This line continues in the second grade, when on the basis of the already formed skills students created a skill to look at themselves. In front of the students is placed a task to present them as they describe qualities and skills of their character that they consider to be their strengths. This assignment provokes students to look at themselves and seek their positive qualities to represent them in the best manner.

In the third and fourth grade the formation of reflexive skills are directed to the school and praxeological reflection through appropriate learning tasks. Students face a problem that they have to resolve. They are confronted with a deficit of knowledge and here it is particularly important the manifestation of reflection.

The formation of critical thinking is a long and complicated process. Its purposeful conduct in the proposed methodology is implemented in three parallel lines.

In the first manifestation of critical thinking the students are proposed a large quantity of information on the topic. They are acquainted with it and on the base of their experience derive the most important and essential on the topic, the things that they need to complete the set task.

The second line, used to work for the formation of critical thinking skills is the ability to formulate a question on certain criteria, using the received information. In first grade students work on a project "Carnival of professions”. In this point they meet with parents who tell them about their jobs. On the base of what students have heard and based on their personal experience, they have to ask different questions to the parents. The question must be adequate to the situation and to request information not given by the parents till that moment.

In second grade the requirements in front of the students are increased. They work on the project "Spring Carnival", and do surveys of different themes and objects related to spring (birds, animals, trees, flowers). They are presented some information on the topic. They in turn are required to obtain additional information on the topic. Their task is to formulate an interesting and curious question for the object. Students prepare an electronic quiz with interesting questions, which present in front of their parents.

During the next grades the work on the second line continues, and in the fourth grade students prepare and conduct a discussion related to the issues of energy. The thematic gradation is expanding the range of vision of the students – from the world around them to substantial problems, common for the people. The leading of a discussion requires a good basic training in the subject in order to formulate specific and precise questions and adequate answers, reasoned defense of their own position, etc.

The third line for the formation of critical thinking occurs in relation to the used applications for the realization of the set tasks. After the theoretical treatment of the problem, students must realize and accomplish it in practice. The selection of an appropriate computer programs and technological tools implies good technology culture. Of particular importance here is the manifestation of learning reflection.

The formation of skills of assessment and self-assessment does not take place in isolation but is in direct connection with the work on the formation of reflexive and critical thinking skills.

Cards for evaluation and self-assessment are introduced and their complexity increases with the age of the students.

In first grade students are required to assess the behavior of their classmates, using a picture of a smiling or frowning face. They are offered two levels of evaluation – good and bad.

In second grade an upgrading in two aspects is carried on. There are three stages to evaluate the behavior of a teammate – bad, good, excellent. Images of men are used again, but they have a characteristic color (by analogy with the traffic light). At the beginning of the period the evaluation of one's own behavior (self-assessment) during the academic activities is introduced. In the middle of the period a big step in terms of personality, self-reflection and self-assessment is made. The students are required to assess their work using the already known scheme. In the third and fourth grade the evaluation cards are considerably more complicate.

5 CONCLUSIONS

Technology integrated learning must not be considered as something isolated or as an end in itself. It should support the process of learning by offering new digital working environment to students. The realization of the constructivism's ideas in pedagogical practice in the Primary school and the integration of the technologies in the learning process is very difficult task, as the main researches are on theoretical base only.

Based on formulated theoretical postulates and on the changes in the educational paradigm one can describe the following conclusions about how quality and innovative learning to be realized:

- The accent should be shifted from the cognitive to the motivational, emotional area with balance between;
- A special learning environment should be created. This environment should offer conditions for student to achieve more complex knowledge and to develop their cognitive potential;
- The assessment process must not be an isolated process, but integrated into the learning process, based on different theoretical approaches;
- The reflection should be a key factor of the learning process;

The learning process in the Primary school should be placed in a way to stimulate and to develop the reflexive skills to young pupils. In this way student could form abilities for self-evaluation of their possibilities, evaluation of the information available, and this will help them in their realization in live.

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e-LEARNING AND SEMANTIC WEB

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Keywords: e-Learning, Learning Object, Metadata, Web services, Semantic Web, Ontology.

Abstract: e-Learning is fast, relevant and just-in-time learning grown from the learning requirements of the new, dynamically changing and distributed educational world. The term "Semantic Web" encompasses efforts to build a new WWW architecture that supports content with formal semantics, which enables better possibilities for searching and navigating through the cyberspace. As such, the Semantic Web represents a promising technology for realizing e-Learning requirements. This paper presents an approach for implementing the e-Learning scenario using Semantic Web technologies. It is primarily based on ontology-based descriptions of content, context and structure of the learning materials and benefits the providing of and accessing to the learning materials.

1 INTRODUCTION

There are two main types of players in the learning economy: producers and consumers. Producers of learning material use various design tools and other software to produce different kinds of learning material. Consumers use learning material created by others (or themselves) to develop new content packages. Producers make their learning material available by placing them in different kinds of repositories accessible from the Internet. Typically, consumers are expected to search these repositories using metadata (way of searching for learning material, we define it better in the next sections). There may be copyright and payment issues associated with the reuse of learning materials.

Current development efforts with learning materials are mostly concerned about metadata and content packaging aspects (way of package the learning content). There has not been any significant work done so far in automating the discovery and packaging of learning objects based on variables such as learning objectives and learning outcomes. There has also not been a significant amount of work done in personalizing e-learning based on learning materials developed and stored at arbitrary locations on the Internet. This is largely because learning materials are a relatively new phenomenon. Automating these processes is also a knowledge-intensive activity likely to require the application of artificial intelligence techniques such as knowledge representation and reasoning.

2 BASIC INFORMATION ON e-LEARNING

A lot of attention has been devoted to educational systems and electronic learning ("e-learning") in recent years, due to the fact that content and tool support can now be offered at a widely affordable level, both with respect to technical prerequisites and pricing. Developed by researchers as well as practitioners, many e-learning systems use the Internet as an infrastructure to distribute content more efficiently even in remote places, to present it, and to ease administrative tasks.

But before continue analysing the distribution of this e-learning content, it is essential to focus on the content itself and how it is organised.

2.1 The Digital Resources

Digital Assets are the simplest form of Digital Resources and they serve as the starting point for an e-learning lifecycle. These assets can be of many different types (e.g. graphics, images of simple text documents) and can exist in several different formats.

The steps involved in the transformation of *Digital Assets* into a Learning Object are:

- **Digital Asset** A *Digital Asset* is defined as any piece of content that is created using technology (Angad, 2005).

- **Compound Digital Assets** *Compound Digital Assets* can be best described as digital assets with contextualised information.
- **Learning Object** There are many different definitions for a Learning Object and there is no general agreement to what constitutes a Learning Object. We have defined a Learning Object as the aggregation of a *Digital Asset*, *Compound Digital Asset* and Metadata with a particular learning purpose. This definition incorporates a number of definitions by other **a**uthors (Hawryszkiewycz, 2002), (Dalziel, 2002), (Wiley, 2000) and (South, 2000).
- **Complex Learning Object** *Complex Learning Objects* are packages consisting of structured assemblies of zero or more *Digital Assets*, zero or more *Compound Digital Assets* and one or more *Learning Objects* (Dublin, 2003).
- **Metadata** in reality is data describing data and it can be used to describe any digital resource.

2.2 e-Learning

A general agreement seems to exist regarding roles played by people in a learning environment as well as regarding the core functionality of modern e-learning platforms (Husemann, 2002). The main players in these systems are the *learners* and the *authors*; others include trainers and administrators.

Content consumed by learners and created by authors is commonly handled, stored, and exchanged in units named as *learning objects* (LOs) as we said. The LOs can be accessed dynamically, e.g. over the Web (Vossen, 2002).

2.3 Metadata & e-Learning

Compared to traditional learning in which the instructor plays the intermediate role between the learner and the learning material, the learning scenario in e-Learning is completely different: instructors no longer control the delivery of material and learners have a possibility to combine learning material in courses on their own. So the content of learning material must stand on its own. However, regardless of the time or expense put into creating advanced training material the content is useless unless it can be searched and indexed easily. This is especially true as the volume and types of learning content increase, meta-data on the objects become a critical factor. Indeed, meta-data are needed for an appropriate description of learning objects so that plug-and-play configuration of classes and courses is possible. As we saw, several standardization efforts have been launched, in order to reuse content from one system to another.

3 WEB SERVICES

In essence, Web services are independent software components that use the Internet as a communication and composition infrastructure. They abstract from the view of specific computers and provide a service-oriented view by using standardized stack of protocols. Web services can be combined to build new ones with a more comprehensive functionality. Even in terms of interoperation of business-to-consumer (B2C) systems, Web services are currently obtaining a growing importance.

In figure 1, the typical steps of an invocation of a Web service are shown. In a first step, suppose that a client needs to find a Web service which provides a specific functionality. This is done by contracting a UDDI registry (step 1), which returns the name of a server (service provider) where an appropriate Web service is hosted (step 2). Since the client still does not know how to invoke the desired service, a WSDL description is requested which contains the name and the parameters of the operation(s) of the service) step 3 and 4). The client is now able to invoke the service using SOAP protocol, which essentially puts the data in the envelope and sends it over the Web by using HTTP. The service provider receives the request and executes the desired operation(s) on behalf of that client. The results are finally sent back to the client by using SOAP over HTTP again (step 6).

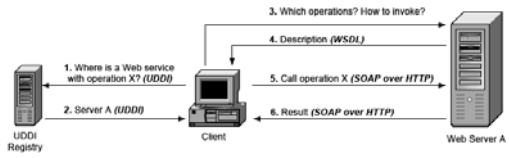

Figure 1: Invocation steps of web service.

4 SEMANTIC WEB SERVICES

4.1 Semantic Web Architecture

The term “Semantic Web” encompasses efforts to build a new WWW architecture that supports content with formal semantics. That means content suitable for automated systems to consume, as opposed to content intended for human consumption. This will enable automated agents to

reason about Web content, and produce an intelligent response to unforeseen situations. Layers of the Semantic Web «Expressing meaning» are the main task of the Semantic Web. In order to achieve several layers are needed (Berners-Lee, 2000). They are presented in the figure 2, among which the following layers are the basic ones:

- the XML layer, which represents data;
- the RDF layer, which represents the meaning of data;
- the Ontology layer, which represents the formal common agreement about meaning of data;
- the Logic layer, which enables intelligent reasoning with meaningful data.

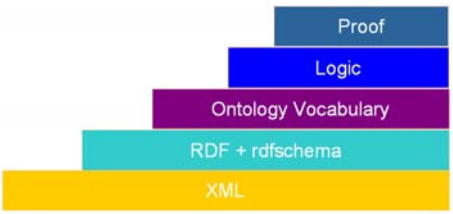

Figure 2: Layers of the semantic web architecture.

4.2 Ontology-based Metadata

The role of ontology is to formally describe shared meaning of used vocabulary (set of symbols). In fact, the ontology constrains the set of possible mapping between symbols and their meanings. But the shared understanding problem in e-Learning occurs on several orthogonal levels, which describe several aspects of document usage, as described in figure 3.

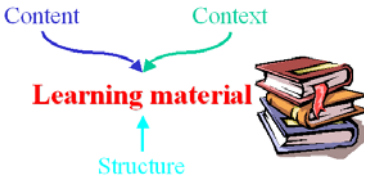

Figure 3: Aspects of document usage.

From the student point of view the most important things for searching learning materials are: what the learning material is about (content) and in which form this topic is presented (context). However, while learning material does not appear in isolation, another dimension (structure) is needed to encompass a set of learning materials in a learning course.

5 LEARNING SCENARIO

Based on the discussion in the previous section, this section presents overall architecture of our ontology based e-learning scenario. The architecture of the system is represented in figure 4. The knowledge warehouse acts as a metadata repository and the onto broker system (Decker, 1999) is a principal differencing mechanism.

The first phase is the production of learning materials that may be used or reused in the construction of training courses. In order to provide learning material, which could be suitable for metadata-searching, each learning material has to be described or "enriched" with the following metadata information:

- what is the learning material about (content annotation),
- which context has the learning material (context annotation) and
- how is it connected to other learning materials (structure annotation).

This "enriching" consists of explicitly adding to each learning material a set of metadata information referring to course ontology. Providing information is for now constrained on manually entering metadata information (facts) through automatically generated templates, based on the definition of concepts in the course ontology.

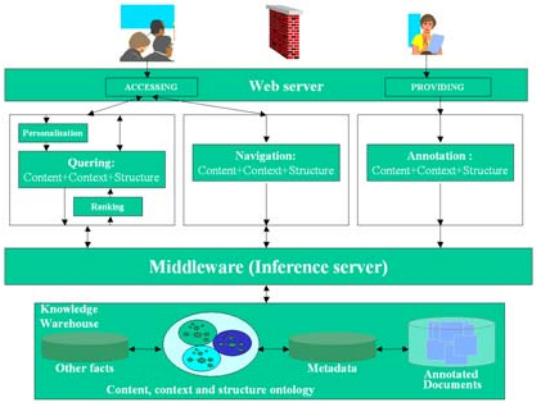

Figure 4: Architecture of an e-Learning portal.

6 CONCLUSIONS

"Making content machine-understandable" is a popular paraphrase of the fundamental prerequisite for the Semantic Web. In spite of its potential philosophical ramifications this phrase must be

taken very pragmatically: content (of whatever type of media) is 'machine-understandable' if it is bound (attached, pointing, etc.) to some formal description of itself.

This vision requires development of new technologies for web-friendly data description. The Resource Description Framework (RDF) metadata standard is a core technology used along with other web technologies like XML. Ontologies are (meta)data schemas, providing a controlled vocabulary of concepts, each with an explicitly defined and machine processable semantics. By defining shared and common domain theories, ontologies help both people and machines to communicate concisely, supporting the exchange of semantics and not only syntax.

In the same time, promising areas for applying the Semantic Web are unlimited. In fact, each area, in which a lot of information should be provided and accessed in a distributed manner, searches for some semantic-based solution.

In this paper we presented an e-learning scenario that exploits ontologies in three ways:

- for describing the semantics (content) of the learning materials. This is the domain dependent ontology,
- for defining learning context of the learning material and
- for structuring learning materials in the learning courses.

This three-dimensional space enables easier and more comfortable search and navigation through learning material.

The purpose was to clarify possibilities of using ontologies as a semantic backbone for e-learning. Primarily, the objectives are to facilitate the contribution of and efficient access to information. But, in a broader or in Semantic Web's view, an ontology-based learning process could be a relevant (problem-dependent), a personalised (user-customised) and an active (context-sensitive) process. These are prerequisites for efficient learning in the dynamically changed business. This new view enables us to go a step further and consider or interpret the learning process as a process of managing knowledge in the right place, at the right time, in the right manner in order to satisfy business objectives - knowledge management. It means the merging of e-learning and knowledge management using the Semantic Web should be the promising integration.

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DESIGN OF A SYNCHRONOUS COLLABORATIVE LEARNING ENVIRONMENT

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Abstract: In complex fields of knowledge, working in unmoderated small groups is a common approach for creating knowledge out of given information. Taking a look at the portfolio of learning environments, only a few systems provide the necessary functionality for synchronous collaboration. In most of them, synchronicity is reduced to communication. The aim of this work is the design of a synchronous collaboration environment which fulfills the requirements to enable members of a small group working together efficiently via computer networks. Based on the three elements communication, cooperation and coordination, a concept for an appropriate groupware is created and a flexible model defined. A sample environment called "SLE" is developed to demonstrate the applicability.

1 INTRODUCTION

Learning in complex scenarios is difficult to be done by an individual alone. A common approach to handle even sophisticated learning scenarios is collaborative work in small groups. In these scenarios, learning is based on different persons having a comparable level of knowledge but different views on the subject. The required information is available and provided in different forms such as books, scripts, and exercises. The information is transformed into knowledge through close collaboration of the group.

Common environments for distributed learning - like Learning Management Systems - focus on loose, asynchronous collaboration. Close and therefore synchronous collaboration is often only supported by small communication tools like text, audio, or video chats and whiteboard functionality. Aim of this work is to build a virtual environment designed to fulfill the requirements for a close, synchronous collaboration amongst a small group of learners.

To identify the requirements for such an environment, elementary works about close collaboration and learning have to be considered as well as existing solutions with a comparable functionality. Therefore, two areas of research, computer supported collaborative learning (CSCL) and computer supported cooperative work (CSCW), are relevant for the given scenario. Based on results of theoretical works and functionality of existing solutions, a basic model which fulfills the identified requirements is designed, which considers aspects of navigation, interaction, and cooperation.

A sample environment, so-called 'Synchronous Learning Environment', is introduced to demonstrate the applicability of the concept. Based on this implementation, first results of an evaluation are presented.

2 RELATED WORK AND REQUIREMENT ANALYSIS

The analyzed tools for distributed and synchronous cooperative work mainly divide into two classes: shared text editors and shared whiteboards. Shared text editors came up at the beginning of the 1990s. One of the first was *GROVE*. The underlying work (Ellis et al., 1991) introduced several important basics of groupware like concurrency issues and views. In (Dourish and Bellotti, 1992) the term 'awareness' was coined and extended with a new type, the

so-called 'passive awareness mechanisms'. Part of this work is the implementation of an editor called *ShrEdit*. Beside this basic developments, newer representatives of shared text editors like *NetEdit* (Zafer et al., 2001) emerged, which implemented more recently developed improvements concerning awareness mechanisms and application design. Parallel to this, 'shared whiteboards' where examined, which were not restricted to simple text manipulation. An early representative of these is *wb*, part of the MBone groupware architecture (Eriksson, 1994). Aiming to share and annotate presentations, it offers simple drawing routines for all users. This concept was extended by *MediaBoard* (Tung, 1998). Based on the possibilities for interactive presentations, shared whiteboards where developed towards interactive conferencing systems like Adobe Connect Pro[1].

