Education for the 21st Century: Impact of ICT and Digital Resources

WCC 2006 Santiago, Chile

Edited by
Deepak Kumar
Joe Turner

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EDUCATION FOR THE 21st CENTURY – IMPACT OF ICT AND DIGITAL RESOURCES

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- Working conferences.

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EDUCATION FOR THE 21st CENTURY – IMPACT OF ICT AND DIGITAL RESOURCES

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Foreword

It is a pleasure to offer you this book containing papers about ICT and education from the World Computer Congress 2006 (WCC 2006), held in Santiago, Chile and sponsored by the International Federation for Information Processing (IFIP). A lot of people worked very hard to make this event happen and to produce this book. The programme committee with IFIP members from around the world issued a call for papers inspiring almost 80 people to submit papers, posters, demonstrations, and workshops to the IFIP TC3 (Technical Committee on Education) sub-conference of WCC 2006. The submitted papers were reviewed by a large group of referees to select the papers to be presented at the conference. What is really amazing is that all these people freely contributed their time and effort to do all this work.

The TC3 sub-conference of WCC 2006 has two themes: Informatics Curricula, TEaching Methods and best practice (ICTEM II), and Teaching and Learning with ICT: Theory, Policy and Practice. These themes represent many of the broad range of interests of the Working Groups of IFIP TC3.

Two kinds of papers are included in this book: full papers and short papers. Full papers are standard papers that are appropriate for an international conference on ICT and informatics education. Of the 64 full paper submissions, 28 (44%) were accepted. A short paper represents work in progress, opinion, a proposal, work with untested results, or an experience report. Of the 11 short paper submissions, 6 (60%) were accepted. (Some full paper submissions were also accepted as short papers.) Additionally, abstracts of posters, a demonstration, and a workshop are included.

IFIP is an idealistic organisation networking professional people from most continents and lots of countries so that they together can do their share, making a difference in improving education in a way that only they can. By presenting and exchanging results of research and experience, all contributors to the book and the conference now have done their share as well. What is in the hearts of these researchers and educationalists is the heart of our IFIP TC3 sub-conference during WCC 2006. However, the book and the presentations are nothing if you the reader or the participant do not add your share by active contribution during the conference and by using the printed material for your further professional work. If you get just one new idea or inspiration to make just one professional contribution, we consider this a success. This is the real goal of all our efforts.

On behalf of TC3, we especially wish to have continuing work with our contributors from South America. We hope to meet them in coming IFIP events around the world to learn more about results and experiences of ICT in education in this part of the world. We always hope that our events contribute to steady progress in making a difference to the education of each child, all around the world!

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Content

Short Papers

Impact of Lifelong E-learning

Evidence and Guidance

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Abstract. This paper deals with lifelong learning. Based on a three-year case study it provides evidence of innovations in this area. The paper aims to add to the body of work in blended learning by providing evidence of knowledge, persuasion, decision, implementation, and confirmation of learning innovations. In particular, the paper provides guidance for future development.

1 Introduction

An innovation is considered to be an idea, a practice, or an object that is perceived as new by individuals or other units of adoption [1]. What matters is the *perceived* newness. Lifelong learning and blended e-learning – the topics of this paper – are relatively new to many individuals. Currently, many individuals are learning to deal with this innovation. For example, they experience a process of development with interrelated education, training, work and retirement (Figure 1).

Moreover, many individuals experience that focus is increasingly shifting from the content to be learned to the definition of competencies to be acquired [2]. Many people thus have to learn to identify their need for competencies in a lifelong perspective.

In addition, they experience that face-to-face education is completed by self-directed learning in a three-way interaction among participants, tutors, and a technology cluster. The cluster being the third partner can be defined as some distinguishable elements of technology that are perceived as being closely interrelated [1]. For example, a frequently-used e-learning cluster encompasses e-mail, learning management systems, and web-based materials.

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Andresen, B.B., 2006, in International Federation for Information Processing, Volume 210, Education for the 21st Century-Impact of ICT and Digital Resources, eds. D. Kumar, and Turner J., (Boston: Springer), pp. 1–6.

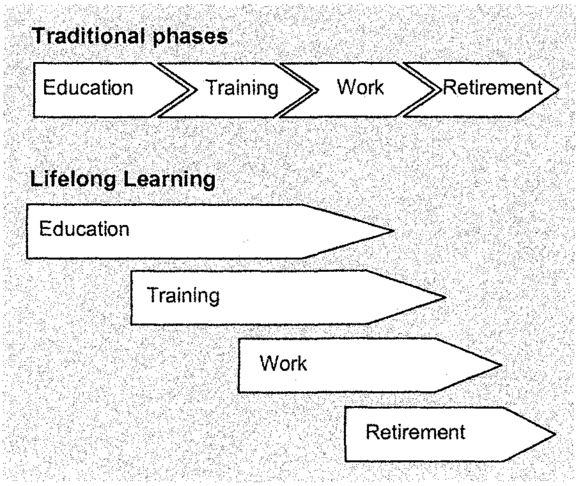

Figure 1. Lifelong learning [3].

This paper gives an account of a case study concerning a three-way partnership of face-to-face, self-directed learning and technology cluster (blended e-learning) in the field of occupational health, which has long been one of the three Danish in-service educations most in demand [4].

The study had the following main stages:

1. Designing and conducting an exploratory case study concerning innovative pilot courses;
2. Analyzing the pilot study evidence and developing the recommendations and implications;
3. Designing and conducting an impact case study;
4. Analyzing the impact case study evidence and developing the conclusions and final recommendations.

2 The Role of the Change Agent

At first, the study examines the crucial role of change agents. The notion of *change agent* is defined as an individual or decision-making unit that influences innovative decisions in a direction deemed desirable by this agent [1]. In this case, a change agent, the Labour Markets Bureau of Service, provided learning objectives, i.e. competencies to be acquired by the participants, and e-resources including learning materials. In addition, the change agent coached the course providers.

This coaching occurred over time and consisted of a series of different events. To begin with, a handful – out of the more than one hundred – of course providers decided to implement the blended-learning approach.

The decision-making process these course providers used included the following stages: knowledge, persuasion, decision, implementation, and confirmation.

Knowledge was created when the course providers were exposed to the existence of the innovation and gained an understanding of how it functions. Initially, the change agent provided knowledge about the new concept. This included the course flow, i.e. the mixed organisation of face-to-face seminars and self-directed learning using web-based course materials and a learning management system.

Persuasion occurred when the course providers formed a favourable attitude towards the innovation. For example, the course providers asked questions about the new concept similar to the questions mentioned in the theory of diffusion of innovations by Rogers [1], e.g.:

- How does the innovation work in our practice?
- What are the intended consequences of the innovation for our practice?
- What will its advantages and disadvantages be in our situation?

In order to provide answers to these questions, the change agent had a crucial role. The answers provided fostered a favourable attitude towards the new course concept and the decision to adopt it.

The *decision* took place when the course providers engaged in activities that led to the adoption of the innovation.

Implementation took place when the course providers put the new approach to use. In the implementation phase, the course providers trained their tutors and applied the learning management technology to a professional development setting.

Finally, *confirmation* took place when the course providers sought reinforcement of the decision already made. Among other things, they examined the results of some pilot courses.

At first, the change agent and course providers considered outcomes of six pilot courses in order to re-invent the course concept. In this context, the notion of *re-invention* refers to the degree to which the original self-directed learning concept was changed in the process of development and adoption. Since most participants were unfamiliar with the learning concept, the general information about the courses had to be revised in order to foster realistic expectations about the learning activities. In addition, the learning tasks had to be revised before they were used in a two year trial period (Table 1).

Table 1. Case study concerning e-learning in the field of occupational health

Type of course	*No. of courses*	*No. of enrolled individuals*
First year pilot courses	6	50
Year 2-3 courses	52	735
Total	58	785

3 For better or for worse?

The study was based on quantitative and qualitative data from former participants regarding their learning processes, i.e. knowledge and methods of analyses and improvement of the health and security of their workplaces. By comparing these data, the study provided evidence – as opposed to assumptions – of what works in the field of lifelong e-learning.