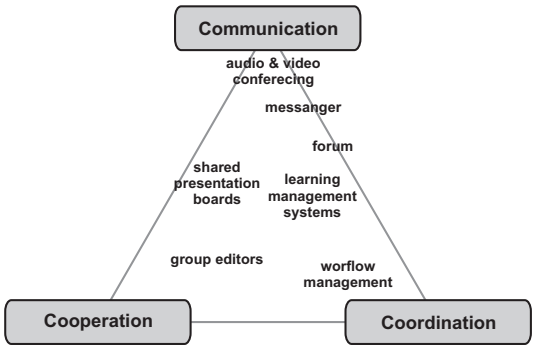

Figure 1: Different groupware in the 3C Model.

Each collaborative technology can be divided into three parts: communication, cooperation, and coordination, see Figure 1. We can thus look at the parts separately and classify the requirements accordingly.

Basics of distributed **communication** were extracted from (Fuks et al., 2006). The optimal form of communication between human beings is a face-to-face conversation because there are no limitations to the communication channels. The available channels are voice, mimics, and gestures. In (Olson et al., 1995) text, voice and video chats were exermined for their value in small group collaboration. According to this study, high quality voice communication enables a distributed group to achieve the same results in collaboration as a local group. While a video communication is only of little additional value for the result, it is beneficial to the acceptance of a collaboration environment.

Elements of **coordination** are based on the above-named groupware solutions and their workspace awareness mechanisms. Main issue of coordination is the concurrency handling. The advantage of a more restrictive system is providing clearer role definitions and requiring less organization between the users. In the given scenario, roles are surely existent, but the role allocation is very dynamic. The role definition should be as dynamic as possible and the concurrency handling therefore less restrictive. With a less restrictive concurrency handling, the cost for organization between the users increases. Aiming to reduce this operative overhead, passive awareness mechanisms collect awareness information in the background and present them directly on the workspace.

In (Dwyer and Suthers, 2006) collaboration with artifact-mediated **cooperation** was analyzed. Cooperation is defined by the interaction of multiple users with a 'shared material'. The goal is to reclaim knowledge by structuring information, so this is the starting point to find an appropriate material for the environment. A common definition of 'knowledge' is 'networked information'. 'Information' is interpretable data. In the given scenario, we can work directly with information because it is already available.[2] According to this definition, the shared material is a workspace which allows to place and link information. The combination of a workspace, information objects, and links is named 'information space' below.

3 INFORMATION SPACE MODEL

The information space should provide a wide variety of information object types and good possibilities to structure information objects. On the other hand, the information space structure should be as simple as possible to avoid distracting the users from the content. A concept for an information space has to consider both requirements and therefore needs to find an adequate balance between them.

The simplest structure for an information space is a linear array of information objects. An example for a linear information space is pure text: the information objects are words, sentences or sections. The linkage is provided by their order. Linear information spaces are easy to access, but aside from the order of objects, there is no possibility of structuring information. The dimension has to be increased to enable those structuring mechanisms. This leads to a class of two-dimensional information spaces. A member of this class is the classic whiteboard. Following the common nomenclature for two-dimensional spaces,

[1] Adobe Connect Pro, Adobe Systems, http://www.adobe.com/de/products/acrobatconnectpro/

[2] In scenarios of moderated learning, the interpretation of data would be an additional step.

an information space with this structure is called 'information graph' in the following.

Many restrictions of classic whiteboards are ommited with the generalization to an information graph structure:

- **Workspace:** A virtual workspace needs not to be bounded. There are no restrictions to the level of detail a workspace can have.
- **Objects:** Information objects can be of any digitally representable form and are not restricted to text and graphic types. Objects can easily be manipulated, moved and removed.
- **Links:** Links are not restricted to symbols. They can be moved easily with the linked objects.

Beside text and graphic objects, common object types in virtual environments are multimedia data, documents, and internal/external links.

While the information space model is synchronized between all users, the visualization is not. This allows a much more flexible handling and dynamic changes between close and loose collaboration. While the local workspace is bounded, the global workspace (i.e. the information space) is not. Users also can have different views on the (global) workspace. A differentiation between the global coordinate system of the information space and the local coordinate system of the local workspace is required. The visualization therefore is a projection from the information space to the local workspace. As part of the global workspace, the information objects are also being projected. This allows assigning multiple representations for a single object type. Two possible representations are a workspace representation, like an icon or label, and a detail representation, which enables access to all object information. The visualization of links between objects strongly depends on form and complexity of the chosen link model.

For the interaction with the information space, a minimal set of object operations has to be realized: *creation*, *manipulation*, *movement*, and *deletion*. Interaction between users takes place through interaction with information space objects, so a small extension to the set of object operations is required: *selection* and *deselection*. An object can only be selected if it is not selected by another user. In addition to the object operations, *linking* of objects has to be provided as inter-object operation.

'Workspace Awareness' is part of visualization and interation. It comprises all mechanisms which support the awareness among the users interacting in the (shared) information space. For visual awareness mechanisms, an additional information channel is needed, which allows identifying the interacting users easily. An appropriate channel is available in form of coloring. Because the workspace visualization realizes loose WYSIWIS[3], awareness mechanisms for loose and close collaboration are required. In a loose collaboration, a user must be informed *where* the other users are acting. In close collaboration, a user must be informed about *what* the others are doing.

4 IMPLEMENTATION AND EVALUATION

The so-called Synchronous Learning Environment (SLE) is a sample implementation of the concept introduced in section 3. It is divided into four separable modules: data management, user management, communication, and workspace. The modularization has several advantages: It allows to enhance or to replace single modules without affecting the others as long as the interface is maintained. For example, the communication module can either be a voice or a video chat depending on user preferences, bandwidth or hardware requirements.

The user management module provides user identification and user session handling. The data management module is informed about information space changes and maintains a persistent representation. In the current version, the communication module realizes a simple voice chat. Central element of the SLE is the workspace module. It is built as client-server achitecture. The server provides a reference model of the information graph. The clients share the global workspace and are responsible for projection, visualization and interaction.

The considerations in section 3 leave room for models of different complexity. The currently implemented information space model is a minimal model according to the findings. The information space has the form of an information graph (two-dimensional), is unbounded and provides the functionality of placing information objects in an origin-centered, real-valued coordinate system.

Implemented information object types are: *Label*, *Image*, *Binary*, *URL*, and *Graphlink*. *Label* is a simple single-line text object. *Image* is a container for JPG, PNG, and GIF graphics. A *Binary* object corresponds to the 'universal' object and handles arbitrary binary files. External and internal links are realized with the *URL* and *Graphlink* object types. Links are realized as simple non-directed 1:1 mappings.

[3] What You See Is What I See.

The implemented Workspace Awareness includes mechanisms for close and loose collaboration. Close collaboration is supported with colored selections and viewport tracking. Colored projections of all viewports on a map simplify orientation during periods of loose collaboration.

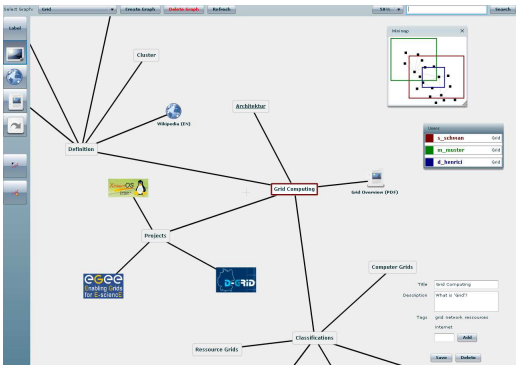

Figure 2: Synchronous Learning Environment.

The evaluation aims to analyze the concrete model selection done in the sample environment *SLE*. The SLE was tested in groups of two and three users. The test started with a blank information space. The topic was unknown to the participants to create an equal level of knowledge. Information material was provided in digital form.

The basic information space structure was accepted by all users. The unbounded global workspace accommodated the demands of a dynamically growing information space much better than a bounded workspace does. Information objects of type *Label* were significantly more often placed than any other types. Beside this fact, the usage of other object types strongly depends on the form of the provided information material. As extension to the given set of objects, a type which provides the possibility of holding complete text was requested. In many situations the possibility of changing the object type was required. This functionality is therefore an important feature for further implementations. The available 1:1 mappings given by the implemented link model fulfilled the users' needs whereas a feature to measure a links weight was missed.

The implemented concurrency handling worked well in learning groups of the given size. It has to be observed how collaboration efforts scale with the number of members in larger groups. An extension showing the current actions of the other users (like 'editing', 'navigating', and 'idle') was requested. In the testing groups, this information was exchanged with the help of voice communication. All in all the provided voice communication was rated as a very important element for the collaboration.

5 CONCLUSIONS

The aim of this work is to virtualize a scenario in which knowledge is built up via information structuring. Such a virtualization provides the possibility of distributing the collaboration. With the information space model, a concept is created which enables a close cooperation. Aspects of coordination are taken into account with the construction of adequate passive awareness mechanisms. A high quality voice communication completes the functionality.

With the SLE, an implementation for the created concept is available to demonstrate its applicability. It enables an early evaluation of the concept, which is at its current state limited to usage experiences. Therefore the evaluation does not replace a comprehensive study about advantages and disadvantages of unmoderated learning in a two-dimensional information space as developed in section 3. So next, such a study needs to be performed, ideally based on a full-featured and refined implementation of the concept.

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HYBRID METHOD TO DESIGN MULTI-LANGUAGE WEB SITES

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Keywords: Web design, Multi-languages, Educational Comenius project 2.1.

Abstract: Language promotes the most suitable way for expressing ideas, habits and values. For a multinational educational project (Comenius 2.1.) with a widespread European target group, it is very important to provide the online educational resources (courses, virtual instruments, etc.) through the project website, in several languages: English (as a worldwide spoken language) and partners' languages. This paper briefly presents three methods to create multi-language web sites and proposes a new architecture – the hybrid method architecture. In addition an example of a multi-language web site implementation is illustrated.

1 INTRODUCTION

Communication is based on language even it involves a mixture of verbal and nonverbal messages or a blend of written and spoken messages. The huge development of telecommunications - including television, radio and the Internet - has led (in the last years) to increasingly sophisticated combinations of visual, spoken, and written "texts" (Tiscali, 2008).

The European Union, had, from the very beginning, as heart of its policies, the preservation of the linguistic diversity. The EU policy of multilingualism as a deliberate tool of government is unique in the world and the use of EU citizens' languages is one of the factors which make it more transparent, more legitimate and more efficient.

2 METHODS TO CREATE MULTI-LANGUAGE WEB SITES

In the *Consideration in the Design of Multi-language Websites* paper, Zev Itzkowitz and David Grunwald propose four architectures for a multi-language web site development. The basic ideas of these methods consist of common operations such as replication and dynamic content generation.

First method, *site replication* is the most common method used to create multi-language web sites. Virtually, the web site consists of architecture of directories, each directory containing the same web site, but in other language. One of these sites is the default site and to access it, in the root of the web, a file that generates a redirection is used. To change the default language, only the redirection file from the root site must be changed.

The European Union web site is the most representative one for the multi-language web site category, mainly due to the fact that it is the most translated site – at present, its translation is available in 23 languages. This web site is built based on the replication method but with different architecture of directories– the directories represent topics and each of them contains HTML files, translated in each language with a particular name.

The main advantage of this method is offered by the possibility to add a new translation without major changes on the web site infrastructure. However, there are many disadvantages that make this method not very attractive: difficult web site maintenance, possible differences between the site versions (in different languages); lose of the uniform image worldwide (for example a 10 web pages site will become a web site with 70 pages when it is translated in 6 languages). Any update or change must be done in each site in each language.

The *selective replication method* uses the same principle as the replication method. This method consists of partial replication of the web content. A pattern file is created for each web page. This file imports data from files with generic names and the

data is stored in a structure of directories based on the available languages. This method provides the preservation of the web site uniformity but still remains the site maintenance problem.

Dynamic Content Generation using Database is a method that can be implemented in certain conditions: (a) the web site host server must be fast, (b) the site shouldn't be too large and it will be translated only in a few languages (usually 2-3), (c) the graphical elements are few. The data is stored in tables; every message is identified by a unique ID.

The disadvantages of this method are presented in Table 1.

The last method, *Dynamic Content Generation using XML Files*, combines elements of the previous presented methods. In the frame of this method, a template is designed for each web page. This template generates the format for the web page displayed to the client. The texts and images for each language are maintained in a separate XML file. The XML files are stored in a structure of subdirectories according to the languages associated. The template file imports messages from XML files and generates the content displayed on the client.

Thus, this method is similar, in principle, with the previous method; the main difference is that the data is stored in XML files, not in a database. Storing data in XML files offers many advantages (see Table 1). This method requires a good initial strategy and organization plan. If this strategy is optimal developed, the site maintenance will not cause problems and adding a new language will not change in a great extent the site infrastructure.

2.1 Hybrid Method Architecture

The hybrid method architecture emerges elements from all the methods presented before. This new method proposes to valorise the advantages of the methods presented above and reduce their disadvantages. Table 1 explains how the disadvantages of one method can be eliminated, using the powerful characteristics of another one.

The disadvantages of the hybrid method can be eliminated by creating several web instruments for information uploading on the server and the web site maintain. The programming language selected to create the script and the server performances are also very important.

According to this method, a template file will be created for each web page. The template can be created using any programming language for CGI interfaces.

The template file will generate the web page format using the data extracted from the database and XML files.

Table 1: Hybrid method versus other methods.

Method	Advantages	Disadvantages
Replication (Site / Selective)	Increased number of languages; High performance - low server overhead.	The uniformity of the site is not preserved; Large number of web files to maintain.
Dynamic Content Generation using Database	Maintain the site uniformity using a web template; It is a good choice for small sites with reduced multimedia content.	Reduced number of languages; Slow performance on server; Difficult to load information in the database.
Dynamic Content Generation using XML Files	Better performance on server unlike dynamic content using database; It is a good choice for larger sites.	Can be implemented only at the initial phase of the design. Difficult to store information on site.
Hybrid method	There is no limit for numbers of languages; Better performance on server (use files on disk and database); The uniformity of the site is preserved; The web site is easy to maintain.	It is difficult to maintain the information on site without any additional instruments; Medium server overhead.

All the messages to be translated are stored in XML files and the database contains only general information used by the template script. In addition, the XML files are stored using a subdirectories-based architecture, in order to be easily accessed. The method architecture is presented in Figure 1.

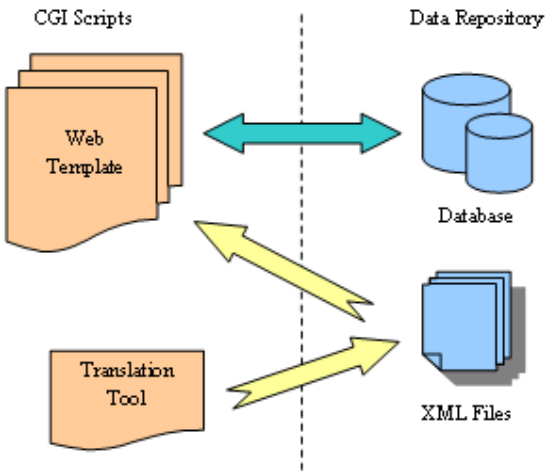

Figure 1: Hybrid method architecture.

The XML files are created using a web instrument - Translation tool. This instrument cannot

make the translation itself; it is used only by the translators to on-line introduce the translated web page content. Using this procedure, the web master doesn't interact with the translation web page content. In this case, the role of the persons involved in translation activities and site maintenance is clearly defined.

2.2 VccSSe Web Site Architecture

VccSSe (Virtual Community Collaborating Space for Science Education) - http://vccsse.ssai.valahia.ro - is a Comenius 2.1. Project funded by the European Commission. The project is aimed to adapt, develop, test, implement and disseminate training modules, teaching methodologies and pedagogical strategies based on the use of Virtual Instruments, with the view to their implementation in the classroom, through Information and Communication Technology tools. In this sense, the partnership assumes to build various pedagogical approaches in a virtual space able to offer efficient ways of using specific tools for logical understanding of the fundamental concepts in sciences. The target groups are formed by approximately 180 in-service teachers from primary and secondary schools involved in Sciences teaching areas in the partner countries (Romania, Spain, Poland, Finland and Greece), institutions' local coordinators, tutors, researchers, local educational authorities and over 3500 pupils who become indirect beneficiaries. In addition, teachers and trainers from Europe will benefit from the project outputs consisting of a number of on-line simulating laboratories.

Having in view the huge amount of transnational work and outputs, the main channel of dissemination is represented by the project web page. In this context, the whole on-line content - first created in English - had to be translated in other 5 languages: Romanian, Spanish, Polish, Finnish and Greek. The increased number of translation languages eliminates the possibility to implement the Dynamic Content Generation using Database method.

Using the hybrid method architecture described before, the translation process is simplified. The web masters developed for each web page a template using a powerful programming language: Perl. The web template is used only to generate the web page format and, in general, it doesn't contain any text that can be displayed in the web page. The web template queries a MySQL database to obtain any information needed to generate the web page or useful for other operations. The content stored in the database is not intended to be translated. All the messages that will be displayed in the web page are stored by in a XML file, created for the English version of the web site. The XML files are stored in the subdirectories architecture based on languages acronym.