In addition, the outcome of the e-learning courses was compared to the outcome of a traditional face-to-face course with identical objectives and content. In both learning scenarios, more than 90 pct. of the participants considered their previous knowledge a starting point in their learning processes and they agreed that the course met their needs for knowledge, skills, and values as well as their expectations and objectives [5].

Furthermore, almost all agreed that the course fostered their development of important competencies in an ongoing learning perspective.

It also prepared them to search for and use information and to analyse and take action.

The e-learning concept has its drawbacks in terms of comprehensiveness. The learning achieved by the participants in the regular course amounts to little more than the general knowledge about the subject achieved by the participants in the blended course.

However, there was a significant difference regarding the learning breadth/depth. The e-learning approach had an advantage, since it allows for greater depth in the learning. The flexible learning concept assigned a sufficient amount of time to complete deeper analysis and elaborate problem solving tailored to local challenges.

These findings are considered evident, since they are generally documented over a three-year period.

4 Intended and unintended Consequences

The impact study addressed the question of the development of competencies in a lifelong learning perspective. Did the blended learning event really influence the lifelong learning of the participants? In order to answer this crucial question, the change agent collected information about the long-term outcome of the e-learning approach in terms of the participants' knowledge, attitudes, and ability to put into practice what has been learnt.

The impact study was undertaken half a year after the last day of the course. The impact was judged with respect to the participants' needs for a broad spectrum of competencies including:

- Communicating and negotiating;
- Searching and using information;
- Analysing and monitoring;
- Investigating and reporting;

The value of the course work with respect to these competencies is shown in Table 2, which indicates that in general, recognised and measurable learning outcomes are achieved during course work.

Table 2. E-learning impact [4].

Activity	*Undertaken the activity*	*Highly or some degree of experienced utility value*
Influencing (communication with colleagues)	71 pct.	81 pct.
Searching (information about working environment)	68 pct.	64 pct.
Monitoring (working environment)	61 pct.	83 pct.
Investigating (accidents and illness due to work)	41 pct.	80 pct.

In particular, the impact study provided evidence of the value of the use of ICT to foster learning. As part of the course work, the partakers used a technology cluster including e-mail, learning management systems, and web-based materials. The participants greatly appreciated using it to share knowledge and distribute information about course work. During the course, they were not just inspired by their tutors but also by the work of other participants, which they accessed through the learning management platform.

In order to benefit from the digital communication the participants needed fluency with respect to the cluster of technology. Since the working environment for some professions does not provide access on a regular basis to a cluster of technology, it is evident that the e-learning approach holds some drawbacks for these groups of professionals.

A desired consequence, however, was increased ICT literacy, i.e. competencies related to the use of ICT, and information literacy, i.e. knowledge on how and where to search and find relevant information. Two-thirds of the participants considered the technology-related competencies they acquired very useful.

4 Conclusion

This paper reports a case study regarding innovations in the field of lifelong learning. Among other things, it provides evidence of professional development, e.g., how to make innovations in learning with deeper learning outcomes and long-term impacts.

In addition it reports evidence of how to foster the development of digital literacy and information literacy, and these results can be used for future innovation in professional development and lifelong learning.

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Technologies and Educational Activities for Supporting and Implementing Challenge-Based Learning

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Abstract. Our Challenge-Based Learning (CBL) method can be described as a special form of problem-based learning, in which the problems are of realistic, open-ended nature. Additionally, CBL contains features of experiential and project-based learning approaches. CBL is supported by the provision of Digital Experimentation Toolkits (DExTs) which comprise materials, initial instructions, references to web resources and specific software tools. Technological challenges lie in the ease of use in accessing these data and in communicating the learners' requests and specifications to the remote sites. Within this article we describe several classroom scenarios for the usage of DexTs in schools. Examples are the calculation of the epicenter of an earthquake, the calculation of lunar heights and the definition of strategies for navigation in a maze. The activities described in this paper were conducted within the framework of our COLDEX project (Collaborative Learning and Distributed Experimentation, http://www.coldex.info).

1 Introduction

Although computer support for learning was in the early days aimed for the individual learner today we find an increasing number of applications supporting collaborative learning. Collaborative learning has been defined as groups working together for a common purpose. It is hard to explain that the learning theories which are based in the collaborative interaction between learners are entirely responsible for this shift of paradigm. The development of communications, and computer connectivity are certainly also responsible for the shift in the way people work, play,

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and learn. However, authors of systems and methodologies implementing Computer-Supported Cooperative Learning (CSCL) are constantly turning their attention to these theories for inspiring or justifying their work.

Vygotsky's sociocultural theory [1] promotes the importance of social interaction and the use of artefacts for knowledge acquisition. Three principles have been proposed for the design of educational environments derived from Vygotsky's works [2]. First, the notion of authentic activities proposes the modeling of activities and tools derived from professional practices. Second, "construction" refers to learners creating and sharing artefacts within their community. Third, educational environments should be designed to facilitate a close collaboration between learners and their peers as well as between students and experts. Regarding these principles several educational scenarios have been developed within the COLDEX project. The COLDEX project aims at designing innovative learning environments in order to support a wide range of global open learning activities within the scientific domains of astronomy, biodiversity, chemistry and seismology. This goal is achieved by combining an innovative pedagogical approach called Challenge-Based Learning (CBL) together with the support of a variety of modeling tools and experimental scenarios. CBL can be described as extended problem-based learning, but it contains also some components from the experiential, project-based and decision-based learning perspectives.

Project-based and problem-based activities are usually focused on a driving question or problem [3]. In CBL the question or the problem is replaced by a challenge. This challenge is initiated either by the COLDEX project, a teacher or a student group. The assignments or "challenges" to be solved might include ways to develop, design and implement solutions for problems related to scientific phenomena. A meaningful learning activity consistent with CBL is to present learners with a challenge scenario and to ask them to think about a number of possible solutions using a variety of interactive tools. Such an activity serves to centre thinking around meaningful problems and is typically effective in facilitating small-group collaboration. Regarding collaboration, it is important that the need for it is not artificially imposed on the community of learners by the system, but grounded in the nature of the task. Only if collaboration is needed to accomplish the task will learners appreciate the value of, and seriously engage in, collaborative activities such as sharing information and discussing partial research results, and come up with shared decisions and synthetic solutions.

The rest of the paper is divided into four sections. In the next section we present related work to the field of science learning supported by the use of modeling, simulations and visualization techniques. Sections three and four describe the COLDEX scenarios and educational activities we have developed and implemented. Some examples of these activities are described in detail in order to illustrate these ideas. Finally, we conclude this paper by reflecting upon our experiences and presenting some conclusions.

2 Related Work

The CoVis Project [9] aims at supporting "Learning through Collaborative Visualization" that resembles authentic practices of science. It provides a variety of collaboration and communication tools and tries to embed the use of technology in the development of new curricula and pedagogical approaches. It focuses on a project-enhanced science learning pedagogy, scientific visualization tools for open ended inquiry and networked environments for communication and collaboration.

For Edelson [9] authenticity refers to a learning context reflecting the context of use. With respect to this notion of authenticity he characterizes science practice with its attitudes of uncertainty and commitment, discipline-specific tools and techniques, and social interaction. Uncertainty refers to the continual reexamination of techniques and results in the pursuit of unanswered questions. Commitment indicates that this pursuit has meaningful ramifications within the value system of scientists – or students. The use of historically-refined tools and techniques also provides a shared context facilitating communication. And social interaction stresses that scientific work exceeds investigation by including sharing results, concerns and questions among a community of scientists. "A vision of learning that integrates these features of scientific practice has students investigating open questions about which they are genuinely concerned, using methods that parallel those of scientists. Throughout the process, they are engaged in active interchange with others who share their interest."

A synthesis between discovery learning in science and collaborative learning, both supported by computational tools, has recently been suggested by van Joolingen [10]. Indeed, there is a variety of different collaborative activities in discovery learning and collaborative modeling. Bollen et al [11] have identified the following aspects of computer support in collaborative modeling:

- Several students can share a running model by synchronizing their simulation environments.
- The actual model-building process can be shared activity using a modeling language and annotations in shared workspaces.
- Simulations are analyzed to generate hypotheses about the global behavior of systems. To do this in the form of group work, free-hand sketches as well as argumentation graphs and mathematical tools (function plots, tables, etc.) are useful tools.
- Data can be collected in a distributed working mode with different parameters. Shared workspaces allow for gathering data from different groups.
- Group work can be supervised by sharing the environment with a distant tutor.

The "Cool Modes" platform [12] supports these activities by providing a uniform shared workspace environment that allows for constructing and running models with different formal representations (Petri nets, System Dynamics, mathematical graphs etc.) and also supports semi-formal argumentation graphs and hand-written annotations. The work reported in this paper has been strongly inspired by these developments.

3 Classroom Scenarios in the COLDEX Project

To support educational classroom scenarios according to the Challenge Based Learning approach several so-called "Digital Experimentation Toolkits" (DExTs) have been developed within the COLDEX project. A DExT includes experimental instructions, scientific background information, modeling and simulation tools, access to real scientific data, and the formulation of initial challenges. What we want to provide is an open-ended learning environment that stimulates learners to identify and solve a challenge according to the educational premises of CBL. Interactive tools for modeling and simulation enable learners to generate and try out hypotheses, and show the experimentation results. These DExTs are intended to be handed out to schools to be used in, but not only in, normal school lessons. They provide innovative use of interactive media to enrich the curricula. Teachers should be enabled to integrate these new resources easily in their lessons. As only a few teachers have time to spend on courses or time-consuming studies for learning to use these toolkits, they are mostly self-describing and trouble-free. DExTs are not to be seen as expert systems which present themselves as authoritative and definitive. Our toolkits adopt a more post-modern position on the problems of practice, celebrating difference and providing a democratic form of interaction that allows the user to create and direct instead of being directed. In this sense, they are perhaps best positioned as a means of representing and sharing practice, rather than a way of privately receiving advice on one's own practice [4]. DExTs rely on tools for modeling or simulation and experimentation. The modeling tool is used when the students organise their thoughts early in a Project or when the students are going to design something later on. Different simulation tools are used for testing estimated values and outcomes concerning different influences of events. Our experimentation tools are a prerequisite for the students to construct, visualize and confirm their thoughts in the learning process. Essential for the toolkits is to get access to modeling and collaboration tools, and to a common repository. This is done through the Internet. A small number of remote sites will be established which generate data.

Table 1. Challenge-based learning and other learning methods.

	Discovery-based	**Problem-based**	**Experiential learning**	**Challenge-based**
Cognitive focus	Knowledge inquiry	Knowledge construction	To grasp and transform experience	Knowledge interpretation, inquiry and construction
Role of student	Detective, picking up clues	Participant, searching	Active participant, choosing	Active constructor/ designer
Role of teacher	"As mystery writer"	Coach	Facilitator	Coach, co-experimenter and designer

One conclusion within our classroom scenarios according to the CBL is a change in the teachers' and students' roles. The students' role gets a stronger focus on being a more self- (or group-) regulated "researcher" collaborating by using construction and designing tools. Due to the open-ended scientific nature of the examined research question, the teacher's role focuses more on being a coach or co-experimenter. Table 1 illustrates how CBL differs from some of the other learning methods.

4 Scenario Examples

4.1 The Seismo Scenario

In this educational scenario, students learn how to analyse earthquakes and to compute and understand some characteristics of the seismic phenomena. For this purpose, a network of six seismographs was installed in different schools of the Metropolitan Region of Chile. When an earthquake occurs, the computers attached to the seismographs generate a file with the seismographic wave. Since every seismograph is located in a different place, they will register different data. By determining the time difference between the first (horizontal) and the second (vertical) hit of the earthquake's wave registered by a single seismograph, the students can determine the distance from the seismograph to the hypocenter, but not the direction. If three or more groups exchange their data and/or results it is possible to define three semi-spheres.

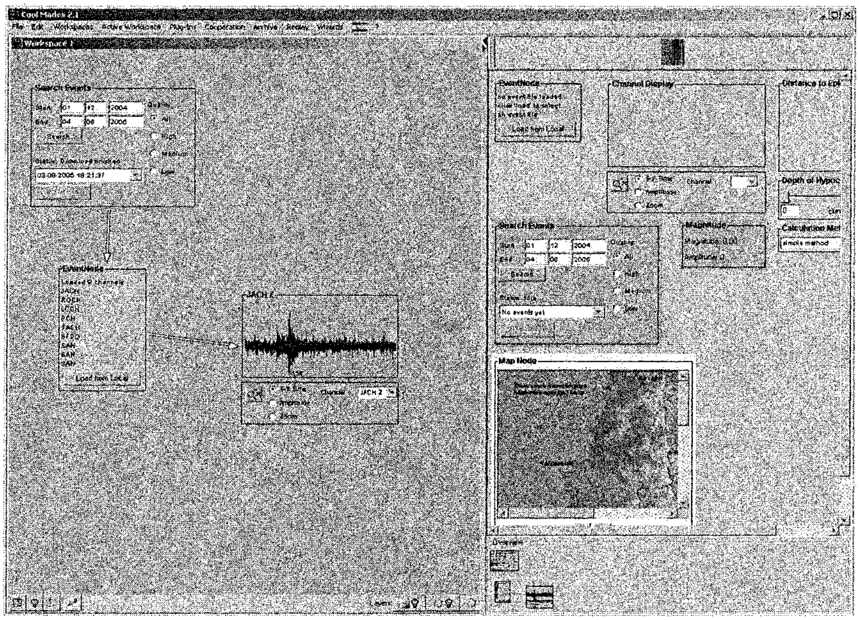

Figure 1: The interface of the Coolmodes seismography palette.

The point where these semi-spheres intersect each other is the point where the epicenter is located. For enabling students to do these calculations easily, we developed a tool with which they can download the data from a seismograph (which has been previously uploaded by the group of the school where it is located), draw the wave and calculate the time difference between the two hits of the wave, on top of the Coolmodes application (see Section 2).

It provides a working area for this purpose, which is meant to support the workflow of the students' activities. A workflow is represented as a network of different types of nodes, each one implementing a further step towards the calculation of the epicenter. Figure 1 shows the palette with the nodes at the right and the construction of the workflow at the left. Nodes can be created and placed in the working area by "drag-and-drop" from a palette of different node types.

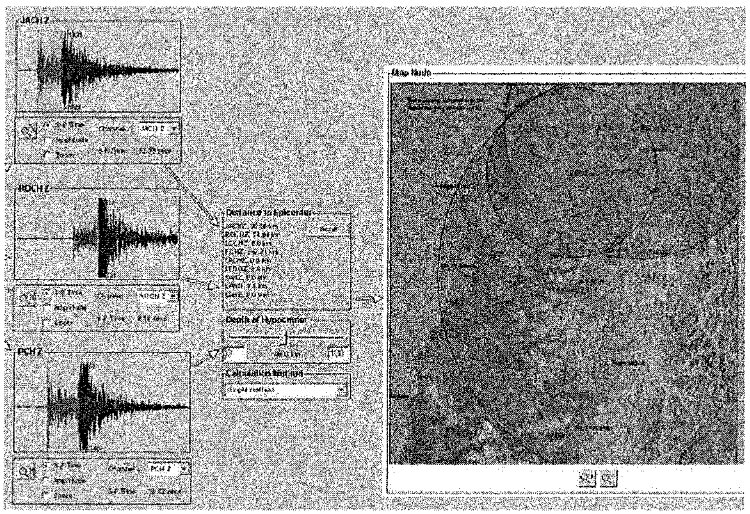

Figure 2: The slide bar of the center's node changes the estimated depth of the hypocenter.