When a user accesses the web page, the web template is executed on the server. The Perl script contains a subroutine (presented below) that verifies the existence of the XML files for each language and creates a list with these languages.

```
 sub langs {
  my $tran;
  my @flags =
("en","ro","es","pl","fi","gr");
   my $altlg =
{en=>"English",ro=>"Rom&#226;n&#259;",e
s=>"Español",pl=>"Polski",fi=>"Suomi",
gr=>"&#917;&#955;&#955;&#951;&#957;&#95
3;&#954;&#940;"};
   foreach (@flags) {
       if (-e
"../langs/".$_."/".basename($0).".xml")
  {$tran = $tran." ".$q->a({-
href=>"/main/".basename($0)."?lang=$_"}
,  $q->img({-src=>"/images/$_.gif",-
border=>"0",-alt=>"$altlg->{$_}"})); }}
     return $q->div({-
id=>"langs"},"$mmsg->{al}$tran");}
```

Based on this list, an image of the flag and a link to the web page in that language is displayed. If the XML file, for a specific language, is missing, the associated flag is not displayed and the web page (in that language) cannot be accessed.

2.3 Results

To translate a web page from English in other language, the person in charge, must access the translation tool, available on the web page. For example, if a Romanian translator wants to translate the Introduction web page, he must access the Translation tool button, located on the English Introduction web page. After an authentication process, he is forced by the translation interface to translate only for the Romanian version of the page (this is accomplished by the authentication information stored in the MySQL database). The translation tool dynamically generates an interface based on the English messages stored in the XML file; the fields dimension where the Romanian messages will be written are proportionally calculated by the numbers of characters of the

English messages. These dimensions are only visual and don't restrict the translated messages size.

The translation tool has two purposes: to create the XML files that contain messages in specified language when it is used for the first time on a web page and to update messages on specified web page. The translators use the keyboard in their languages and the specials characters are dynamically converted by the CGI script in web codes; as a result of this feature the problem of the character set is eliminated – it is not necessary to generate web pages with a specific character set declaration.

The translation tool is the only instrument used by the partners to translate and update the web content in their languages. This Perl script (partially presented below) is very small - 4.1 Kbytes and contains only 345 words, being executed very fast by the server (a Dual Core CPU server).

```
 print $q->b("Language: $lang");
  print          $q->start_form(-name=>
"translate",-method=>"POST"),$q-
>start_table;
 my $count = 0, $bgcolor = '';
 foreach (keys %{$en}) {
  $count++;
   if ( $count/2 == int($count/2) ) {
$bgcolor = "bgcolor='#CCCCCC'"; } else
{ $bgcolor = ""; }
   my $lines = (length $en->{$_})/50;
    print        $q->Tr({$bgcolor},[$q-
>td(["$en->{$_}",
    $q->textarea(-name=>"$_",-
rows=>"$lines",-columns=>"50",-
value=>"$olang->{$_}")])]);}
   print     $q->end_table,$q->hidden(-
name=>'op',-default=>'s'),
    $q->hidden(-name=>'page',-
default=>$page),
    $q->submit(-name=>"",-
value=>"Save"),$q->end_form;
   print               $q->start_form(-
name=>"authen",-method=>"POST"),
    $q->hidden(-name=>'page',-
default=>$page),
    $q->hidden(-name=>'logout',-
default=>'yes'),
    $q->submit(-name=>"authen",-
value=>"Logout"),$q->end_form;
```

Using this hybrid method, the web site uniformity is preserved. The persons that translate the web content are forced to translate phrase by phrase; the text is presented in a random list. The number of people involved in this action is reduced and the possibility to appear errors is insignificant.

3 CONCLUSIONS

The hybrid method architecture for designing multi-language web sites was implemented in the Comenius 2.1 Project VccSSe (Virtual Community Collaborating Space for Science Education). The website is available since the beginning of the year 2007 and it can be accessed at: http://vccsse.ssai.valahia.ro. The web site is under development until the end of the project. It is easy to add new web pages or new languages for translation without making changes in the site architecture.

The English content posted on the site has been translated in all five languages of the project partners (Romanian, Spanish, Polish, Finnish and Greek) using only the translation tool. The translation tool – a very small and fast script - can be used to create new web pages in other languages or to update the online-content for a specific language. This tool cannot be used to change the English content. To fulfil this action, another web tool is developed.

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TOWARDS LIBRARY SUPPORTED COLLABORATIVE LEARNING

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Keywords: Library Marketing, Digital Libraries for e-Learning, Collaborative Learning/Filtering, Data Mining.

Abstract: Due to the development of information and communication technology our information environment has greatly changed. People's requests to libraries have been changing along with it. As a result the library materials are changing from printed ones to network media. Considering such a circumstance we anticipate that learning assistance should be one of the major library services in the future. In this paper, we propose a model of collaborative learning in which the library users, or patrons, are implicitly helping each other as they learn. The basic idea of this approach to collaboration comes from the mechanism of collaborative filtering. Not only the learners but also the librarians are supposed to help the learners with advising their learning materials and managing their learning processes; which is considered to be a style of extended reference service by libraries. We anticipate that by mixing up the traditional reference services and the ones that support patrons' learning processes the future libraries would be able to keep existing as reliable organizations and librarians would be considered to be their reliable supporters.

1 INTRODUCTION

The aim of this paper is to propose a model of library supported (implicit) collaborative learning (CL) system and to demonstrate its importance.

The spreads of information and communication technology (ICT) is one of the most influencial changes for our society in these couple of decades. Accessing to the Internet with mobile phones becomes very popular now. We are able to access a wide variety of information anytime, anywhere.

Libraries have been playing an important role in our society as organizations that provide us with services for reading materials (Ranganathan 1957). Due to the development of ICT, the library materials are changing from printed ones to digital media privided via network. Then what sort of library service is required in such an ICT age? Our answer is that the services that support the library users, or patrons, with their learning. People in these days are eager to keep studying. Libraries have advantages for playing such a role because they have good experience in assisting patrons' learning.

Our goal is to construct a system so that the librarians support their patrons based on their professional skills and the data that are collected as the patrons learn. This model is a kind of CL in the sense that the data are used for helping others. There are two types of CL; explicit and implicit. Explicit CL is the one that learners collaborate by explicitly communicating each other by using a chat system, for example (Ueno 2005). Implicit CL is the one that learners do not communicate explicitly; they just study. The data are automatically collected as they learn, shared by them, and used for helping them.

2 COLLABORATIVE LEARNING

2.1 A Model of Collaborative Learning System

Figure 1 illustrates an overall organization of the collaborative learning system poposed in this paper. The left part indicates the system users who learn a subject. Patron 1 studies materials based on the library's recommendation. Patron 2 uses an intelligent bookshelf (IBS) (Finkenzeller 2003) (Minami 2008) (Zhang and Minami 2007) that is connected to the home server. The learning server detects what books are taken out and returned at which times. Such timestamp and other data are used

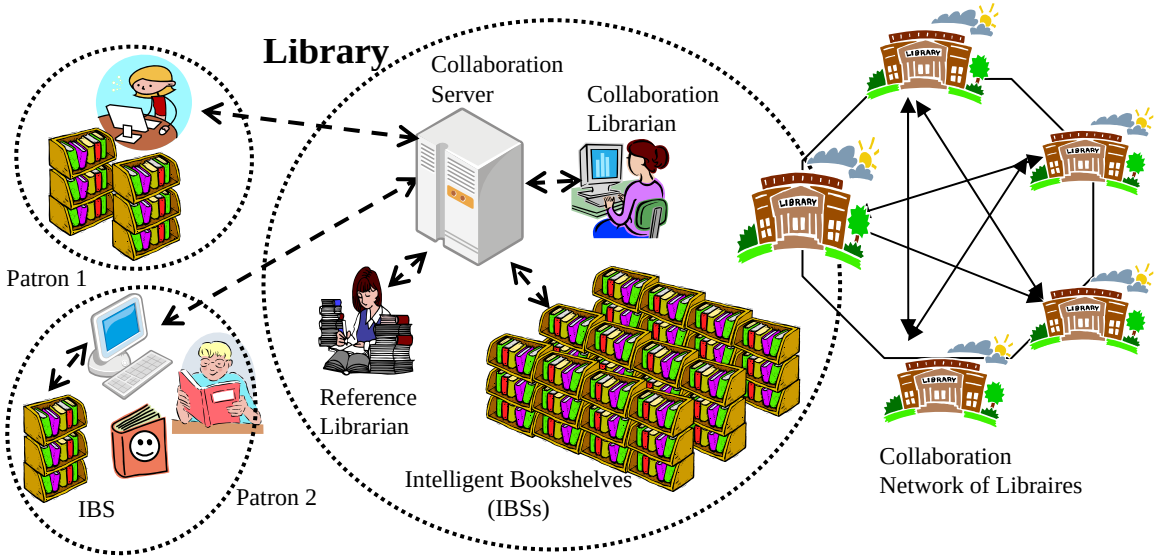

Figure 1: A Conceptual Model of Collaborative Learning System Supported by Libraries.

for supporting Patron 2 with his study.

The middle part is the library, which has the central collaboration server. Each patron is connected to this server. All, or some, of the IBSs access the server. Further, the librarians also access the server in order to carry out their jobs. Reference librarians use it for collecting data about reference services as well as use it for looking for the information and knowledge provided by the server. Collaboration librarians also use the server. The system provides them with information obtained by analysing the raw data. The collaboration librarians can change and/or add extra knowledge or policies that specify how to use the knowledge of the server.

Libraries are also working collaboratively. They have already been working cooperatively such as in inter library loan (ILL) service.

2.2 Implicit Collaborative Learning

Learning Assistance with SASS

SASS (Searching Assistant with Social Selection) (Oda and Minami 2000) is a system which was planned and developed as a keyword recommendation system for information searchers (Fgiure 2). The input area is in the upper pane. It also contains the given keyword(s), the type of recommendation among several candidates. One type is based on the relatedness of keywords. Another example one is to find keywords which are used in combination with the given keyword and also which are closely related to the keywords that are used in combination with the given keyword.

It is a surprise for us when we found SASS can be used as a learning assistance in a sense that we can recognize our knowledge level with the recommended keyword list from the system. They are related to the original keywords that are given by the user in some senses. So we try to find the reason how the recommended keyword is related to the original keyword and why other searchers used them.

If we are can guess the reason then we can think ourselves that we know well about the field that is represented by the keywords. If we can not explain, then we may consider that we do not know the field sufficiently well. Thus we will set a goal of studying this field in learning the recommended keywords; starting with learning what the term means and then learning what it is related to other terms and concepts in the target field.

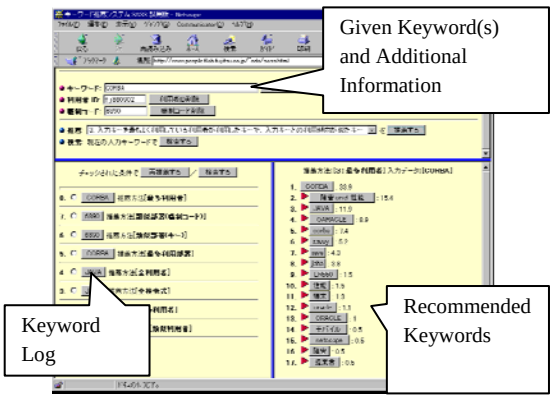

Figure 2: A Screen Shot of SASS.

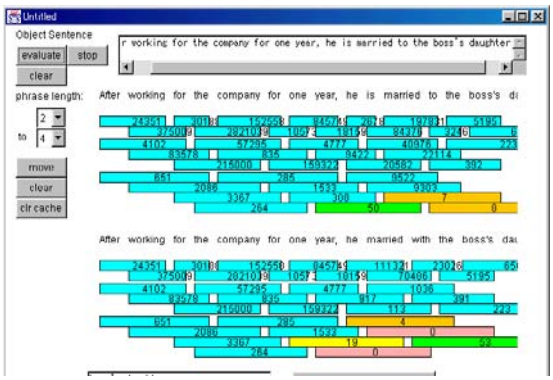

Figure 3: A Screenshot of WebLEAP.

Learning Assistance with WebLEAP

WebLEAP (Web Language Expression Assistant Program) (Yamanoue, Minami and Ruxton 2000) is a system that helps users with writing articles in English (Figure 3). The input field is in the topmost part, where the user types an English sentence or an expression as a list of words. Then the system replies with occurrence numbers of combinations of consecutive words (n-grams) in the expression. The occurrence numbers come from a Web search engine specified in the system. The users are supposed to read and compare the occurrence numbers and try to find out what they mean including if the expression he/she has given is right or not, if it is appropriate, if it is popularly used, and so on.

In order to put appropriate conclusions by reading and comparing the numbers, we have to think hard, which is very good for us in training ourselves in our studying of English. This is another type of system that is good for educating ourselves.

2.3 Learner Profile Estimation

Figure 4 illustrates an example set of learning materials M1, M2, ..., M6 together with the arrows for representing their dependencies. Suppose that these materials are the ones a learner has to study in order to master a subject field. Let us take the material M1 for example. There are two arrows toward the material M1, which means that in order to study the material M1, the learner must have studied both of the materials M2 and M3.

Material Construction

The original material structure comes from the knowledge and decision from experts in the target field. We can refer textbooks for this. A lot of companies have already provided such coursewares.

In addition to logical dependencies, we may use other types of dependencies. Suppose, for example, the material M3 has no direct dependency with M4. We also suppose that M3 and M4 both contain proofs that use mathematical inductions. We further suppose that the mathematical induction used in M4 is simple and easy to understand, while the one in M3 is somewhat difficult to understand.

We suppose further that it becomes easier to understand the proof in M3 if the learners have already studied the proof in M4. In such a case we may consider that M3 is dependant with M4 not in logical sense but in the sense of learning procedure. In such a case we can put another dependency arrow from M4 to M3. It also could happen that such hidden dependency relationship may be detected from the log data of patrons' learning procedures. Let us take the similar supposition as the previous paragraphs. Then the learners may feel difficulties if they study M3 before studying M4 and they would feel it easier to study M3 after studying M4. This difference may appear in study time and/or achievement test of M3 or M4.

Learner's Profile

In order to give advice to the patrons as they learn, the librarians need to recognize the learning status, or profile, of the patrons. In this paper we take the set of learning materials and the patron's achievement degrees as the first approximation for patrons' profile data.

The achievement degree is from 0 to 1, or 0% to 100%, where 0 means that the learner has not studied the material yet, or even after learning he/she has failed to solve all the questions in the achievement test or in some other methods of evaluation. Degree 1 means that he/she has solved all the test and he/she can go forward to the next step.

For other methods of evaluating the achievement degree, we can take one described in Section 2.2; for example, the system or librarian put a list of terms that are supposed to have learned in the study topic

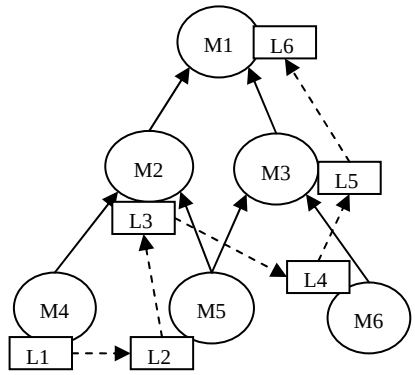

Figure 4: An Example Structure of Material Dependencies and a Path of Learning for it.

and ask the learner to explain what they mean, how two terms are related each other.

Study time is also a good index for assessing the learner's achievement. If the learner spends a lot of time in studying, he/she may be in difficulty in the studying material. Suppose, for example, the learner's study time is 20% longer than the standard study time of the material then his final achievement degree for the material may be calculated as the raw degree times 0.8 or in other method.

It would be good to combine some types of achievement degrees and decide the learner's final degree for the material. It is not necessary to require the degree of 1 to go forward to the next step. We put some threshold value, say 0.8, and the degree is more than this value, the learner can go forward to the higher level.

2.4 Material Recommendation

A learning plan is recommended by the collaborative learning system. Then the reference librarian checks the plan and modifies it if necessary. The final plan will be decided upon negotiating with the learner himself/herself.

Due to the dependency constraint, the possible study order is limited. For example, the set of study material in Figure 4 has 16 possible study orders. An example order [M4, M5, M2, M6, M3, M1] is shown in the figure. How can the system evaluate and choose a possible study order? A possible way is to use importance of study order. Let us suppose the importance is in the order of M1, M2, M3, M4, M5, and M6. The possible first material to start with is either one of M4, M5, or M6, because other materials are depending on some other materials in this set. From the importance order the material M4 is the most important, so the system chooses M4 as the first study material. Then the next material to be studied is either M5 or M6 and M5 is more important to study than M6, thus M5 is the next. As M4 and M5 have studied, the next candidates are M2 and M6, and M2 is more important than M6, so the system takes M2 as the next one. By repeating such processes the recommended study order becomes the one in Figure 5.

3 CONCLUDING REMARKS

In this paper, we proposed a new library service model of implicit collaborative learning. A key feature is that the data are automatically collected as a patron learns with the system, stored, and are used for assisting all the patrons. Another important feature is that not only the system but also the librarians are involved in assisting the patrons with providing their expertise and make final dicisions on the ways of assisting. Also we discussed about the methods of recommending study materials, including their study orders.

The CL system proposed in this paper is an education system in two different aspects. One is that for patrons, of course. This is the major aim of the system. Another one is that for the librarians. They can learn as they use the system and help the patrons with their learning. Even though this aspect is rather a sub-aim, it is very important for both sides.

One of the biggest aims of this paper is to suggest a direction to future library service when libraries are facing difficulties in finding the way to keep being as reliable organizations for our society.

The next goal of this research is set to design the CL system in detail, implement, and demonstrate its usefulness through experiments.

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A COMPARATIVE ANALYSIS ON USING SEVERAL VIRTUAL INSTRUMENTATION SOFTWARE IN EDUCATION

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Keywords: Virtual Experiments, Cabri Geometry, LabView, Crocodile Clips, Comenius 2.1. Project.