Adding an edge between two nodes transfers output values of one node as input values for the successor, but of course, this is allowed by the system only between nodes where this operation makes sense. On the node containing the map, circles representing the calculated distance from the sensors are drawn (see Figure 2). By changing the supposed depth of the earthquake's genesis location (called hypocenter) the diameter of those circles also changes. The point where they all intersect is the location of the epicenter. This setting allows various kinds of collaborative learning activities.

4.2 The Moon Scenario

Within our astronomy scenario the students are enabled to calculate lunar heights by using moon images taken by themselves or retrieved from a repository via the internet. Within the COLDEX project we have access to several different-sized telescopes in Europe and South America (Chile). All the telescopes are remote controllable and accessed through web services so there is no change needed on the client side software when choosing another telescope. To calculate lunar heights, the students need to be able to model calculation networks. Mathematical backgrounds are the sentence of three and the theorems of similar triangles. In a first step they have to discover the needed relationship between several measurements (crater shadow length, distance crater-terminator,) by using a dynamic 2D-geometry model. After deciding how to proceed they can take measurements out of their moon image using a special measurement tool (e.g., including zooming) storing the measured values automatically into produced input nodes in the same (possibly network shared) workspace. The students then can calculate the lunar heights by using a visual language to define calculation networks. Fig. 3 shows the measurement tool and a calculation network having the taken measurements as inputs.

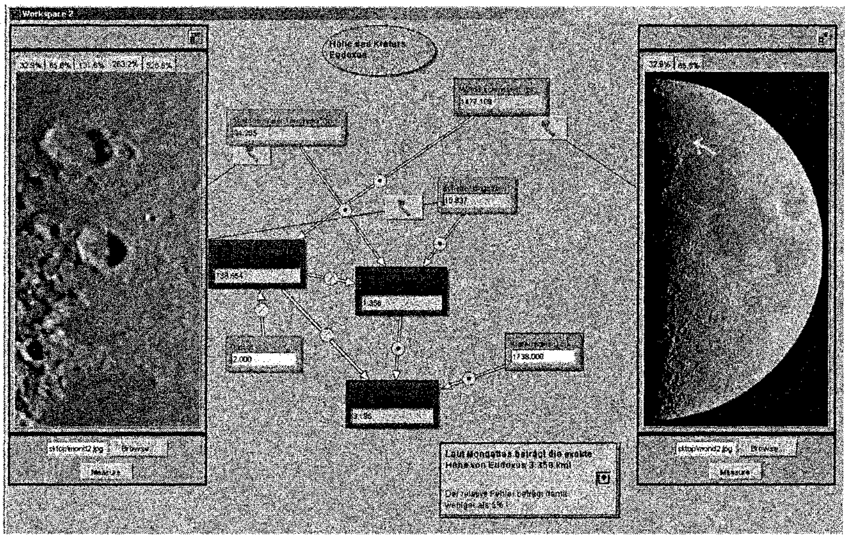

Figure 3: The lunar heights calculation

Several competitive or cooperative scenarios using the described environment are possible. Within a collaborative school project "building a moon lexicon" one chapter could be about the biggest mares and highest or deepest craters. Therefore tasks could be distributed like:

- developing the needed formula / calculation network
- producing / retrieving moon images (When to take? Which are the best?)
- working on different areas of the moon

An example of a competitive scenario using the described environment could be a "moon measuring contest". At the beginning of the contest students get access to the dynamic geometry model, to the telescope image repository and to the names of the craters which are part of the contest. Within a predefined time limit they have to understand the calculation principle and to measure the heights of the craters as exact as possible to them. Therefore they could, e.g., use different images, process their images and build the averages out of their results. The effectiveness of such group work will be related too how the students distribute the different parts of the work within their groups. This could be a focus of the following discussion. A more detailed scenario description can be found at [5].

4.3 The Maze Scenario

The leading challenge within this scenario is to define a maximally-general strategy to let a robot escape from a maze. Although this question has its own history [6], the parallelism to the little (at least partially) autonomous acting robots sent to Mars over the last years also inspired us within COLDEX to create this scenario. The robot "senses" its direct neighbourhood (free or wall in front, to the right or to the left) and searches for a given rule how to behave in this situation. A very easy to implement strategy is "wall following", which will not assure the escape out of mazes with "islands". These can be solved by more sophisticated algorithms using additional information (absolute heading). A special feature in our scenario is the possibility of "reactive programming-by-example". The robot has to react to the current situation description. It starts with an empty memory. In a situation to which no existing rule applies, the user/learner will be prompted to enter a new action. Each user-defined reaction will be added to the memory as a rule which will be applied under the same circumstances. Rules can be generalised by replacing concrete elements of situation descriptions by jokers which would match any value.

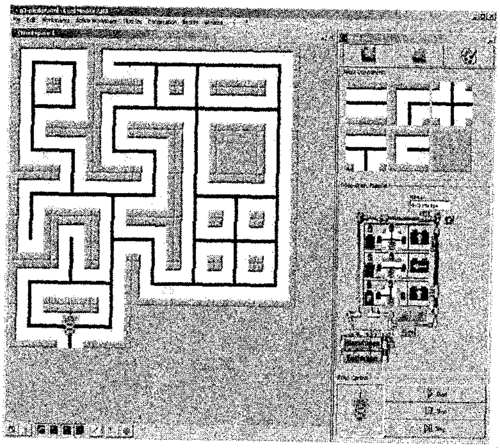

Figure 4a

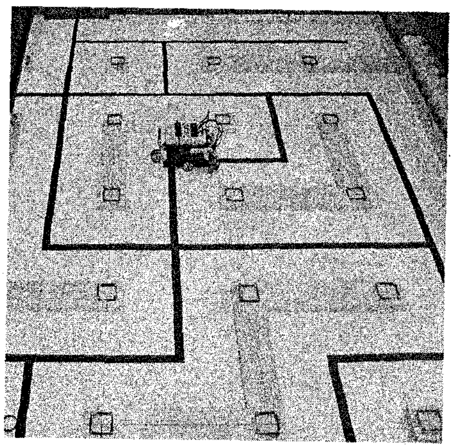

Figure 4b

The user will react only by defining actions in concrete situations without having to define global control strategies (local reactive programming). Our maze scenario consists of physical (wooden maze, RCX-driven Lego Mindstorms robot, communication via PDA or PC, see Fig. 4a) and virtual environments (software plug-in for our Cool Modes environment [7], see Fig. 4b, and a tiny PDA environment). Developed rule sets can be stored in and retrieved from a local server within a WLAN. This scenario fits, e.g., for competitive group work building a maze the other groups' robots cannot deal with / developing rule sets to be able to escape from the other groups' mazes. A more detailed scenario description can be found in [8].

5 Experience and Conclusions

The principles, methodologies and tools described in this paper have been successfully used in real scenarios in schools located in different countries. So far, about 40 teachers and 200 students haven been involved in usage scenarios ranging from short-term activities of a few days and longer-term activities over a whole school year in which COLDEX DExTs supported parts of an integrated science curriculum. Many of the interesting learning products have been fed into a common repository. Since these learning products originate from the same basic challenges and since they have been elaborated using the same set of tools, it is quite straightforward to exchange and share these between different learning groups or individuals. The COLDEX repository is directly connected to the Cool Modes learning environment supporting upload with automatic indexing as well as similarity-based retrieval with given examples. Beyond the provision of tools and challenges, this community repository is another feature of the COLDEX approach to learning which has been explained elsewhere in more detail [13]. The evaluation of the COLDEX scenarios presented in this paper took place in several countries using generic evaluation instruments in order to be able to provide the same evaluation possibilities for all scenarios. We created a quantitative basis using questionnaires and analyzed qualitative data eliciting contextual and scenario specific information. The instruments were adapted and tailored to the collaborative and technological nature of COLDEX scenarios. Different types of evaluation were conducted in order to assure appropriateness of the evaluation results. Based on the results from our evaluation [14], the COLDEX project has been successful in creating innovative educational scenarios and supporting authentic scientific activities mediated by advanced learning technologies. These results provide some indications that show that students have become more interested and involved in science learning when these tasks can be supported by authentic scientific inquiry activities, done in collaboration with other peers and supported by multimodal interaction. The results of the different experiences conducted within COLDEX have been gathered in Sweden, Germany, Chile and Colombia and they can be summarised as follows:

- Teachers have been able to adapt and apply the tools to their situational needs very flexibly and creatively. Several additional suggestions and materials have been proposed and elaborated by teachers.
- Students have been able to operate the tools with ease. Although this is not ideal, it has been possible to work through the moon scenario within half a day under strong time constraints. We have seen many cases of creative co-construction with high quality results.
- Teachers have responded very positively to the community repository which was only provided in the last phase of the project. They clearly saw the added value of sharing learning results in the nonstandard domains of COLDEX.

Acknowledgments

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An Integrated Content Modeling Approach for Educational Modules

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Abstract. Educational modules – concise units of study capable of integrating theoretical/practical contents and supporting tools – can be seen as relevant mechanisms to facilitate the student's apprenticeship. The establishment of processes and modeling approaches should ease the cooperative work to create, reuse and evolve educational modules, taking also into account the impact on the learning process. There are initiatives to address the problem of modeling educational contents, but none of them provides a complete set of features addressing the conceptual, instructional and didactic perspectives. Moreover, these initiatives do not consider a systematic process for developing educational modules. In this work we summarize the main aspects of a standardized process for developing educational modules we have proposed, focusing on the modeling activity for structuring the learning contents. An integrated modeling approach is presented and its application is illustrated by the development of an educational module for the software testing domain. The material produced has been applied and preliminarily evaluated in terms of the student's attitude toward content, usability and navigational aspects.

1 Introduction

Educational modules, which correspond to concise units of study delivered to learners by using technological and computational resources, can be seen as relevant mechanisms in order to ease the learning processes [1]. Besides that, the educational modules should be evolvable, reusable and adaptable to different learning scenarios and objectives. There are initiatives to address the problem of modeling educational module contents[1]. In fact, these initiatives aim at providing ways to establish effective educational products capable of creating and/or improving motivational learning situations, but none of the initiatives provides a complete set of features addressing the conceptual, instructional and didactic perspectives. Moreover, they do not consider a process for developing educational modules.

[1] An overview of modeling approaches for educational contents can be found in [1].

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We investigate the establishment of a process for developing educational modules, aiming at providing a set of guidelines and supporting mechanisms to create, reuse and evolve them [1]. Particularly, we are interested in the content-modeling activity, which helps the author to determine the relevant parts of the knowledge domain, providing a systematic way to structure the concepts, also promoting reusability and adaptability. In our research line, at the very end, we intend to provide a context for "open learning materials".

In this paper we focus on the content-modeling activity, presenting the main aspects of an integrated modeling approach for developing educational content (*IMA-CID: Integrated Modeling Approach – Conceptual, Instructional and Didactic*). We illustrate the practical application of *IMA-CID* by the development of an educational module for the software testing knowledge domain. The testing material produced has been applied and preliminarily evaluated in terms of the student's attitude toward content, usability and navigational aspects.

The remainder of this paper is organized as follows. In Section 2, we provide a brief overview of educational modules. In Section 3 we summarize the main aspects of a standardized process for developing educational modules we have previously proposed and describe the main aspects of *IMA-CID*. Also, *IMA-CID* is applied to the development of a software testing educational module, which is described in Section 4. Some results from a very preliminary evaluation on the effectiveness of *IMA-CID* are discussed in Section 5. Finally, in Section 6 we summarize our contributions and discuss the perspectives for further work.

2 Educational Modules

Educational modules are concise units of study, composed of theoretical and practical contents which can be delivered to learners by using technological and computational resources [1]. For theoretical contents we understand books, papers, web information, slides, class annotations, audio, video, and so on. Practical contents are the instructional activities and evaluations, and their resulting artifacts (e.g., executable programs, experiments, collaborative discussions). Specific tools related to the knowledge domain as well as the results obtained from their application can also be seen as practical contents. In the case of testing, *Proteum* [4] is an automated tool that can be integrated in an educational module to enable the application of testing concepts in real situations, fostering education and training situations and promoting exchange of technology between industry and academia.

Theoretical and practical contents are integrated in terms of learning materials. Learning environments, presentation tools, and mechanisms to capture classroom lectures and to support discussion spaces and collaborative work are examples of the required infrastructure for delivering the learning materials.

The development of educational modules should consider the intrinsic characteristics of knowledge, such as its dynamic and evolutionary aspect. In the testing domain, for instance, practical activities involving the conduction of experimental studies can result in new knowledge on testing techniques and criteria, which should be incorporated to the contents previously defined. Also, there is a need for adaptability and reusability – educational modules should be seen as independent units of study, subject to be adaptable and reusable in different education and training scenarios, according to some aspects such as the learner's profile, instructor's preferences, learning goals and course length, among others.

3 Developing Educational Modules

- **A Process for Developing Educational Modules**

Similar to software modules, educational modules require the establishment of systematic processes in order to produce quality products. The Standard Process for Educational Modules [1] is based on the ISO/IEC 12207, tailored to the context of educational modules by including aspects of content modeling, practices from instructional design, and issues of distributed and cooperative work. The standard establishes a set of processes that can be used to acquire, supply, develop, deliver, operate, and maintain educational modules. Primary processes deal with the main activities and tasks performed during the life cycle of an educational module. Supporting processes contribute to the success and quality of the development project. Organizational processes are employed by an organization to establish, implement and improve an underlying structure made up of associated life cycle processes and personnel. Aspects of specialization and instantiation have also been explored in order to apply the standard process into specific projects, for different knowledge domains. In the same line as CMMI for software, a maturity model for educational modules – *CMMI/Educational* – was proposed as a mechanism to support the specialization of the standard process in different maturity levels.

- **The IMA-CID Approach**

Content modeling plays a fundamental role in the development process of educational modules [1]. It helps the author to determine the main concepts to be taught, providing a systematic way to structure the relevant parts of the knowledge domain. How the contents are structured can also affect the reusability, evolvability and adaptability of the module. Despite its relevance, there are few approaches for modeling educational contents. Besides that, each of these initiatives deals with different perspectives, which can be suitable for a given learning scenario but inadequate for others.

Motivated by this scenario, in a previous work we proposed a preliminary set of modeling requirements [2]: (1) concepts taxonomy, (2) concepts composition, (3) specific relationships, (4) hierarchical decomposition, (5) knowledge categories, (6) learning contexts, (7) pedagogical order, (8) history mechanisms, and (9) event propagation. We also identified some modeling perspectives – conceptual, instructional and didactic – in order to characterize the models for representing educational contents [2, 1]. Based on the requirements and perspectives, we carried out comparisons among the existent modeling approaches. In short, we noticed that some approaches seem to be particularly interesting in dealing with conceptual issues, while others deal with relevant elements under the instructional perspective, and still others demonstrate an expressive power for representing didactic aspects.

Finally, we established a connection between the perspectives and requirements, which was the starting point for the definition of the models for educational contents and their integration into *IMA-CID* (*Integrated Modeling Approach – Conceptual, Instructional and Didactic*) [2, 1] – an integrated approach for modeling contents, composed by a set of models, each one dealing with specific aspects of the development of educational contents (Figure 1).