Abstract: Using Virtual Experiments become one of the main methods for Science teaching in actual Education. Their power on creating simulation-based learning environments is well-known and many teachers have already adopted the virtual experiments to be used in their classrooms. The great extension of the Virtual experiments determined 9 institutions to propose a Socrates-Comenius 2.1. European project called *VccSSe - Virtual Community Collaborating Space for Science Education* project (code: 128989-CP-1-2006-1-RO-COMENIUS-C21) coordinated by Valahia University of Targoviste, Romania which has as main objective to adapt, develop, test, implement and disseminate training modules, teaching methodologies and pedagogical strategies based on the use of Virtual Instruments, with the view to their implementation in the classrooms. In the first year of the project, three software products were chosen for developing the process of training: *Cabri Geometry II*, *LabVIEW* and *Crocodile Clips*. This paper presents the results of a comparative analysis, made by the tutors who trained the in-serviced teachers on using the mentioned software products.

1 INTRODUCTION

In general, setting up demonstrational experiments needs time and effort. These setups must be tested and reset before they are displayed. Real experiments may also require technique expertise and a lot of work. A modern solution implies the use of virtual instrumentation in the teachers' demonstration experiments. Virtual instruments are in fact software applications which, concerning their functions and appearance, imitate real or realistic instruments or equipment (Kántor and Gingl, 2002). From an educational point of view, Virtual Experiments support students to learn scientific phenomena and concepts. The responses of the learning processes that involved Virtual Experiments have demonstrated that the virtual environments can be used as a useful methodology in Science education for school students (Shin, 2003).

In this sense, in the last period, several European projects targeted on promoting Virtual Experiments in Education. Lab developing training systems which integrate virtual experimentation and intelligent tutoring technologies become usual subjects. Beside previous projects, *VccSSe* project is addressed - on the one hand - to in-service teachers training on using virtual instruments (VIs) in the teaching process of different Science disciplines (Mathematics, Physics, Chemistry) and - on the other hand - to the pupils (as end-users) who benefit by the implementation of the Virtual Experiments in the classrooms. In addition, the project partnership assumes to build pedagogical approaches in a virtual space (*VccSSe e-Space*) able to offer efficient ways of using specific tools for logical understanding of the fundamental concepts in Sciences.

2 VIRTUAL INSTRUMENTATION ENVIRONMENTS

In the frame of the above mentioned *VccSSe* project (http://www.vccsse.ssai.valahia.ro), the partnership

composed by 9 educational institutions from Romania, Spain, Poland, Finland and Greece, prepared and developed specific materials for training on using *Virtual Instrumentation in Science Education*. The training materials were designed to in-service teachers from primary and secondary schools involved in Sciences subjects in the partners' countries. As a decision of the project staff, the training materials presented three Virtual Instrumentation environments (*LabView*, *Crocodile Clips* and *Cabri Geometry*) (Gorghiu (coord.), 2007) and the participants were asked to select one of the software environments for understanding its main functions and creating at least one learning object that has to include a virtual application.

In order to give more help to the course participants in the selection of the Virtual Instrumentation environment to use, it was provided a set of already made simulation-based virtual instruments, organized by area and category. This set of VIs is on-line provided in the VccSSe e-Space, integrated in the project web site, special designed to support the teachers' activities. The main science areas are: Mathematics, Physics, Chemistry and Digital Electronics.

Through e-Space, the partnership aims to offer examples of virtual instruments (free accessible by any web site visitor) which can be used to teach a wide range of science lessons. The VI examples aims to: (a) give a better understanding of VI environments, (b) provide an idea of what topics can be better taught using VIs (c) and help teachers to create the final products.

The training sessions were provided using the *Moodle* (*Modular Object-Oriented Dynamic Learning Environment*) e-learning platform. When necessary, special face-to-face learning sessions were held for given supplementary explanations and presentation. Hereinafter are presented several considerations regarding the software products used for training (Suduc et al., 2008).

2.1 LabVIEW

LabVIEW software was the first option for training activities. It is an intuitive graphical programming language with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. This software is suitable for creating a wide range of applications in different areas of industries but also in education for Science subjects teaching.

From the student's point of view, *LabVIEW* has many advantages. The first one is the intuitive graphical interface that allows using the "drag and drop" technique to create specific user interfaces for the applications with pre-built objects. The application functionality can be specified by assembling block diagrams. The intuitive graphical nature of *LabVIEW* allows students to focus on the theory being taught and not on the tool manipulation and on the programming nuances. The time to develop complex applications is shorter than using a general programming language. Because *LabView* is specifically design for engineers and scientists, and it is used in a wide range of areas, the students' transition from school to industry is smoother.

From the teacher's point of view, the additional materials provided by National Instruments represent a real help in curriculum developing. The Measurement & Automation Experiments Library contains experiments written by educators that show the use of National Instruments products in academic labs around the world. The Courseware is a collection of related experiments that encompasses an entire course or topic. Every experiment and courseware is free to download, ready-to-use, easy-to-modify.

Another *LabVIEW* advantage is offered by the possibility to remotely control the applications, facility that opens a new window in the technical distance teaching.

All these benefits with the very unique software licensing give the possibility to improve the face-to-face and distance education.

2.2 Crocodile Clips

Other two environments were proposed by the partners to be used in training: *Crocodile Clips* and *Cabri Geometry II Plus*. The new tools were proposed as alternatives which can fit their necessities for being suitable with the national curricula.

The *Crocodile Clips* simulation packages are developed specifically for education and allow students and teachers to recreate experiments, model mathematical theories or simulate real life quickly and easy. *Crocodile* simulators let students experiment in a safe, accurate environment, and come with a wealth of ready-made simulations and models. *Crocodile Clips* includes four packages: *Crocodile Physics*, *Crocodile Chemistry*, *Crocodile ICT* and *Crocodile Mathematics*. In the frame of the *VccSSe* project, the first two packages were selected.

The main *Crocodile Clips* advantages are related to the user-friendly interface and curricula focus features for the primary and secondary school. In

order to easily learn how to use these tools, the *Crocodile Clips* developers provide many useful free training videos.

2.3 Cabri Geometry II Plus

The mathematics teachers had also the opportunity to use the *Cabri Geometry II Plus* software environment. *Cabri* allows the dynamically exploration of Euclidian, transformational and coordinate geometry. It makes the math's concepts easier to learn thanks to its kinesthetic learning approach. It is easy to create a geometric figure, an equation or graph a function on the *Cabri* screen - which comes alive as a manageable object. *Cabri Geometry II Plus* is an environment recognized by experts in pedagogy, specifically for its simplicity of use and solid educational foundation.

3 METHOD

After the end of the *Virtual Instrumentation in Science Education* course development and its first edition, the chosen software environments were evaluated, taking into consideration the following ten criteria: (1) usability, (2) collaboration, (3) active learning, (4) expression of students' knowledge, (5) holistic approaches in learning, (6) interesting activities, (7) promoting pupils' reflection, (8) providing appropriate feedback, (9) designing various activities and (10) concept / content teacher. The whole analysis was made based on a questionnaire with 10 questions related to the criteria mentioned above. The questionnaire was filled by the course tutors and covered the partners' institutions which participated in the project. 31 tutors, with technical and pedagogical background, filled in the questionnaire. The tutors have been asked to choose one of the five answers: *Not good*, *Weak*, *Middle*, *Good*, *Very good* for all the criteria. The answers were collected and processed with the view to evaluate the Virtual Environments software and to take decisions regarding eventual needed modifications for the second edition of the course.

4 RESULTS

Assuming the percentage as a ratio of the *Very Good* answers (over 50% of them - for a given criteria), the strengths of the respective software can be stated. On the other hand, the ratio of the weaknesses was evaluated as more than 25% of the negative answers (*Middle*, *Weak*, *Not good*) for a given criteria. Having in view those remarks, concluded information tables (*strengths / weaknesses*) can be expressed.

Table 1: Final image of the *strengths* analysis.

Software product	Strengths
Cabri Geometry	usability, active learning, promoting pupils' reflection*, providing appropriate feedback*, designing various activities*
LabVIEW	active learning, interesting activities, promoting pupils' reflection, providing appropriate feedback*, designing various activities
Crocodile Clips	active learning**, concept/content teacher**

Observations can be emphasized also concerning the opinions with major differences (*) and the criteria which have the biggest percentage of *Very good* answers, but nevertheless, they are not predominant (**).

Table 2: Final image of the *weaknesses* analysis.

Software product	Weaknesses
Cabri Geometry	designing various activities
LabVIEW	holistic approaches in learning
Crocodile Clips	collaboration, promoting pupils' reflection, providing appropriate feedback, designing various activities, concept/content teacher

Using the ratio mentioned above, the software which stands out with respect to the required criteria is indicated in Table 3 and Figure 1.

A general result can be drawn on the basis of the overall evaluation of the software. *Cabri Geometry* has a global appreciation rated at 92%, *LabVIEW* at 85% and *Crocodile Clips* at 72%.

The very good appreciation of *Cabri Geometry* environment is not a big surprise as it provides a real opportunity to approach a variety of subjects concerning Euclidean Geometry. We think that its great usability, the possibility for providing a real active learning and an appropriate feed-back brought it very near of both Mathematics teachers and students.

Table 3: Result of the standing out for each criteria.

Criteria	Software
usability (1)	*Cabri Geometry* (A) 71%
collaboration (2)	*Cabri Geometry* (A) 29%
active learning (3)	*Cabri Geometry* (A) 57%
expression of students' knowledge (4)	*LabVIEW* (B) 33%
holistic approaches in learning (5)	*Cabri Geometry* (A) 29%
interesting activities (6)	*LabVIEW* (B) 56%
promoting pupils' reflection (7)	*LabVIEW* (B) 89%
providing appropriate feedback (8)	*Cabri Geometry* (A) 72%
designing various activities (9)	*LabVIEW* (B) 67%
concept/content teacher (10)	*LabVIEW* (B) 33%

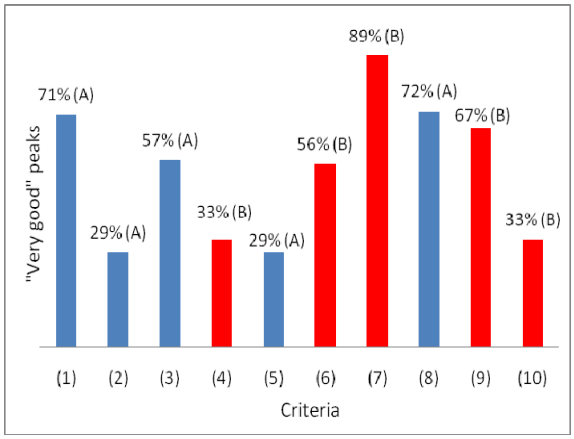

Figure 1: Criteria – "Very good" peaks representation.

LabVIEW also presented strong educational features and good feed-back on expressing of the students' knowledge, designing interesting and various activities, promoting pupils' reflection or expressing a powerful concept / content teacher. More, the teachers and students (even they are acting in lower secondary education) can change the point of interest on the graphical user interface and programming language. In this direction, *LabVIEW* proposes a programming environment very good adapted to the easy designing of professionally interfaces or even real-time simulations of the experimental situations.

Finally, *Crocodile Clips*, despite of its large scale usability, was insufficient pointed to win a criteria. But, as this analyze is going to be repeated after the second edition of the *Virtual Instrumentation in Science Education* training modules, it is a chance to change the situation in a way. In addition, a free and multi-platform dynamic mathematics software (*GeoGebra*) will be included in a similar analysis. As *GeoGebra* has received several international educational software awards, it is possible to refine some of the results given here.

5 CONCLUSIONS

Virtual Instruments are interactive tools with a tremendous potential to make an immense difference in education. The enthusiasm manifested by the in-service teachers trained in the frame of the *VccSSe* project and the pupils' positive feedback proves the project main objective accomplishment.

The results of the comparative study do not reflect the real weaknesses and strengths of the software presented above. The results are reflecting only the tutors and local coordinators perception on these software features and their applicability in the frame of the *VccSSe* project.

The study planned after the second edition of the teacher training course will provide a more real image on these environments due to the experience gained by the tutors in the previous edition.

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TOUCHING VIRTUAL REALITY
An Effective Learning Chance for Visually Impaired People

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Keywords: Learning support, Haptic technology, Multimodal interaction, Virtual reality, Visually impaired people.

Abstract: This paper presents a Virtual Reality (VR) system that allows visual impaired users to explore Virtual Environments (VEs) by a haptic/acoustic interaction. The system may have many interesting educational applications: indeed visually impaired people can access and learn informative contents conveyed by opportunely designed and rendered 3D VEs. Moreover a visual 3D scene editor allows domain experts, responsible of the learning process, to design the VE even if not well grounded in VR. This tool enables an easy prototipization and a fast modification of the haptic/acoustic rendering to fit users feedback: therefore the design of the learning experience arises from the cooperation of the domain expert with the final users.

1 INTRODUCTION

Virtual Reality can help visually impaired users to learn information expressed as 3D virtual environments (VE), which can represent objects shape but also more abstract concepts.

Haptic devices such as PHANToM (Massie, Salisbury, 1994), gestures inputs such as CyberGlove (Immersion), TextToSpeech and Speech Recognition technologies enable more intuitive and natural Human-Machine interaction. Force feedback, besides traditional auditory and visual rendering, allows the tactile manipulation and exploration of interactive 3D virtual objects.

Haptics and VR have been investigated to enhance the learning of concepts involving three-dimensional spatial data by sighted students (Jones, Bokinsky, 2002). (Magnusson, Rassmus-Gron, 2005; Yu, Brewster, 2002; Jacobson, 2002) present valid educational haptic/acoustic VR applications for visual impaired users: they facilitate the comprehension of information usually conveyed by physical artefacts, less effective and more expensive.

VE can offer several views of a scene to convey the information of interest in an ordered and progressive way. Haptic and acoustic effects make easier to acquire and comprehend the characteristics of 3D view, improving their integration into a meaningful mental schema.

The proposed multimodal system (OMERO) combines the use of touch, vision and hearing for the exploration of multiple views of 3D virtual environments. Blind and seeing people can share their knowledge by experiencing (each with its own interaction modality) the same virtual scene.

The VE must be designed by domain experts to make simple and effective the cognitive process. A visual editor enables inexpert users to associate the multimodal description (MD) to a virtual scene. It also involves in the design process the final users whose feedbacks drive the customization of the MD.

OMERO has experimentally proved to be an effective learning tool in several different domains.

2 THE OMERO MULTIMODAL FEATURES

OMERO has been designed to offer an enhanced multimodal virtual experience whose aim is not to mimic the interaction with physical objects by the exploration of their approximated digital versions. Its goal is to design a digital representation of reality whose information contents and characteristics make easier and more effective (in particular for visually impaired people) the perception, the comprehension and the learning of contents that can be expressed as spatial data.

The user seats in front of the multimodal workstation (figure 1) and interacts with the virtual world via the haptic device, the keyboard and the

audio speakers. The PHANToM desktop, a single point haptic device, allows the user to perceive the scene as if he\she were touching a physical scaled model placed on the desk with a pencil-tip. Multimodal effects (haptic and vocal) enhance the interaction. Moreover, seeing people can communicate with blind user: the model is visually rendered on the screen and a red sphere shows the current 3D position of the haptic device tip in the virtual world. The point of view of the visual rendering can be changed by suitable GUI commands (thumbwheels or a "bring me to" button) to appreciate the avatar movements but does not affect the stability of the haptic reference system.

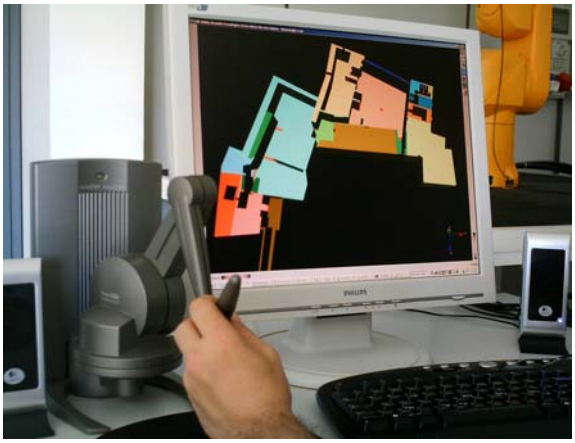

Figure 1: The exploration setup.

The MD of the scene is fundamental for an effective learning process and influences data representation and data retrieval.

Data Representation defines type and amount of information represented by the virtual scene, their mapping to 3D components of the virtual world, their organization in several semantic views.

Active Objects are parts of the scene that activate a specifically defined action when touched by the user. Haptic interface can generate tactile effects (such as vibration, viscosity, …) that can convey further information beyond shapes. Active objects can be haptic, acoustic or haptic/acoustic and can provide data (i.e. historical/ artistic descriptions, dimensions, material, etc.) by vocal messages.

Active objects can be dynamic; their dynamic behaviour can be activated either automatically whenever the user touches them or on demand by proper commands.

Scenarios try to overcome the serial nature of touch, which does not provide a quick and unitary perception of scenes as sight does. A complex virtual world, rich of details, generates long sequences of local perceptions that are hard to integrate into a coherent meaningful mental schema. Scenarios are sets of active objects representing semantically consistent and coherent views of the information content of the scene. When the user selects a scenario, he\she focuses on the information associated with its active objects, temporarily discarding all the other data.

Data Retrieval concerns how the user interacts with the virtual world: the navigation (how the user can move inside the scene) and the exploration (how 3D objects transmit their associated information).