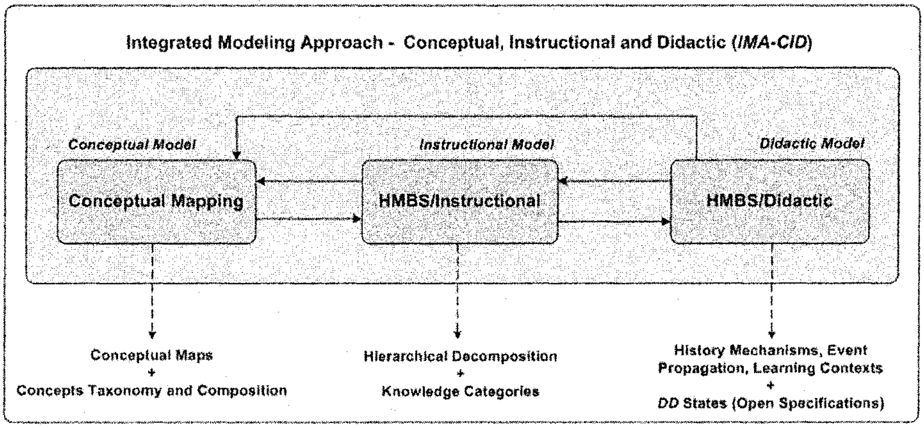

Figure 1. The IMA-CID approach

The *Conceptual Model* consists of a high-level description of the domain, representing its main concepts and the relationships among them. The relationships can be divided into two classes. Structural relationships (such as *type-of* and *part-of*) are useful to set up taxonomies among concepts and make inferences about the knowledge, representing a generic category of relationships, applicable to any kind of domain. Domain-specific relationships are user-defined and have their meaning associated with a particular subject, carrying their own semantics. They represent specific relations, whose interpretation depends on the domain being modeled.

To construct the conceptual model, we focused on the Conceptual Mapping ideas [9]. Among the reasons for choosing this technique we point out: (1) it is suitable for representing concepts and for structuring the knowledge domain; (2) it is intuitive and easy to use; (3) it is based on educational principles, having a good acceptance among educational specialists and professionals; and (4) it is adopted by the majority of existent modeling approaches for educational contents. We also included some additional notations to the rules for creating conceptual maps aiming at representing the relationships of concepts taxonomy (*type-of*) and concepts composition (*part-of*).

Besides concepts, information items and instructional elements should be considered as part of the knowledge domain. In the *Instructional Model* we are interested in defining such additional information, relating it to the concepts previously identified. Notice that we are not interested in how the information will be sequenced, but in what kind of information we can use to develop a more significant and motivating content. Several theories and techniques can be referenced to support the establishment of information items. We adopted the Component Display Theory [7], which specifies *concepts*, *facts*, *procedures* and *principles* as information items. The instructional elements can be classified into three categories. *Explanatory elements* (examples, hints, suggestions of study) deal with the complementary information for explaining a topic. *Exploratory elements* (guided exercises, simulations, hands-on assignments) allow the learner to navigate through the domain, practicing the concepts and relevant information. *Evaluative elements* (diagnostic, formative and summative evaluations, in terms of subjective and/or objective questions) allow assessing the learner's proficiency on the domain.

As a support to construct the instructional model, we adopted the HMBS (Hypertext Model Based on Statecharts) model [10]. In short, HMBS uses the structure and execution semantics of Statecharts to specify the structural organization and the browsing semantics of hyperdocuments. We focused on the mechanisms for hierarchical decomposition HMBS provides, complementing the idea of hierarchical organization already explored in the conceptual model. Notice the hierarchy deals with the depth of the knowledge/material to be presented. To make HMBS suitable for modeling the instructional aspects, it was extended for representing different *knowledge categories* – concepts, information items and instructional elements. The extended version of HMBS is named *HMBS/Instructional.*

The *Didactic Model* is responsible for the establishment of prerequisites and sequences of presentation among conceptual and instructional elements. The specification of behavioral aspects can also be explored. Thus, the model can be used to illustrate the way the didactic space is modified while being navigated by the user, i.e., which information becomes active/inactive when a given path is traversed. Didactic models are also useful to represent dynamic contexts of learning, where the elements of the content are determined according to specific parameters (defined in terms of the characteristics of the course, learners and instructors).

Since HMBS deals with relevant aspects under the didactic perspective (history mechanisms, event propagation and learning contexts definition), it was also adopted to construct the didactic model. In addition, by using HMBS we can validate the educational content through the analysis of the subjacent statechart properties [10]. As an extension to HMBS at the didactic level, we introduced the idea of *open specifications*, which provide support for the definition of dynamic contexts of learning. Depending on aspects such as audience, learning goals and course length, distinct ways for presenting and navigating through the same content can be required. An open specification allows representing all sequences of presentation in the same didactic model. So, from a single model, several versions of the same content can be generated according to different pedagogical aspects. Moreover, when an educational module is implemented based on an open specification (*open implementation*), its navigation paths can be defined by the user himself, in "execution time". That is, during the presentation the user is able to dynamically decide which topics should be navigated and in which sequence, based on the learner's feedback for instance.

To represent open specifications, we extended HMBS with the notion of *DD* (Dynamically Defined) *states*. In short, all OR substates of a *DD* state (OR_{DD}) are totally connected to each other. That is, from any substate of a *DD* state *X*, we can reach all other substates of *X*. For the sake of legibility, transitions and events are implicitly represented. We also established a hierarchy of *DD*-superstates – leaving a *DD* state *X* can activate the OR_{DD} states from the hierarchy of *DD*-superstates of *X*. Both the notions of *DD* states as well as the hierarchy of *DD*-superstates help us to the establishment of open specifications in the sense that they allow us to represent all sequences of presentation in the same didactic model. The extended version of HMBS to support *DD* states (and open specifications) is named *HMBS/Didactic*.

4 An Educational Module for Software Testing

IMA-CID was applied as part of the development process of an educational module for software testing (Figure 2). Concepts, facts, principles, procedures, examples and exercises were modeled and implemented as a set of slides, integrated into HTML pages, text documents, learning environments and testing tools. The module was designed and implemented according to the Standard Process for Educational Modules and the *IMA-CID* models [2, 1]. For the sake of space, in this section we present a specific model – the *HMBS/Didactic* –, developed for a particular subject of testing – the mutation analysis criterion [5]. The model is illustrated in Figure 3 and corresponds to an open specification.

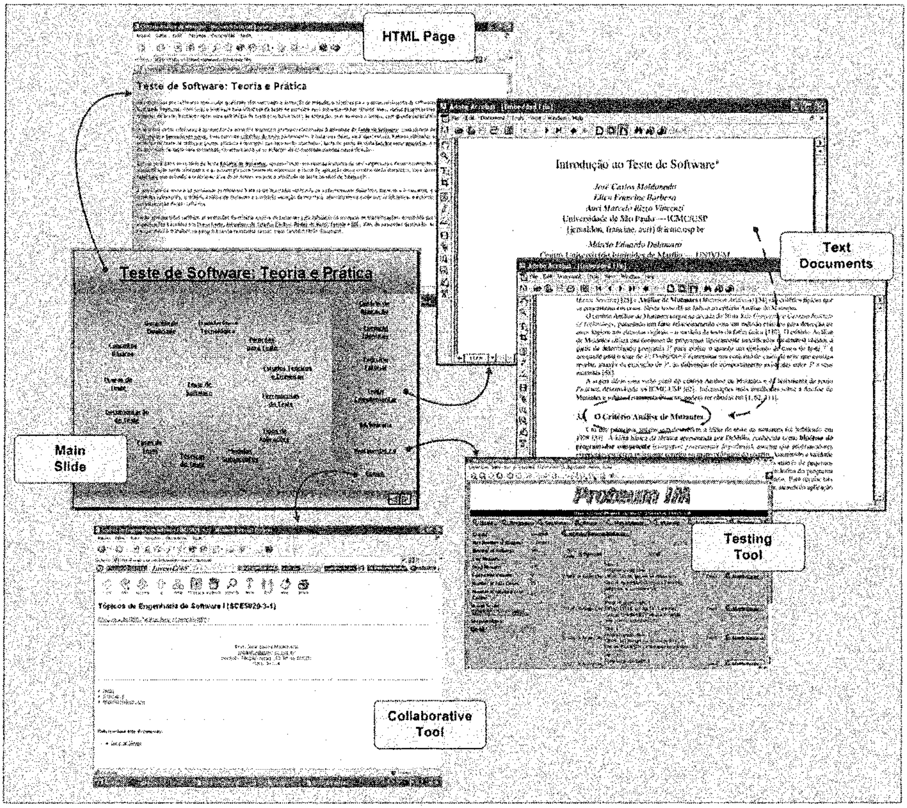

Figure 2. Educational module for software testing

Consider, for instance, the `MutationAnalysis` state. Besides the concept itself (`MA:concept:text`), some related facts (`MA:fact:text`) and principles (`CompetentProgrammer:principle:text` and `CouplingEffect:principle:text`) are specified too.