The following features support the **navigation** task and facilitate the visit of the scene:

Containment box: a virtual box surrounding the scene to prevent blind users from moving too far from their goals. It has proved to avoid the waste of time in useless regions of the workspace. It also makes easier to find the objects of interest.

Guided path: a sort of guided visit around the virtual environment. Suitable attractive forces drive the exploration along predefined paths (De Felice, 2005). It proved to be valuable to become familiar with the scene and to build complete and effective mental schemas.

Dragging: can dynamically select which part of a large model is shown in the workspace. Inside OMERO the haptic stylus can drag the virtual scene or the containment box (by pushing on its walls).

Scaling: dynamically changes the relative size of the model with respect to the user fingertip (that being fixed in the real world can prevent the perception of small details). Increasing the size of a model makes accessible small details and reduces the dexterity required for their correct perception. Scaling, if the user is touching an object, is applied with respect to the contact point to keep a meaningful reference that prevents the user from being confused by the environment changes.

Similar dragging and scaling techniques can be found in (Magnusson, Rassmun-Grohm, 2003).

3 MULTIMODAL DESCRIPTION

Multimodal rendering can provide information through different sensory channels (redundancy) and in alternative forms (polymorphism). The MD ("how" the rendering is done) has been decoupled by the structural description of the virtual scenes ("what" is rendered). Thus the same geometrical representation can be rendered in different ways by modifying the associated multimodal rendering.

The system loads a VRML file containing all the information about the geometry of the virtual scene and an XML file, based on a schema called OMDL (OMERO Multimodal Description Language), that describes the multimodal appearance of the scene.

Creating complex virtual scenes is a difficult task (Magnusson, Rassmus-Grohm, 2004). Proper tools are required to make faster and easier this design phase. VRML models can be created using several applications (CAD system, Google SketchUp, etc.). A visual editor, providing an intuitive and straightforward authoring of rendering, has been developed (figure 2).

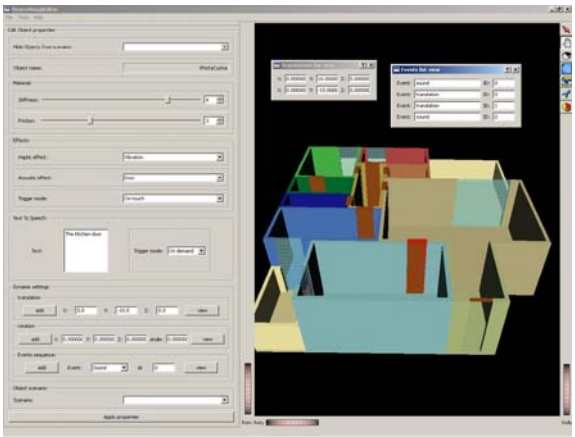

Figure 2: The look and feel Visual Editor.

Contextual menus allow the user, even not well grounded in VR, to visually edit active objects and scenarios using the mouse or the haptic tool. People responsible of the learning process and the final users cooperate in the design: the former select solutions fitting their cognitive aims, the latter provide feedback about the multimodal rendering.

4 OMERO APPLICATIONS

The previously described features of the system have been implemented and verified in different fruitful educational applications.

Svevian Castle. A VRML model of the accessible areas of the ground floor of the Norman-Svevian Castle, located in Bari (Italy), has been realized (figure 1). Its complex topology requires a huge amount of information to be transmitted to the user. The multimodal application has been tested, using different protocols, on two different groups each composed by four visually impaired people that had never visited the castle before (De Felice et al, 2007). The test sessions were followed by a real visit of the castle to check both the effectiveness of the proposed features and their best use to produce an intuitive and simple multimodal interaction.

The application has been also proposed, during the 'International day of people with a disability', to twenty blind visitors of the castle. They started with a basic model representing the whole plan of the castle with active objects highlighting passages between different environments and then moved to an enlarged version of the main environments and of their internal objects, with the associated historical and artistic information. More than half of them experienced a more conscious real visit of the castle due to the mental schema constructed during the virtual experience. They easily found real objects whose presence had been emphasized in the virtual model by attractive forces and vibrations. The most curiouses found really interesting and stimulating the vocal explanations on history, dimensions, buiding materials and curiosities.

A blind child with psychomotor problems was able to concentrate, to move correctly in the virtual environment and to recognize and open doors.

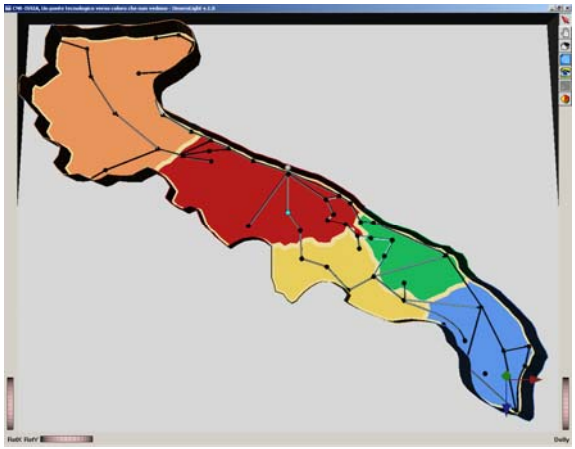

Figure 3: The streets scenario of the Apulia map model.

Geographical Map. The virtual model of the Apulia region (figure 3), constructed from GIS data, has been organized in several semantic views (provinces, rivers and lakes, towns, highways) that blind users have used to progressively build a complete mental schema of the territory.

It has been proposed to eight visually impaired users to check its potentialities (De Felice et all, 2007). Then it has been informally experienced by eleven visual impaired during a meeting of the Italian National Blind Association. Ten of them

came from other Italian regions and had almost no knowledge of Apulia. The only native user, using her known contextual cues, found very easy to move through the map and judged the haptic interaction realistic and effective. Two users were unable to complete the exploration of the model: one was very tired for previous meeting activities while the other had some hands coordination problems. The other users moved through the scenarios with a growing interest, also caused by an increased familiarity with the haptic device. All the users were able to learn new information. Also the native users increased her knowledge discovering new characteristics.

This type of application received great interest from blind users, which provided many suggestions to improve the information contents and the interaction modalities of the VE.

5 CONCLUSIONS

A framework to allow visually impaired people to access virtual reality by a multimodal interaction including touch has been presented. The haptic feedback extends the visual and auditory interaction and enables the effective and efficient fruition of the information content of the virtual scenes by blind users. This multimodal interaction and the multilayered representation of the real world strongly help visually impaired people to construct a mental schema of the scenes.

The OMERO system proposes the use of virtual reality to generate an augmented experience that conveys information of different nature (shape, geometric, abstract concept) in an integrated and compact way.

The experiences made with blind users suggest that the multimodal interaction needs to be tailored to the specific user: the OMDL schema allows a quick and easy design and implementation of rendering without affecting the geometrical structure of the virtual scene. A visual editor allows this design to be made also by domain expert without specific preparation about virtual reality.

Almost all the visually impaired users have found natural the use of the system and have reached satisfactory results, providing positive feedback about this new tool. The approach represents a way to overcome some serious limitations of the direct exploration of physical objects and opens to the blind community new active and exciting learning opportunities.

ACKNOWLEDGEMENTS

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DEEP THOUGHT
Web based System for Managing and Presentation of Research and Student Projects

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Keywords: Python, Subversion, Project management system, Web 2.0, Tagging, Ontology, XML, Wiki, Trac, Plug-in, Bug-tracking, Visualization, Portal, Metadata, Agile programming, Extreme programming, Semantics.

Abstract: There are plenty of projects solved each day at academic venues – small in-term students' projects without any real usability, bachelor and diploma thesis, large interdisciplinary or internationally supported projects. Each of them has its own set of requirements how to manage it. Aim of our paper is to describe these requirements, and to show how we tried to satisfy them. As a result of further analysis we designed and implemented system *Deep Thought* (under development since autumn 2007), which united the management of distinct categories of projects in one portal. System is based on open-source technology, it is modular and hence it is capable to integrate heterogeneous tools such as version control system, wiki, project presenting and managing. This paper also introduces aims of the future development of the system, such as interoperability with other management systems or better connection with the lecture content and teaching process.

1 INTRODUCTION

Our department has mixed objectives – learning and research. Programming oriented lectures are held, bachelor and diploma thesis (aimed on developing some software utility or describing some design patterns, frameworks etc.) are offered. On the other hand, also non-learning research projects are solved. Each project has to be properly managed – and its original cause and importance is irrelevant for management purposes. Every project has its program artifacts, whose have to be presented and managed, its deadlines and users.

For example, in the particular case of the department of the authors, we can talk about tens of each-term student projects, circa thirty bachelor and diploma theses and some non-learning research projects each year. This amount is growing because of rising popularity of programming lectures (such as *Introduction to Java*, *Modern tagging languages* etc.). Such amount of the projects requires formal management. Following sections show manager requirements, techniques which was adopted to solve them, and finally, the system Deep Thought itself.

2 MANAGER REQUIREMENTS

During last five years of managing student and research projects, these manager requirements were identified:

- Centralized and hierarchical repository – required for further usage and archiving. Hierarchical division is vital for preserving a overview in such broad database. Students' projects should be archived too.
- Project describability – functionality description, assignment, reference lists etc. These *metadata* are important for usability preservation in the future. Further development and employment of the project is impossible without documentation.
- Project status examining – the manager has to be informed about develop processes. Some of them are explicitly created by developer (technical notes), others are created automatically (statistics, quality metrics). Possibility of monitoring the status can be seen also as learning issue. Processes like *examination of the programming code quality* or *monitoring of development* have learning values.
- Output presentation – If the project evolves into

some usable tool, it is important to have utilities and site to present it to the possible users. Such presentation have to be user-friendly, it must offer downloadable artifacts, user documentation, bug reporting tool, some interface for communicate with the developers etc.

Further information about these issues can be found in (Gregar et al., 2008) (written in Czech).

3 OLDER APPROACH

We use system *Subversion* (SVN)(Collins-Sussman et al., 2008) for storage of students' and research projects. It is version control system, capable to upload new versions, resolve document conflicts (document conflict is a state, when exact part of the document is edited by two or more users simultaneously, with different output) etc. SVN is integrable in the majority of operating systems, into the IDEs of different programming languages. Subversion works as accessible and safe archive.

Wiki is a suitable tool in the area of creating and editing data about projects, as well as collaborative preprocessing, analysis, background research, projects reviews etc. Wiki allows to easily create and format hypertext documents. We have been using MediaWiki(Barrett, 2008)[1] implementation with some modifications (for example cooperation with authentication service from the information system of the university).

We also utilized system Maven2(J. Van Zyl et al., 2008). It is Java-based shell for automatic compiling and building an application. It provides a possibility to generate various reports and quality measurements of the project.

4 PROJECT MANAGEMENT SYSTEMS

Every category of projects has slightly different accent of the common requests (i.e. research project should has better output presentation, in-term project requires deep status examining). It would be a benefit to have a portal, which can satisfy all main requests and can be used for all categories of projects.Other important requirement was to retain wide amount of data from already managed projects. Search of such project management system started in November 2007.

[1]http://kore.fi.muni.cz:5080

We did not find any suitable existing system – either the license was too expensive (for example portal for MIT's Simile project[2], Jazz from IBM) or lack some important features (for example SourceForge[3], XPlanner).

System *Trac* (see section 3.1) satisfies our requirements for the managing one project but it *cannot work as a multiproject portal*. We decided to utilize and extend Trac as a part of our portal. During state of the art analysis we found several projects, one of them was named DrProject, multiproject system based on Trac. But system was functionally insufficient for our needs that time. Without finding any usable project, we decided to develop our own portal system.

4.1 Trac

Portal Deep Thought was build upon the system Trac (Edgewall Inc., 2008). Trac is an enhanced wiki and issue tracking system for one project software development. Trac uses a minimalistic approach to web-based software project management. It has not all abilities we require, but it has a modular structure and can be modified (added other data interfaces, user rights processing, new modules for new functionality etc.). Trac is written in object oriented script language Python.

It has these standard modules:

- User friendly browser of the project code. SVN repository is one of the supported tools. Browser also allows viewing source code as differences between distinctive versions, the antecedent revisions of the code etc.
- Bug reporting and tracking utility – structure of the page concerning this issue, named *ticket*, can be modified according to author's requirements.
- Project management – definition of the development milestones, project component declaration, development monitoring etc.
- Presentation materials creation with integrated Wiki system.

Trac can manage only one project. Other problems comprise a requirement to have access to server command line (for creating project, updating system), lack of the free-form GUI modification etc. It also does not allow localization in any way (which is problem in non-english speaking countries.)

[2]http://simile.mit.edu/
[3]http://sourceforge.net

4.2 DrProject

DrProject is based on similar idea as our implementation. Both of them are derived from Trac and specialized for academic purposes. Massive changes in Trac's source code had been done due to functionality extension in DrProject. It causes inability to use some plugins. It has no internationalization support.

On the other hand, DrProject in the recent time grows into useful application. It has advanced tagging engine (relation between tag and its project visualization, global vs. local tagcloud). System has also nice, javascript framework driven, GUI.

5 DEEP THOUGHT

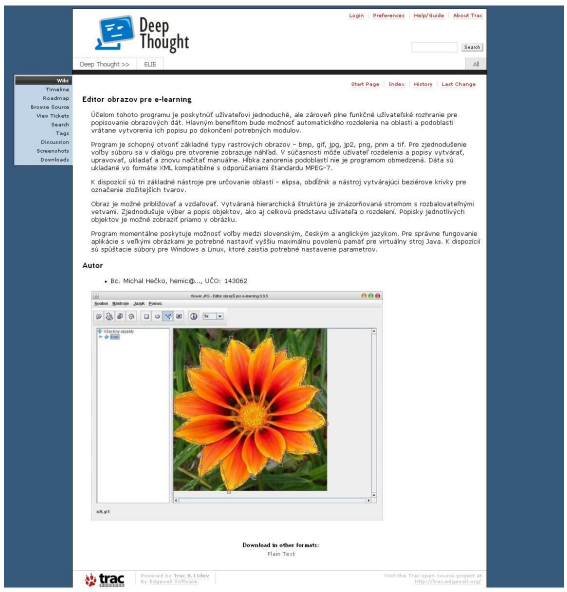

Figure 1: Deep Thought screenshot - project presentation.

5.1 Requirements and Development

Design and implementation of the system are done by prototyping using extreme programming techniques. Wiki was used in analyzing important capabilities and for communication about the development process. We try to unify the project management as much as possible while covering the wide range of requirements coming from very different projects' nature. In the analysis and development of such project management system, we took the advantage of a rich built-in functionality (in Trac) but it had to be strongly modified to satisfy the important functionality requirements. Modifications contain:

5.1.1 Multiproject Management

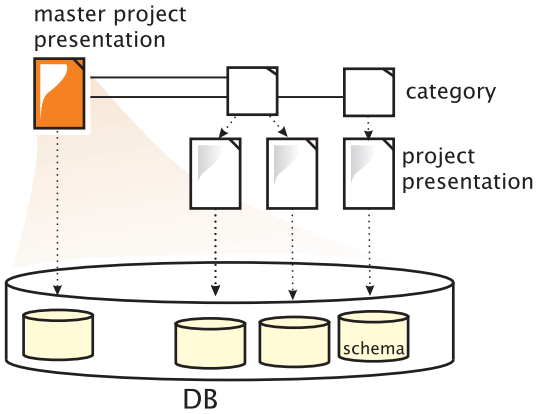

Figure 2: Deep Thought Structure.

In Trac, every single project, configuration, source codes, user rights are treated separately. Trac programmers community generated some concepts how more projects can be treated (none of them officially accepted). Some proposals change database structure, others base system components. We would like to avoid such changes. They decrease a possibility to use third-party modules and plug-ins without complex changes of the source code.

We found one ellegant solution[4]. It is based on utilization of schemes in shared PostGreSQL database. This minimalizes interventions in source codes and allows to gain global view (with help of user defined database stored procedures) on the data.

Other important issue is to centralize the settings. Configuration files used by the system work with a concept of inheritance. The whole project file-system was rebuilt into multi-project structure, in which is global configuration separated from particular project information. Access rights management have to be centralized as well. Plug-in *TracForge* was used to do this. Authentication proceeded by HTTP-Basic, was changed to utilization of faculty Kerberos server.

5.1.2 Project Presentation

Presentation of the projects is also simplified by hierarchical structure of project categories(Pospisilova and Gregar, 2008). User can switch between projects and categories. Management of these categories and their content is easily done by the system administration module. It uses wiki pages to create this hierarchical structure.

New database and directory structure is created within Deep Thought installation. This structures are

[4] http://trac.edgewall.org/wiki/TracMultipleProjects/ComprehensiveSolution

ready to add further projects. Meta-project, called *master*, is also created. It does not describe any particular project. It contains texts and documents about the entire portal, shows global ticket lists, global tag lists, it allows to administrate the whole system etc.

5.1.3 Project Management Simplification

Deep Thought system has *New project* web administration module (in the Trac system it had to be created in command line and set manually). With new project creation, the path to the repository is mapped, basic web-pages are created, user rights for basic user-groups are adopted from master settings. Transportation of projects, which were managed with the older approach, became easier.

5.1.4 Internationalization

Python allows to develop internationalized programs. Trac does not contain such feature. One of its development branches tries to add this support. We used it as a basis for our work. Many changes had to be made to clarify, clean up and correct that branch. We also redefined a set of translation strings. That capability is important (see section 2), but no other multiproject system utilizes it. We have started to solve localization of wiki pages and tickets after we finished localization of texts and the other GUI features. We need variants for distinct languages in the internationalized DT. Unfortunately, the modification of wiki version system is relatively complicated – it requires many changes in the Trac core and in the GUI. Therefore we decided to create a new wiki-macro. Tag `lang`, occurred in the page, signalize that the latter text is in the defined language. Tag contains locale information about consequential text (see an example in screenshot).

5.1.5 Better Output Presentation for Users

Presentation functionality was enriched by external Trac plug-ins, sometimes modified to offer better incorporation or better functionality(A. Thomas et al., 2008).

- Pictures and Screen-shots gallery – ScreenshotsPlugin[5] module
- Databases of downloadable files – DownloadsPlugin[6] module
- Incorporation of output from Maven tool – slightly modified MavenTrac module

[5]http://trac-hacks.org/wiki/ScreenshotsPlugin
[6]http://trac-hacks.org/wiki/DownloadsPlugin

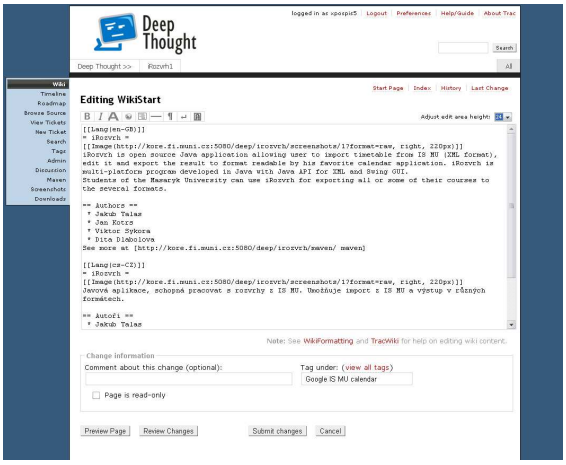

Figure 3: Multilanguage wiki-page editing.

- Discussion forum
- Tagging – user-driven tagging of documents within system. This plug-in – TagsPlugin – was modified to provide global overview of the tags. It will be described in next section.

5.1.6 Design Changes

Trac offers some possibility to change a design. The basic configurable part of the design (like logo) are adjustable in the project configuration file. Output of the system is written in modular HTML. Slight change, creating the global container, had to be made to enable *page* design. Graphic changes have been made by cascading styles (CSS).

6 SEARCHING AND SEMANTICS

The important part of any presentation portal is searching. Deep Thought uses two different ways to find a document, and third way is under the development:

- Fulltext search
- Tagging – It employs usage of user-defined tags (i.e. words or multi-word concepts) connected with documents (i.e. wikipages and tickets). These tags build lightweight database, in which can be searched. Such database also allows to create visual presentation, which shows what concept is more common, searched more etc. It adds another web 2.0 capability to the system(Golder and Huberman, 2006).
- Advanced semantic search – Under development since November 2008. Subproject, solved as a

diploma thesis, is aimed to incorporate semantic approach into document processing. It should be done by modifying the text editor module. Tagging of the text with concepts defined by ontology, proposing them to user automatically, or even tag the document automatically should be possible with such modifications. This *tagging* can produce better searching output than user-driven tagging because of formal description of concepts. Possibility to use of other semantic-driven techniques (visualizations, links to semantic dictionaries etc.) belongs also among other benefits of semantic definition of document content. This subproject will collaborate with RDFS-repository Sesame 2(Aduna Inc., 2008).

7 FUTURE GOALS

System is online, projects from our archive were included in the portal, their sites were set up. Portal gives us a possibility to present already finished projects, without any management processes, as well to start new project with full management tools utilization. Further goals in the near future comprises:

- Source code and internationalization actualization – Trac, which is base of our portal, is active project and its source code evolved since it has been used in the DT. Some atributes and functions of its core were improved. Hence transport of DT to the actual build of the Trac system would be an improvement. Such transportation is not easy, because of numerous changes in source code and implemented internationalization.
- User rights system modification for better usage outside our faculty – new set of automatically generated hierarchical rules have to be prepared. These rules will be shared among the whole system, every project, and will build multilevel hierarchy of user rights. Other goal in this area is to allow to keep some documents (like wiki pages) private.
- Further GUI improvement – alternative graphic design will be created and system will be modified to change designs easily. Support for including the multimedia data (such as mind-maps, flash) will be add. Higher rate of multimedia usage is caused by utilizing the system for e-learning.
- Incorporation of semantic-related technologies – to implement new plugin as described in *Searching* section). Adding automatic relations between pictures and text.

8 CONCLUSIONS

Preparation and managing of large amount of research and in-term students' projects is challenging and requires formal processing. The introduced tool unites (without big issues) the older distinctive processes for different categories of projects and adds new qualities. The system structure and the development process enable further modifications, like Trac plugins incorporation or new add-ons development.

The paper provides basic overview of Deep Thought Portal, reasons this system was created, its structure, characteristics, implemented modules. The paper also briefly introduces the possibilities of expanding the functionality of the system and describes basic functions for each declared type of users. It also describes its cooperation with semantic technologies and intended usage this advanced functionality in the searching and enrichment of the stored project data and metadata.

System Deep Thought can be used in any academic venue, where bigger amount of developer projects have to be managed.

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STUDY ON ACQUISITION OF LECTURER AND STUDENTS ACTIONS IN THE CLASSROOM

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Keywords: Lecture archiving system, Students' viewpoint, Detecting student's face, Faculty development.

Abstract: Recently, there are many lecture archiving system that provide lecture video, presentation slide and written text/figure on whiteboard. However, the contents of lecture archiving system are decided by the provider of the service. In this paper, we propose a new lecture archiving method based on students' viewpoint. Our archiving method adopts the viewpoint that the majority of students are watching. We conduct verification of our proposal method, by preliminary experiment. Furthermore, we consider that our acquisition technology of lecturer and student action helps lecturers to recognize students' ROI (Region of Interest) in the classroom.

1 INTRODUCTION

With the development of information technology in recent years, web-based learning system including lecture archiving system has become popular. And the adoption of system to support teaching and learning activities has been rapidly increasing in the higher educational institutions. Recently, many higher educational institutions distributed lecture materials, including presentation slide and lecture video, as a contents of lecture archiving system, OCW (OpenCourseWare) and lecturer's own web site.

Nakamura et al. work on creating lecture contents that catch the attention of students (Naka mura et. al., 2006). The system highlights important term to keep pace with the tempo of lecturer's explanation. Nagai works on lecture recording that uses a HDV (high-definition video) camera and virtual camera work (Nagai, 2008). Le et al. propose an automatic digest generation method from the presentation video recorded by commercial software (Le et. al., 2008). Many software are sold, which can easily convert footage of lecturer and presentation slide into web contents, and deliver lecture contents over Internet.

Many lecture archiving system contains footage of lecturer, presentation slide, written text/figure on whiteboard, and interaction between lecturer and students. The system provides lecture information that combine several materials given above. Existing lecture archiving system 1) provide footage of lecturer depending on lecturer's movement, 2) set the direction of the camera beforehand, 3) edit the video after the lecture. The contents of the system are decided by the provider, lecturer, teaching assistant and system administrator. Existing services don't consider the interaction between lecturer and student that occurs in the classroom.

In higher educational institutions, interaction between lecturer and student is the most basic activity, and the classroom is the primary place for

such interaction. In this paper, we focus attention on student's face orientation, as one of the non-verbal interaction occur in the classroom. We propose a new method that generates lecture archiving content based on students' attention, that is, using their face orientation. We consider that our acquisition technology helps lecturer to grasp students' condition and ROI (Region of Interest). Lecturers can use students' attention for improving lecture method.

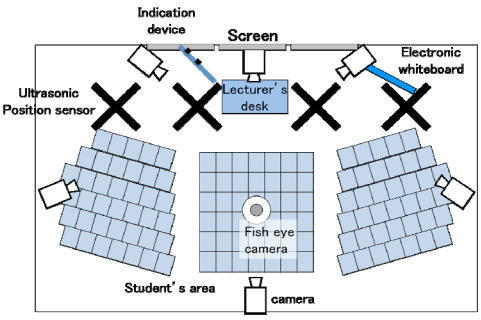


Figure 1: Equipment layout in the classroom.

In Section 2, we describe the overview of our lecture archiving method. Then in Section 3, we describe the acquisition of lecturer and students' actions occur in the classroom, and we propose a new lecture archiving system based on interactions between lecturer and student in Section 4.

2 OVERVIEW OF OUR LECTURE ARCHIVE SYSTEM

In this section, we describe the overview of lecture archiving system. We have been developing automatic lecture archiving system that records various information, such as lecturer and students' voice, video, presentation slide and written text/figure on whiteboard (Marutani et. al., 2006).

Figure 1 shows equipment layout in the classroom. There are three screens at the front of classroom; as a student's view, presentation slide are displayed on the left and center screen, written text/figure on the whiteboard are displayed on the right screen. The cameras located at rear side, right side and left side of the classroom shoot lecturer, and the three cameras located at front side are shooting students. Furthermore, the system acquires lecturer's position and movement by the ultrasonic location sensors, which set on roof, lecturer and indication device.

Our lecture archiving system records and synchronizes audio/video of lecturer and students, presentation slide, written text/figure on the whiteboard, then provide these data as a lecture archiving system.

3 ACQUISITION OF ACTIONS IN CLASSROOM

We have been working for the acquisition of time sequential context occurs in the classroom, such as lecturer's action and movement; utterance, pointing and writing whiteboard, and student's action; face-raising or note-taking (Marutani et. al., 2006), (Hattori et. al., 2008).

3.1 Acquisition of Lecturer's Action

In the classroom, there are three major classes of lecturer's action based on lecturer's location and orientation; descant, explanation of presentation slide and explanation of text/figure on whiteboard. Our system acquires these lecturer's actions using various sensors in the classroom. Ultrasonic location sensors; installed on roof, lecturer and indication device, given location information of lecturer and pointing information. The archiving system records the contents of slide and time to changing slide, furthermore, contents of written text/figure on whiteboard and time when the text/figure are written. Then the system acquires lecturer's actions.

3.2 Acquisition of Students' Action

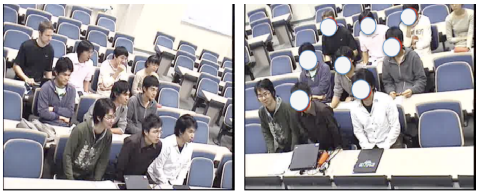
Three cameras located at the front of classroom shoot students' actions. Left camera is set up at the top of left side screen, right camera is set up at the top of right screen, and all three cameras focus on center zone of students' area. Then we acquire students' face orientation utilizing detecting faces from recorded images.

Now, we categorize student's action in the classroom into four types; hear the lecturer's explanations, view a front screen, view a whiteboard and take lecture notes. We identify these four types based on installation position of equipments and student's face orientation.

3.3 Detecting Student's Face

We experiment to verify the possibility of realize the new archiving method based on student's face orientation. In usual, when lecturer explains using left screen, students view left screen. At that time,

the system detects many faces from the image shooting by left camera, on the other hands, the system detects no faces from image shooting by right camera.



right camera
no faces

left camera
8 faces

Figure 2: Detection results when lecturer explains using left screen.

Figure 2 shows the result of face detection when lecturer explains displayed on left screen. Left figure shows the detection result of the image shooting by left camera, there are no faces, and then right figure shows the detection results of the image shooting by right camera, there are 8 faces.

3.4 Face Detection Performance

We conduct verification of student's face detection by preliminary experiment. 10 trial subjects take seats in the central area of students' area in the classroom. Three cameras located at the front of classroom shoot students' actions. Lecturer moves freely at the front side of classroom; to descant standing in front of a center screen, to explain presentation slide standing in front of left screen, to write text/figure on whiteboard standing in front of whiteboard. Students turn their face toward lecturer/screen/whiteboard according to lecturer's directions.

Table 1: Face detection performance of sample situation.

	Right camera	Center camera	Left camera
View front screen	5.08	10	4.42
Note taking	0	0	0
Sit chin in hand	0	3.7	0
View left screen	6.11	9.32	0
View whiteboard	0	7.13	7.12

We conduct verification of student's face detection for student's typical condition in lecture room; hear the lecturer's explanations, view a screen, view a whiteboard, take lecture notes, and put their chin in their hands. Table 1 shows the average number of face detected in preliminary experiment. When students view center screen, 5.08 faces were detected by right camera, 10 faces were detected by center camera, and 4.42 faces were detected by left camera. "0" means no faces were detected. We make sure that we can use students' face orientation to grasp their attention.

4 LECTURE ARCHIVING METHOD BASED-ON STUDENTS' VIEWPOINT

Most of lecture archiving systems provide many kind of data, such as footage of lecturer, presentation slide, written text/figure on whiteboard, and so on. However, we consider that it is difficult for audience to pay attention every data. Therefore, we propose new archiving method based on student's viewpoint in real classroom.

In consideration of preliminary experiment described in Section 3, we decide the archiving rule as follow:

- Over two-thirds faces are detected from the image shooting by left camera, the system judges most of students view left screen. Then the system brings the presentation slide displayed on left screen into our archive data.
- Over two-thirds faces are detected from the image shooting by right camera, the system judges most of students view whiteboard. Then the system brings the whiteboard image into archive data.
- Over two-thirds faces are detected from the image shooting by center camera, and no faces are detected form other camera, the system judges most of students view lecturer's explanation. Then the system brings the footages of lecturer into archive data.
- There are no cameras detecting over two-thirds faces, the system judges most of students are taking lecture notes, and then the system brings presentation slides into archive data.

Figure 3 shows the image of proposal lecture archiving method. Horizontal axis is a time scale. Upper 3 lines are data for archive; lecture video, presentation slide and written text/figure on whiteboard. Next 3 lines are data for estimating students' viewpoint; the image shooting by left side camera, center camera and right side camera. And bottom liee is generated archive data. At first, we check leftmost row's three images shooting by left

Figure 3: Image of proposal method.

side camera, center camera and right side camera. If over two-thirds faces are detected from the image shooting by center camera, and no faces are detected from other camera, the system judges most of students view lecturer's explanation. Then the system brings the footages of lecturer into archive data. Then the system checks next image, and the system decides which image are incorporated into archive data. By repeating same procedure, the system generates new archive data. Students can use these generated new archive data during their commuting time by using PDA like iPod touch, and full/traditional archive data are available on PC(web browser).

We consider that good lecture have some relationship between lecturer's action and students' action, interaction between lecturer and student. For providing high quality educational service, lecturers have to grasp students' condition and then lecturers should modify lecture materials or refine teaching method. Our face detection method can help lecturers for grasping students' movement. Therefore, our method can use in FD(faculty development) field.

5 CONCLUSIONS

In this paper, we try to recognize students' face orientation using three types of images shooting by three cameras. And we propose new lecture archiving methods based on students' viewpoint. We consider that our acquisition technology of lecturer and students action can use not only our archiving system, but also grasping students' condition in faculty development. As for future works, we verify the effectiveness of our acquisition technology to apply our technology to real lecture.

ACKNOWLEDGEMENTS

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SUPPORTING THE AUTONOMOUS LEARNING PROCESS WITH SIENA

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Keywords: Conceptual graphs, Student model, Progressive inquiry, Bayesian networks.

Abstract: This paper present a tool called SIENA that helps in the building knowledge in an autonomous learning process through: a) an open student model; and b) a student conceptual map to explorer and for instrospection. However, this new tool uses adaptive tests based on a Progressive Inquiry (PI) model. This tool has been used for teaching Computer Architecture in the School of Computer Science in the University of La Laguna, Canary Island.

1 INTRODUCTION

The european convergence process proposes an European Space of High Education which has involved to remove a teaching-learning centered in the teacher and a passive traditional learning and it proposes a new model which is centered in the learner and the second part of the binomial teaching-learning. Moreover, the concept of e-learning is moving to e-learning 2.0, where the keys and tools are the social nets, the collaboration and the autonomy, where the student can control his own learning (Kay, 2001).

New technologies have contributed to this new approach with blending learning and social tools. In order to obtain this kind of learning and the same time a significative learning where it is emphasized the social component of learning is essential to create new tools, new learning materials as well as specific applications in different subjects of knowledge.

On the other hand, the key in the educational process is that students can achieve the learning objectives effectively. That means to help the student acquire the required level of knowledge and skills in the subject domain. Thereby, it is necessary to adapt the teaching to each student particular needs. It is commonly agreed that, for adaptation, some kind of student representation is needed. One of the most common mechanisms to represent the state and evolution of student learning are Student Models.

The present works deals with the representation of the building knowledge in an autonomous learning process with through: a) an open student model; and b) a tool called SIENA, a student conceptual map explorer and instrospection.

2 OPENING STUDENT MODEL

Student Models can help teachers and students to pick up the learning characteristics of student and his evolution during the learning process.

The goal of any Student Model is to collect the information related to the student that influences in his/her learning such as the level of knowledge, the acquired skills, the learning objectives, the learning preferences, etc.

Usually, in the traditional Student Model the access to the data they contain is a problem. So, the community of Artificial Intelligence in Education has proposed the Open Student Model, where the student representation is designed for allowing inspection. This model allows the direct intervention of students in the process of diagnosis, and that permit to infer the knowledge that students has on the learning-teaching domain (Dimitrova, 2002).

This type of student model can be inspected by: a) the own student, b) his classmates and c) his

teachers (Bull&Nghiem, 2002). The fact that a student can access to his own model, help him to better understand which learning strategy is following, because a new source of information is available. With this source he can think about his own learning Bull, S., McEvloy, A.T. & Reid, E., 2003).

Systems building under this perspective allow externalizing the student models, and in some cases, providing mechanism to teachers and students, can change the contents. The selection of an effective mechanism of communication reduces problems of understanding of the behaviour of student (Dimitrova *et al*., 2002).