Consider now the MutationAnalysisDetails state. By exploring the notion of *DD* states, the MutationAnalysisDetails substates (OR_{DD} states) – MutantOperator, MutantGeneral, MutationScore, Application and ApproachesGeneral – are all connected to each other by implicit transitions, which are responsible for establishing the navigation paths among them. So, from MutantOperator we can get to the states MutantGeneral, MutationScore, Application and ApproachesGeneral (and vice versa).

We can also explore the idea of a hierarchy of *DD*-superstates. Consider the sequence (MutantGeneral, MutationAnalysisDetails, MutationAnalysisGeneral, ErrorBasedTechnique, TestingTechnique, SoftwareTesting TheoryPractice) as the hierarchy of *DD*-superstates of the Mutant state. According to this hierarchy, from Mutant we can reach all OR_{DD} states of MutationAnalysisDetails. To define the full set of states we can reach from Mutant, this analysis should be carried out for all states of the hierarchy. Notice we cannot get to the states AlternativeApproaches and ApproachesClassification from Mutant. Indeed, ApproachesGeneral does not pertain to the hierarchy of *DD*-superstates of Mutant.

Explanatory and exploratory elements were also represented. For instance, the concept of a mutant (Mut:concept:text) is illustrated by an example (Mutant:example:figure), which corresponds to an explanatory element. The exercise represented by the ApplicationMA:exercise:text state corresponds to an exploratory element, where mutation analysis is applied to test the factorial program. The required tools for doing the exercise are modeled too. The Coweb:tool state represents a collaborative environment (*CoWeb* [6]), used as a discussion space among learners and instructors. The ProteumIM:tool corresponds to a testing tool (*Proteum* [4]), used for applying the mutation analysis.

Besides the open specification, a *partially open specification* and a *closed specification* were also considered in order to define the didactic model for mutation analysis [1]. In a partially open specification, while some sequences of presentation can be established in "execution time", others are previously defined by the domain expert and/or the instructor during the development of the module. Instead of having just implicit transitions, the idea is to make some of them be explicitly represented in the didactic model. In a closed specification, all sequences are predefined, that is, just a fixed sequence of presentation is available in the module. In this case, the transitions are explicitly represented. Notice the sequences of presentation derived from partially open specifications and from closed specifications represent subsets of the total set of sequences established by an open specification. As highlighted before, a didactic model defined in terms of an open specification can be seen as the basis from which all sequences of presentation are derived. So, by using the didactic model illustrated in Figure 3, several implementations of the same content about mutation analysis can be obtained. This characteristic is essential to generate differentiated contents (and modules as well), whose topics, depth and sequences of presentation are established according to some particular aspects (e.g., course length, pedagogical goals, instructor's preference, learner's profile).

The decision on which kind of specification to use should be based on the users (learners and instructors) and on the expected characteristics of the module. One

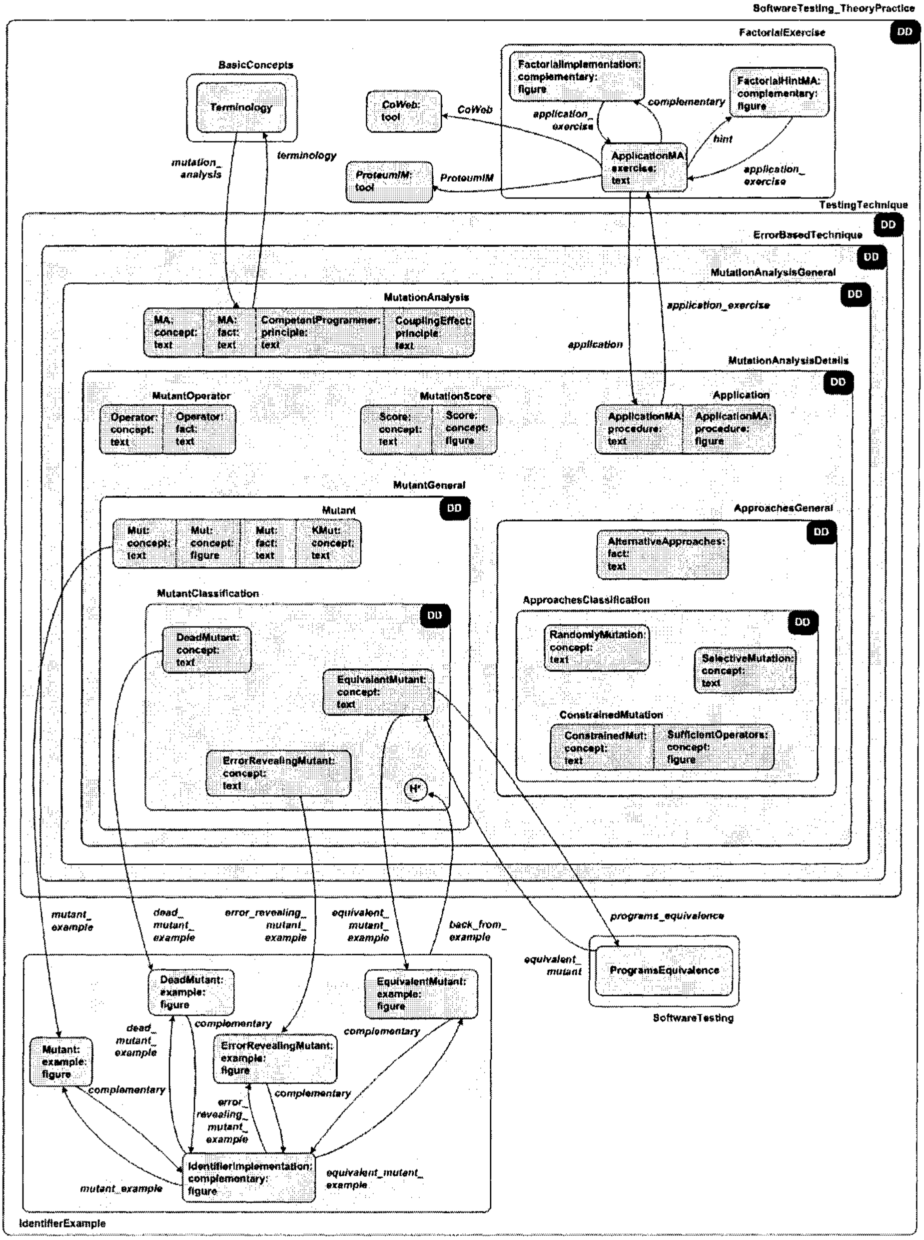

Figure. 3. Didactic model (HMBS/Didactic) for mutation analysis

strength of open specifications is the flexibility to navigate the material according to the feedback and questions of the audience. On the other side, the instructor has to make sure to achieve the objectives of the lessons in order to keep the learners localized. Indeed, while for less experienced instructors a closed specification (and implementation) seems to be the better choice, for the most experienced ones, an open specification would be an adequate alternative too.

5 Evaluation of the Educational Module for Software Testing

To provide a preliminary evaluation on the effectiveness of the testing module, we applied it in a three-hour short course on software testing for a group of 60 undergraduate students with some previous knowledge on software engineering. We focused on theoretical aspects of testing, providing an introductory perspective on this subject. Practical aspects were illustrated, but due to time constraints there was no direct participation by the audience. The effects of our approach were informally evaluated by applying a voluntary survey to the students after they had finished the course. The survey was composed of four sections, covering the student's attitude toward: (1) content, regarding the concepts, additional information, examples and exercises used; (2) usability, in terms of the interface; (3) navigational aspects; and (4) general aspects about the module. Sections 1, 2 and 3 were composed of objective questions while section 4 consisted of subjective questions.