Student model and conceptual graphs are a power tools to represent the knowledge. The knowledge represented in a visual way is easier to explore and understand. Cook y Kay (1994) was pioneer in to mix text and conceptual trees based on diagrams. Other approach of Dimitrova et al. (2002), is the inspection and discussion of a student model trough conceptual graphs (Rueda U; Larrañaga M; Arruarte A; Elorriaga Jon A., 2004).

Taken into account these previous works, we have developed a tool called SIENA, where the Student Model is represented and where the processes where each student can build his knowledge about a particular domain, in this case Computer Architecture.

3 WITH RESPECT TO SIENA

SIENA stands for Sistema Integrado de Enseñanza-Aprendizaje, and in English SCOMAX/SCOMIN: Student Conceptual Map Explorer/Student Conceptual Map Instrospection. It is a new tool to provide the learning which is based on conceptual maps, adaptive tests and a Progressive Inquiry (PI) model (Leinonen, T., Virtanen, O., Hakkarainen, K., Kligyte, G., 2002; Morales, R., Pain, H. and Conlon, T., 1999)

SIENA requires a conceptual map which is exported from Compendium called Pedagogical Concept Instructional Graph PCIG. It consists of a map with an organization among the nodes which are situated in the map in the order that the students requires for its comprehension. The student can visualize in the graph and the nodes his own state of knowledge in real time.

This tool has two main objectives:

1.- To allow to the teachers to know the skills of students about a subject.

2.- Self-evaluation of students in a autonomous virtual learning.

SIENA was building to solve the problem related to handling information flows in a knowledge-building environment, making students more aware of the nature of progressive inquiry process (Le Mans, France. Mühlenbrock, M., Tewissen, F., Hoppe, H.U., 1998).

The pedagogical model of progressive inquiry learning (PI model) was designed to facilitate engagement in an in-depth process of inquiry and expert-like working with knowledge.

The purpose of this tool was to develop and test a new pedagogical tool helping students to gain on more efficient meta-cognitive thinking by helping students to raise important ideas from the knowledge building, being more aware of the group common activities and stage in the progressive inquiry process.

The idea was to give students some real-time software tools helping them to make their own interpretations of the process they are involved in.

The tool presents the contents and carries out a test based on Bayesian networks among concepts and questions in all the nodes of a conceptual map of a subject. However, the questions in the adaptive test follow the scheme of the PI model, in this way:

a) Setting up the Context: questions about problems to central conceptual principles of the domain of knowledge in question or to authentic, rich real-world problem situations

b) Presenting Research Problems: questions or problems that guide the process, explanation-seeking why and how questions.

c) Creating Working Theories: conjectures, hypotheses, theories or interpretations for the problem being investigated, explication and externalization of these intuitive conceptions (through guiding students, for instance, to write about their ideas).

d) Critical Evaluation: to assess strengths and the weaknesses of different explanations and identify contradictory explanations, gaps of knowledge, and limitations of the power of intuitive explanation.

e) Searching Deepening Knowledge: search for new scientific information about the problem.

f) Developing Deepening Problems: weaknesses or limitations, questions and working theories often provide significant guidance for inquiry.

All aspects of inquiry, such as setting up research questions, searching for new scientific information, constructing of one's own working theories or assessing the explanations generated, are to be shared with other inquirers. These is the last phase of inquiry process, called "distributed expertise", and consist in explaining a problem to other inquirers.

4 FURTHER WORKS: COLLABORATIVE BUILDING OF KNOWLEDGE WITH SIENA

Advancement of inquiry can be substantially elicited by relying on socially distributed cognitive resources emerging through social interaction between the learners, and collaborative efforts to advance shared understanding (Hoppe, U.,1995). Through social interaction, contradictions, inconsistencies and limitations of a student's explanations become available because it forces him or her to perceive conceptualizations from different points of view.

For this reason, we are working on building a model of group represented from the information of the individual models, and with new information, such us, solidarity in the development of tasks and collaborations among students in the tasks carried out on SIENA, dialogues, etc. So, with this new model, will be possible visualize the interaction among students, with four basic elements that influence the formation of group: a) presence, in a particular activity, b) identity, of students c) interaction, among students y d) communication (Zapata-Rivera, J. and Greer, G., 2000; Rueda, U., Larrañaga, M., Arruarte, A., Elorriaga, J.A., 2003).

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LEARNING WITH FUN
An Application of Visual Cryptography

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Keywords: Visual Cryptography, Information Sharing, Computer-Aided Instruction.

Abstract: Visual Cryptography, an emerging cryptography technology, exploits the characteristics of human visual system to decrypt the overlapping images without mass and complicated computations. Almost all the related studies of visual cryptography were concentrated on the topics of the information security. In this paper, we propose to use the technique of visual cryptography to teach young kids counting. It can stimulate the curiosity of the kids and increase the fun of learning.

1 INTRODUCTION

It is not uncommon to transfer multimedia data via the Internet recently. With the coming age of Electronic Commerce, it is urgent to solve the problem of how to ensure the information safety in the open network environment. The encrypting technologies of the traditional cryptography are usually used to protect the information content. The data become disordered after encrypting and then are recovered by the correct key. After encrypting, the content can hardly be recognized even though unauthorized persons steal the data. Hence it can achieve the goal of protecting information safety.

Naor and Shamir proposed a new cryptography area, Visual Cryptography, in 1995 (Naor and Shamir, 1995). The most notable feature is that it can recover the secret image without any computing. It exploits the human visual system to read the secret message from the overlapping shares and thus overcome the disadvantage of huge and complex computation in the traditional cryptography. The (k, n)-threshold scheme (Naor and Shamir, 1995, 1996) makes the application of visual cryptography more flexible. The manager can first produces n copies of transparency drawn from one secret image for his members. Each one holds only one transparency. If any t of them stacks their transparencies together, the content of the secret image will show up. If the number of transparencies is less than t, the content of the secret image still keeps hidden.

There have been many published studies (Ateniese et al, 1996, 2001, Blundo et al, 1996, Naor and Shamir, 1995, 1996) of visual cryptography. All of them, however, concentrated on discussing the topics about information security. In this paper, we use the technology of visual cryptography to generate shares with numbers on them. When playing with kids, we can show them two shares, and ask for the answer. The correct answer will show automatically when you superimpose one share over another. This can stimulate the curiosity of the kids and increase the fun of learning.

2 VISUAL CRYPTOGRAPHY

2.1 Basic Theorem of Visual Cryptography

The output media of visual cryptography is transparency, so the white pixels are treated as transparent. The most common way of black-and-white visual cryptography is to decompose every pixel in the secret image into a 2*2 block on the two transparencies according to the rules in the Table 1. When the pixel is white (black), randomly choose one of the first (last) two rows of the Table 1 to form the corresponding content of the block on the two transparencies.

As to the security of the shares, there are six possible patterns of every block on the transparency,

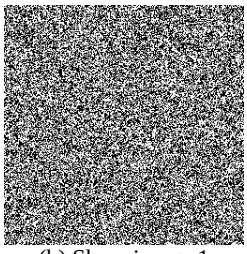
Table 1: Sharing and stacking scheme of black and white pixels.

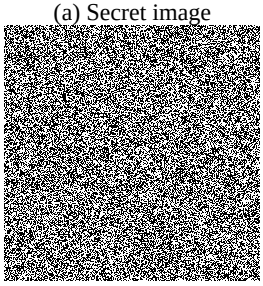
Secret image	Share1	Share2	Stacked image
			
			
			
			

and they are chosen randomly, so the secret image cannot be identified from a single transparency. Because every block on the transparencies consist of two white pixels and two black pixels, no matter it comes from white pixel or black pixel of the secret image, there is no clue of revealing the secret image on the shares.

When stacking two transparencies, the block corresponding to the black pixels in the secret image will be full black, and that corresponding to the white pixels will be half-black-and-half-white, which can be seen as gray pixel (50% black). This gives enough contrast to recognize the secret information on the stacked shares by human eyes. Take Figure 1 for example, a secret image with the words of "淡江資管" are decomposed into two shares. When we stack them together, we can get the reconstructed image. Though the contrast of the stacked image is degraded to 50%, human eyes can still identify the content of the secret image easily.


(a) Secret image


(b) Share image 1


(c) Share image 2

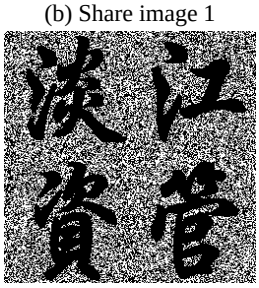

(d) Recovering image

Figure 1: Visual cryptography for "淡江資管".

2.2 Visual Cryptography for Grey-level and Colour Images

Every kind of the media has different ways to represent the colour level of an image according to its physical characteristic. The general printer, such as dot matrix printers, laser printers, or jet printers etc., can only control a single pixel to be printed (black pixel) or not to be printed (white pixel). Hence one way to represent the gray level of an image is to control the density of the printed dots; for example, the printed dots of the bright part are sparse, but those of the dark part are dense. Such method that uses the density of the net dots to simulate the gray level is called "Halftone". Hou might be the first researcher to use the concepts of colour decomposition and halftoning technology to produce shares needed by visual cryptography for both grey-level and colour images (Hou, 2003). By means of halftone, we can transform an image with gray level into a binary image (Figure 2). Because human eyes cannot identify too tiny printed dots and will mix with the nearby dots, though the transformed image has only two colours - black and white, we can simulate different gray levels through the density of printed dots.


(a) Continuous tone

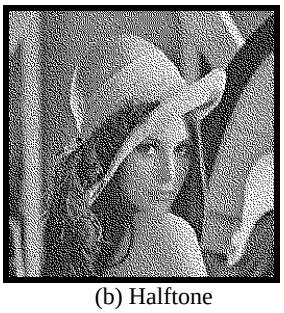

(b) Halftone

Figure 2: Grey-level image and black-and-white image.

The transformed halftone image (Figure 2b) is a black-and-white image, such image format is very suitable to apply the traditional visual cryptography method to generate the shares (Figure 3). Secret image Figure 3c is hidden into Figure 3a and 3b.

As for colour image, most colour printers use cyan, magenta and yellow inks to display colour. These three components of a colour image can be decomposed to form three monochromatic images. This monochromatic image is like a single gray-level image which can be handled by the above mentioned method. Each participant will get a colour share which is composed of cyan, magenta and yellow monochromatic shares. After stacking these shares, colour secret image can be revealed.

2.3 Extended Scheme of Visual Cryptography

The shares generated by visual cryptography (Naor and Shamir, 1995) are noise-like and meaningless. There is no clue of the secret image on the share. It meets the requirement of security. But the meaningless shares will cause adversary's attention and invite the illicit attempts. Ateniese (Ateniese et al, 2001) proposed an extended visual cryptography scheme (Table 2) to hide a secret image into two meaningful sharing transparencies. When stacking the transparencies generated from Table 2 together, we will get the secret message with no trace of the original cover image on the shares.

Table 2: Sharing and stacking scheme of black and white pixels.

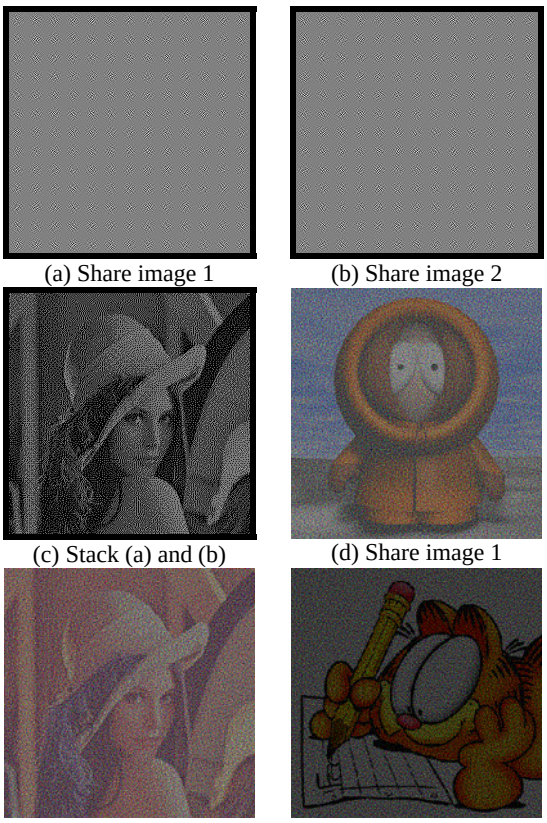
Secret image	Share1	Share2	Stacked image
white (W)	(W)	(W)	
	(W)	(B)	
	(B)	(W)	
	(B)	(B)	
Black (B)	(W)	(W)	
	(W)	(B)	
	(B)	(W)	
	(B)	(B)	

According to Table 2, blocks with 2 white pixels and 2 black pixels on the share image represent a white pixel of the cover image. Blocks with 1 white pixel and 3 black pixels on the share image represent a black pixel of the cover image. There is 25% contrast between black and white pixels on the sharing transparencies. Hence, we can disclose the content of the cover image.

When the pixel of the secret image is white (black), choose one of the first (last) four rows of the Table 2, depending on the corresponding colours on the cover images, to form the content of the block on the two transparencies. As to the security, there are six possible white patterns and four possible black patterns to be chosen as the content of every block in the transparency, and they are determined randomly. Therefore, to have share1 or share2 alone, there is no clue of revealing the secret image on the sharing transparencies.

When stacking two transparencies, the block corresponding to the black pixel in the secret image will be full black, and those that corresponding to the white pixel in the secret image will be 3-black-and-1-white, which can be seen as gray pixel (75% black). There is also 25% contrast between black and white pixels on the stacked transparencies. Hence, the content of the secret image can be disclosed easily by our visual system.

Take three colour-level images for example, Figures 3d and 3e are two meaningful sharing transparencies produced by using the sharing scheme of the Table 2. Figure 3f is the reconstructed secret image produced by superimposing Figure 3d and 3e. In other words, secret image Figure 3f is hidden into Figure 3d and 3e or Figure 3d and 3e cover secret image Figure 3f. Though the contrast of the sharing images and stacked secret image are degraded to 50% and 75% respectively, human eyes can still identify the content of the cover images and the secret image easily



(a) Share image 1 (b) Share image 2

(c) Stack (a) and (b) (d) Share image 1

(e) Share image 2 (f) Stack (d) and (e)

Figure 3: Visual cryptography with meaningless and meaningful shares.

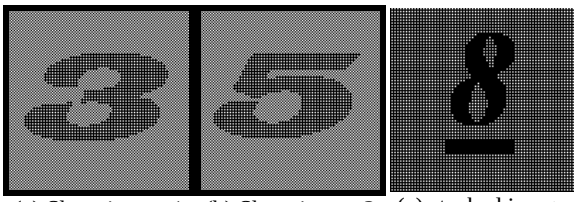
3 POSSIBLE SCENARIOS IN EDUCATION

Teaching of counting has created significant difficulties to both teachers and young kids. Class size is one of the major barriers to effective instruction. As the lowering cost of the computer hardware and widely spread of the Internet, pupils might have their own laptop personal computers for homework and instruction, especially in some highly computerized cities or countries. A well-designed pedagogy, such as Computer-Assisted Instruction (CAI), can make the instruction most effective.

In the information security field, visual cryptography is used as one of the technologies to implement the topics about watermarking, information hiding and information sharing. It can generate shares, stack them together, the secret information will automatically show up and recognize by human eyes. Therefore, it is a good tool to be used to practice counting for kids.

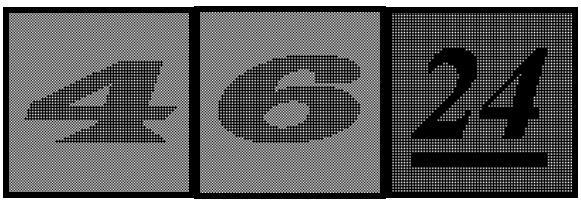
For example, the sum of two numbers can be treated as a secret number, the generated share 1 and share 2 can be treated as the summand and the addend. When kids are doing their counting exercises, they can select one number share, dragging it to another share, stacking them together, magically, the number on these two meaningful shares disappears, the correct answer shows up on the stacked shares. When you shift these two shares a little bit, pixels are not stacked properly, the answer will fade away. It can stimulate the curiosity of the kids and increase the fun of learning.

Figure 4 and Figure 5 are examples of the sum and the product of two numbers, respectively.



(a) Share image 1 (b) Share image 2 (c) stacked image

Figure 4: Sum of 3 and 5.



(a) Share image 1 (b) Share image 2 (c) stacked image

Figure 5: Product of 4 and 6.

A set of programming exercises have been designed with help of computer assisted instruction. The demo system can pose questions to students, return feedbacks, and select additional questions based on the kids' responses. By using this system, kids can practice counting and learn the basic principle of the visual cryptography.

4 CONCLUSIONS

Visual Cryptography exploits the characteristics of human visual system to decrypt the overlapping images without mass and complicated computations. Traditionally, visual cryptography is used as one of the technologies to implement the topics about watermarking, information hiding and information sharing. In this paper, we propose a teaching system which uses the technique of visual cryptography to teach young kids counting. The technology of visual cryptography can be used to generate numbers, stack them together, the result will automatically show up and recognize by human eyes. It can stimulate the curiosity of the kids and increase the fun of learning.

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COMMUNITY-LEGITIMATED e-TESTING
A Basis for a Novel, Self-Organized and Sustainable (e)Learning Culture?

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Abstract: Based on the assumption that educational standards can be operationally defined by pools of specific testing items properties of such item pools are discussed. The main suggestion of the paper is that pools of testing items defining a standard should be free accessible in internet, that they provide immediate feedback in form of scores and that certified results should be equivalent to results of classroom work. For the development of the item pools, web-2.0-type methods can be much more effective than closed expert groups and item evaluation by statistic methods.. Finally the consequences of such transparent community-legitimated standards for the future role of teachers and future forms of learning environments are discussed.

1 e-LEARNING AND e-TESTING - THE PRESENT SITUATION

Present attention of both teaching professionals and the general public towards e-learning and e-testing seems somewhat unbalanced: On google, about 200 times more hits are found for e-learning than for e-testing. This may lead to the conclusion that there is much more interest into tools to support learning than into ways to test the success of learning and the actual topics that should be learned. Norms and standards in education are even harshly criticized as “teaching to the test” while autonomous “learning to the test” may be one of the most important “soft skills” in the future.

The established way of learning in secondary education is still the classical teacher-in-classroom paradigm in which both the presentation of knowledge and the control of learning progress are done as a more or less not standardized “batch process” with a groop of 10 to 50 learners. Even if there is a well-thought syllabus behind this learning model, both learning and testing items and the respective assessment often seem arbitrary and planless to the learners – and there’s quite a bit of empirical evidence that this impression is not even wrong (European Commission, 2008).

In many countries such as Germany, sucess in this kind of arbitrary learning and learning control environment has a great impact on the learners’ future development such as admission to university studies. The school system’s monopoly on this is almost complete and unchallenged – hardly an egalitarian and democratic access to educational opportunities. Recently, the school system’s absolute power in Germany was even increased by introducing a number of required classroom hours in secondary school for university access (EQF, 2008; KMK, 2006) – instead of introducing a catalog of required qualifications for university access. In other countries such as Finland, the US or Brasil, a common standard of competences for university access is either secured by central tests for graduation from secondary schools or by University entrance exams that my be run nationally (such as the SAT in the US) or by the individual universities. In such exams, competences are tested instead of the way the candidate has had to learn these competences. If the testing criteria are transparent, this approach offers much better chances for equal opportunities than the school-based model as

preparation for the exams may also be done by self-organized learning and does not completely depend on the success in a school system with arbitrary learning and testing processes. (The existence of such external exams nevertheless may even lead to the establishment of special schools that aim at a good preparation for the exams. As such schools tend to be costly private schools the failure of the public school system to prepare for the entrance exam may again lead to seriously unequal opportunities; this is for example the case in Brazil.)

2 THE SUCCESS OF NORMS AND STANDARDS IN INDUSTRY

In the first half of the last century, norms and standards have been developed in many fields of industrial goods (e.g. 1917 the DIN norms in Germany, international norms: ISA since 1926 and 1947 ISO norms supported by the United Nations). In addition to basic engineering norms for material properties or threads of screws also more abstract issues such as the classification of books and other printed products (ISO 2108 covering the International Standard Book Numbering ISBN), layout of documents (ISO 2145 Numbering of divisions and subdivisions in written documents) and a multitude of other even more complex testing and certification problems are internationally standardized. The procedures for the creation of ISO norms consist of many different steps involving experts and committees to ensure norms and test methods based on sound expertise and with broad acceptance in the communities affected.

Norms and standards improve or even enable intersubjective comparability of industrial goods. Like that, they also provide a basis for exchange of manufactured goods over large distances as customers can expect well-defined product quality and properties. This holds true both for simple goods as shoes as well as complicated manufacturing equipment. In both cases, standardization doesn't mean uniformity: rather, the customer has a wide choice between different products and is not forced to accept a dedicated one-off.

In the educational sector, generally accepted norms are still an exception. Examples are tests like TOEFL or SAT which are offered by ETS in the United States and even frequently used by universities outside the US in order to assess e.g. a candidate's proficiency in English.

In the absence of transparent standards learning progress and even more so learning results cannot really be objectively judged. Therefore, the learner is left with very limited possibilities to assess his or her learning progress. This, in turn, makes self-organized learning almost impossible. Nevertheless, self-organized learning is often more effective than school-based learning which is also often not very sustainable. A strong focus on exams obtained by school-based learning is therefore especially difficult for mature students and other learners with unconventional educational biographies who might find themselves shut-out from educational opportunities despite better qualifications than the graduates of the conventional school system.

In countries like Germany where a poorly standardized school graduation exam is the main requirement for access to university education, universities often organize pre-term courses to catch up with elementary deficits from school education – regardless whether the required skills were not taught at all or not taught sustainably. For school graduates who go for vocational training instead of college education the regional Chambers of Commerce and Industry (IHK) organize entry exams which are not standardized even on the state level and where the test items are usually not made publicly transparent.

Like this, there is the paradox situation that the skill levels of new employees are much less standardized than more or less everything else in industrial production. The development of community-legitimated sets of subject-specific transparent tests may offer a way out of this paradox situation and encourage self organized (life long) learning (EQF, 2008).

2.1 Definition of Educational Standards by Subject-specific Test Modules

Almost all cognitive qualifications which are taught and learned on the secondary school level can be tested by appropriate test items. It even may be much more appropriate to define educational standards by means of classes of test items than by abstract verbal descriptions such as those presently used in Germany's so-called national educational standards (KMK, 2003).

Classical test psychology is based on tests which consist of items which are chosen from an item pool according to a statistical test model (e.g. the Rasch model). The validity of tests and test items is assessed on the basis of the test model. The strict

obsvervance of this statistical model may lead to didactically problematic results as „too difficult“ or „too simple“ items may never make it into the item pool as they are eliminated during the pilot runs of the test even if they should be included from the didactical point of view. For example, the multiplication with 0 was eliminated from a mastery-learning-oriented elementary multiplication test as it was wrongly answered by too many learners who obviously were not taught it along with the remaining multiplication rules. Like that, didactical failures dictate the item pool instead of using a didactically sound item pool to identify possible deficits in elementary multiplication completences.

Another problem with the item pool in standard test psychology is the practice to keep the item pool itself secret in order to prevent candidates from “learning the right answers” to the item pool. While this may be a good practice in actual psychological tests such as IQ tests, this secrecy of the item pool is also uncritically taken over for tests in secondary education where learning is the actual goal. Keeping learning objectives secret is therefore highly contraproductive. This is especially true in those fields in which test items with numerical answers can be created automatically with random parameters so that it is impossible to “learn” the results for individual test items (Nestle et al. 2007). We therefore suggest an alternative use of item pools in secondary education and entry level college education: Open, community-legitimated item pools that serve both as a operational definition of an educational standard and as a transparent pool of test items.

The production and maintenance of open item pools can be organized in a similar way as open source software development or web 2.0 projects such as wikipedia: These projects are not run and organized by a closed small panel of experts but by an open community that produces, discusses and evaluates the contributions to the project.

Based on this approach, wikipedia has developed within a few years into a comprehensive and multilingual encyclopedia of a quality that meets or even exceeds the standard set by established encyclopedias such as the Encyclopedia Britannica or the German Brockhaus. The content in wikipedia is not only freely available to all users but all users can modify the entries or initiate new entries when they consider the available information incorrect or incomplete. All changes are documented and other users can control, discuss or reject them. For controversial cases, the community has developed moderation and mediation procedures. This system has proven to be remarkable stable against biased manipulations even by powerful players such as big companies. Wikipedia therefore provides an example for the successful production, maintenance, evaluation and legitimation of content and knowledge by an open community. The processes of Wikipedia may serve as a model for the generation of a comprehensive item pool.

Similarly, open source software projects such as Linux or OpenOffice provide successful alternatives to commercial software packages and even offer better stability that those products. A major reason for this is the large community that contributes in identifying and fixing poorly functioning parts of the software.

A common feature in open source software and web 2.0 projects such as wikipedia is the free accessibility of the software and/or he content under the GNU public licence. Nevertheless, this public accessibility does not necessarily mean that all activities in the field are done in a non-for-profit parallel world. Donations to the developer communities allow the establishment of professional management structures for most of the larger projects and services around the programs also might be profit-oriented (e.g. installation support or customization of the programs or user trainings). Similarly, certified qualifications based on community-based standards may be offered for profit. This could provide a sound basis for funding the activities and infrastructure needed to support the creation of such communities and standards.

Furthermore, courses to support learners in their studies for a specific test module may be offered on a commercial basis. However, the existence of such courses would be an indicator of the failure of public schools to support the community legitimated standards and an adaptation of the public school system to the standards would be a more desirable development. Nevertheless, the experience with university entrance tests in countries like France and Brasil seems to indicate that the existence of such tests also opens up good business opportunities for preparatory schools.

2.2 The Vision: Bringing Community-legitimated Standards to Work

In order to make community-legitimated standards really work, some requirements concerning the nature of the item pools, the accessibility and the

documentation of work with the item pool must be fulfilled.

2.2.1 Test Items

Main requirements for test item pools accessible via the internet should be the following:

- Sufficiently large item pools: If test items are randomly chosen from a large item pool, learning individual test item results by heart is no longer realistic
- Items must allow automatic evaluation of user input. In most cases this doesn't actually restrict the formulation of test items. Possible forms of test items may be cloze tests, multiple choice answers or restricted free answers (e.g. numerical values). The correct answers may be static or dependent on random generated numerical or string values. The latter case is preferable. In addition to the correctness of the user's results, also the time needed for working through the test items is recorded and a score is calculated from the time and correctness. Various individual and general score lists for each set of items are kept and published in order to provide the user with feedback both on his or her own learning progress and the comparison to the general learners' community.
- Commenting and rating possibilities for each item. The user rating for the items (along with a teachers' and graduates' rating) will be used to evaluate and legitimate the items. Compared to the statistical model, this approach is more transparent and flexible.

Authoring systems that support all these requirements are available. An example is eExercise (Nestle et al., 2007).

2.2.2 Access

The access to the item pool may either be free (if sponsoring/advertisements or public funding is available), or communities may charge a small annual fee for the access. Various types of access to the item pool must be provided:

- Anonymous access with the possibility to view and work through test items, receive feedback, comment test items and suggest new test items. Under this kind of access, learners can train and test their learning level, and the general public can gain an insight into the respective standard.
- Access for certified testing under registration. Certified tests are to be done in an environment where the identity of the candidate and the independent work through the test can be appropriate checked and documented. The certified success in the test must be considered equivalent to the respective qualification from classical schooling.
- Registered access to modify test items, suggest new test items or test topics or delete or regroup test items. This kind of access must require a proof of qualification before registration. Modifications and deletions of test items are provisional for a fixed period in which other users with the same rights can contradict. If no contradiction occurs, the deletion or modification is permanent.

All accesses to the item pool (anonymous, registered candidate for certified exam or qualified user modifying the item pool) are documented and archived. This is a standard procedure in web 2.0 projects such as wikipedia, too. This offers on the one hand novel possibilities for learning research (Nestle et al., 2007) and provides a possibility to identify destructive accesses to the item pool that may need action such as retraction of access rights.

2.3 Consequences of Community-legitimated Standards

The existence of a transparent data base of test items has consequences for all actors in this educational system as well as for the general public.

2.3.1 Consequences for Teachers

Presently, teachers are faced with a Herculean cognitive and emotional challenge: Preparing lessons and keeping their own skills in the subject up to date by continuous education, permanent self evaluation und evaluation of student's learning performance and providing education in soft skills to the students.

Evaluation their students' learning progress takes often more than 20 % of teachers' working time. Nevertheless, this work is done with a giant uncertainity. For example different teachers may judge student's work according to enormously different standards. Therefore, the present teacher-and-examiner classroom model allows no equal opportunities for learners. Rather, there is a lot of randomness in the assessment of students' progress that should not be accepted by a democratic and egalitarian society.

If a community legitimated standard for qualifications in a certain field is available, this will make the teacher's role in this field much more simple. First of all, the teacher won't need to invest a lot of time into the development and evaluation of written exams any more. Furthermore, the teacher's work will become independent from parents' pressure to give better marks to the students as the standard for rating students' performance will become external and transparent. Instead of the teacher-examiner role conflict, the teacher can concentrate on the original art of teaching: helping students learn and advising and challenging them in the respective subject. Students may chose to accept this help from the teacher or opt for self-organized learning. Their performance in the test will be dependent on their learning progress and not on their relationship to the teacher or the teacher's subjective standard for the exams.

2.3.2 Consequences for Students

Students can check their learning progress without observation by the teacher or their peers. Like this, feedback on their performance will no longer be a possibly fearful and embarrassing classroom experience. Furthermore, students are free to choose their own learning pace instead of being forced into the rhythm of their class. Such self-organized learning is much closer to most learning situations in professional or other non-school contexts. Therefore, open standards are much better to develop self-organized learning as a key soft skill than usual classroom learning.

Similarly, students can also choose more freely the focus of their learning efforts than in classroom learning bound to a teacher's (maybe outdated) interpretation of a (maybe outdated) syllabus. The possibility to obtain certified proofs of qualifications outside standard school subjects will be a great incentive to students to learn special skills outside traditional curricula. The existence of such certification possibilities may even trigger the demand for schools to adapt their curricula to qualifications that many students or employers are interested in. Like that, the selection of subjects at schools will become much closer coupled to real life than it is today.

2.3.3 Consequences for Society as a Whole

Certified exams based on community-legitimated standards will provide less biased and more transparent information on a persons' skills and qualifications than grades from traditional schooling.

Item pools on specialized subjects provide a new flexibility for the establishment of qualification profiles. Each social or economic group may provide new educational objectives without fighting them tiring processes in the administration of the public school system. And new subjects can be chosen by students who are interested in them instead of forcing all students through curricula with very limited possibilities for choice.

There is a lot of matters that are regularly recommended for introduction as novel subjects at school: economics, health education, psychology, … Introducing all those subjects compulsory for all students would lead to an unacceptable swelling of classroom hours. Offering those subjects via transparent item pools, allows students to decide whether they are interested in the respective qualifications or not. If there's a real need for them from universities' or employers' point of view, large numbers of students may choose them and maybe even trigger the demand for a support of those subjects in the public school system.

3 ONLINE GAMES AS A MODEL FOR THE FORMATION OF ONLINE COMMUNITIES

Children up to age 12 are naturally eager to learn. To conserve this motivation in classroom learning is a still unsolved problem. By contrast, other contexts that allow self-organized and active participation result in the formation of large communities. In addition to somewhat nerdish activities as open source programming, online computer games have formed large communities in which many people around the globe invest a lot of time and creative energy.

Such games often win the permanent battle for attention and "learning" over other activities such as studies, work or physical exercise. Like that, they also pose a serious hazard to physical, mental and social health of persons involved too heavily into gaming. Nevertheless, they provide an interesting example to study the formation and dynamics of online communities and their certification systems.

An example: In less than four years the game „World of Warcraft" has grown into a worldwide community of more than ten million people. These gamers pay a substantial monthly fee – and most of them spend 20 to 50 hours per week playing the game. This time is lost for more productive occupations as learning, music, other cultural events, sports and so on.

A google search on 10. Januar 2009 produced more than 600 000 hits to 'play world of warcraft', but only 300 000 contributions to 'learn mathematics'. ('learn math' with about 1,2 millions of contributions lies in the same order). Obviously, the attractivity of just this one online game is comparable to a more than 2 000 years old cultural tradition.

The similarity between 'World of Warcraft' (WOW) and our vision of community-bases educational standards is the production and rating of test items by a community. In WOW, the gamer can choose and solve 'quests' to gain status in the WOW community, and they also can develop and suggest new quests themselves. The gamer's status in the community depends on his gained 'level' and his equipment. Solving quests is rewarded with level and equipment. The rewarding system is transparent: Gamers know in advance which quests will get them which rewards. It's evident that WOW satisfies elementary human desires which classic learning at school does not serve. There is no problem with addiction to learning, but online games may cause serious addiction. Communities supporting open educational standards are probably not going to be addictive, nevertheless, they may still be more motivating than classical schooling for some learners.

4 ON THE WAY TO A WIKI-TESTING COMMUNITY?

At the moment community-based educational standards on internet are a mere vision. It may share the fate of most visions and remain an utopian dream. Alternatively, it may also grow into reality. A possible way to achieve this may be the integration of community based open standards for automatic exams into the Wikipedia family (maybe as a workhorse for organizing exams and training opportunities in Wikiversity).

Community-generated online content was not invented by Wikipedia. Already 1993 Richard Stallmann, founder of the GNU project and one of the godfathers of open source programming, wrote:

„...Since we hope that teachers and students at many colleges around the world will join in writing contributions to the free encyclopedia, let's not leave this to chance. There are already scattered examples of what can be done. Let's present these examples systematically to the academic community, show the vision of the free universal encyclopedia, and invite others to join in writing it.

Courses in the learning resource are a generalization to hypertext of the textbooks used for teaching a subject to yourself or to a class. The learning resource should eventually include courses for all academic subjects, from mathematics to art history, and practical subjects such as gardening as well, to the extent this makes sense. (Some practical subjects, such as massage or instrumental ensemble playing, may not be possible to study from a "book" without a human teacher—these are arguably less useful to include.) It should cover these subjects at all the levels that are useful, which might in some cases range from first grade to graduate school.“

It lasted only some years until Wikipedia has accumulated a volume and quality that has already surpassed that of venerable traditional encyclopedias filling whole bookshelves. Extending the presentation of knowledge online to training and testing online with immediate feedback is a logical next step building on Stallmann’s ideas.

e-testing based on community-legitimated standards can help to advance the idea of e-learning and also help to provide a novel basis for defining educational standards. It may start with a handful of subjects – either supported by a platform like wikipedia or fostered by motivated educators in established educational institutions who are interested in basing exams and training for their students on a transparent pool of test items.

We concede that presently available resources to create e-testing modules still not have reached the usability comfort levels known from contributing to the Wiki world, but this is only a problem of time and cooperation. Who will help?

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