Regarding the content, the students pointed out as positive aspects the way the module was structured and how it addressed the topics discussed. The connections between concepts were highlighted and the examples and additional information seemed appropriate. Regarding the proposed exercises, we noticed some expectation for practical tasks where the students could actively participate. Although practical exercises involving the use of testing tools had already been integrated into the module, the short time available in the course made them intractable in the context of the course. The results pointed to the need for more concise exercises that can be explored in this kind of course. In terms of usability, the schema of colors, the distribution of information through the pages/slides and the representation of the interface functions were, in general, well accepted by the students. Specific comments indicated some disappointment with respect to the size of fonts and figures. Regarding the navigational aspects, we observed a positive attitude toward the flexibility on choosing the sequence of presentation. Despite the large amount of information available, the students did not "get lost" in the module. Finally, aspects such as the instructor's energy, enthusiasm and objectiveness were also reported.

The results obtained provide some very preliminary evidence on the practical use of *IMA-CID* and its modeling mechanisms as a support to the development of effective educational modules. However, we highlight the need for conducting a more systematic and controlled experiment to validate our ideas. This experiment has been planned for the next term, involving three different courses on testing, offered to graduate and undergraduate students at ICMC/USP. Both students and instructors' attitudes toward the module should be evaluated.

6 Conclusions and Further Work

In this paper some mechanisms for developing educational modules were discussed and an integrated modeling approach (*IMA-CID*) was presented. Also, some points of the application of *IMA-CID* were illustrated by the development of an educational module for the testing domain. As further work, we intend to investigate the definition of supporting tools for the *IMA-CID* models. We are interested in automated tools for helping the interpretation and execution of the *HMBS/Didactic* model, providing mechanisms to simulate and validate executable specifications of the content. Tools for automatic content generation should also be explored.

Moreover, we are motivated to keep investigating the mechanisms we have proposed in future offerings of testing courses. In this sense, we are now working on the development of an educational module for the integrated teaching of testing and programming foundations in introductory CS courses [3]. Since our mechanisms can be applied to different kinds of domains, we are also interested in using them to develop and evaluate educational modules for other areas.

Another perspective is to explore the development of learning objects under the context of educational modules. The idea is to apply our modeling mechanisms to structure, store and retrieve the internal components of these objects. Further studies have also been planned in order to investigate the use of conceptual models on the development of domain ontologies and vice versa. Finally, at the very end we intend to establish a culture for "open learning materials", so that the use and evolution of them would be better motivated.

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Error Simulation in a Maturity Environment for Software Engineering Teaching

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Abstract. The software industry blames universities for their graduates lacking necessary skills, meaning that just the possession of knowledge does not necessarily imply the competent performance required by the profession. Professional maturity in software engineering is one of software industry's major needs and in-office training can not address this need as efficiently as university education can. This paper exposes the experience reached in a software engineering course in which students develop their software projects in a mature environment. The emphasis here is to use a tool inside a maturity environment that can simulate user errors when operating the software, so that students can learn how to prevent them in their software projects.

1 Introduction

In the last ten years, the software industry has been concerned with a maturity movement, dedicating a significant share of resources to worker training in quality models such as SEI-CMM, ISO, PSP and others. In Brazil, many software organizations implemented those models, but one of their main obstacles was the professional culture in which workers were not used to working in a quality environment and thus had bad habits that needed to be changed.

The software industry blames universities for their graduates lacking necessary skills, meaning that just the possession of knowledge does not necessarily imply the competent performance required by the profession. Bach [1] emphasizes the difference between what software engineers do and what they should do. Although most software engineering books are centered on methods, computer science undergraduate courses experience difficulties in teaching abilities and attitudes.

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There must be an effort for computer science courses to prepare their students for long term needs and non-technical skills, such as social, interpersonal, managerial and strategic skills. So these courses must teach cognitive, attitude and skill characteristics, which are considered the maturity characteristics for software engineering [2].

This paper exposes the experience reached in a software engineering course in which students develop their software projects in a mature environment. This is important because usually students make their projects as a non-experienced developer behavior. This way, they do not know the main kind of errors the user can make when operating the software. So this paper also presents a computer tool that simulates human performance under error, the S. PERERE, allowing students to put into practice errors that they did not know about, so that they can prevent them in their projects.

S. PERERE simulates human behavior during interaction with computer software. So this paper contributes to the possibility of minimizing the problems related to computer users and to the students' capacity for preventing human errors.

We believe that the simulator S. PERERE has a great potential to contribute to the studies of software development in a mature environment. This contribution is related to use the simulator, which prints out the several possibilities of human errors associated with some task. So the student can evaluate each possible situation and increase functionalities of his or her software, in this way permitting a better integration of the user with the software under development.

This paper is organized as follows: Section 2 describes the Maturity Environment; Section 3 describes the tool S. PERERE; Section 4 presents a project case and Section 5 presents the conclusions.

2 The Software Engineering Maturity Environment

Numerous studies address the software industry no-return path towards maturity through the establishment of software development processes [3] [4] [5]). This movement is strengthened by a global market requirement for quality in software development, not only as a means of establishing productivity and competitive advantages but in many cases as a safe means of exchanging software products within a globally distributed organization.

The 1990 decade was characterized by application of SEI's Capability Maturity Model in many software organizations in order to respond to the international tendency. Only recently, however, the SWEBOK – Software Engineering Body of Knowledge – definition process by SWECC has established the need to move software development quality and maturity from the level of training to the level of education.

Nonetheless, people have always been the fulcrum in a quality improvement process. Organization employees must be trained to understand the value of their cooperation and their responsibility in organization improvement, as training is an important issue in the quality improvement process.

In this direction, many software development organizations promote training programs so that their employees can access the necessary knowledge to engage in a quality improvement process. Software quality training intends to increase the employee's ability to develop his or her work in the organizational way, at the same time increasing efficiency and reducing rework.

However, employee training costs can become very high, and in some cases, especially for small companies, this cost can overwhelm the quality improvement effort. Considering natural personnel rotation at IT companies, permanently-offered training may be necessary. In some software industry centers competition is reinforced and personnel rotation is maximized.

Knowledge and practice in a mature environment is one of the desired professional characteristics in such situations. As a consequence, it is now important to change the inclination of computer science courses from just presenting software engineering concepts to presenting those concepts within a maturity environment, so that the practice of software development quality can be incorporated into these students before they are delivered to the job market. Educational organizations must quickly take the mature professional formation activity from industry's hands in order to provide the demanded professional profile.

Part of this project defined a pedagogical structure in order to permeate a computer science undergraduate curriculum with Software Maturity concepts. This pedagogical structure has been implemented and tested for 5 years by Begosso and Filgueiras [2]. The Maturity Environment definition started from the identification of learning objectives for cognitive, skill and attitude concepts, after evaluation of concepts embedded in SEI CMM, SWEBOK and also the requirements of the software industry as presented in software literature. SEI CMM's KPAs and SWEBOK's KAs have been scrutinized in order to identify the required concepts, which were mapped to related courses in a computer science curriculum.

In the beginning of this project, a broad literature review provided the desired profile for a software engineer, which unfortunately is not currently developed in computer science courses. Table 1 summarizes this profile, grouped regarding the significant learning objective categories.

Table 1 – Software Engineering Maturity Characteristics

Cognitive Characteristics	Attitude Characteristics	Skill Characteristics
SE Best Practices Documentation Project Management SE Methods Quality Standards	Professional Market Acknowledgement Professional Ethics Continued Education Humanistic Perspective Sociability	New Practice Adaptability Work Environment Adaptability Oral and Written Communication Experience in Maturity Environ. Software Engineering Tools Other's work maintenance Team Work

The Maturity Environment has been implemented in a controlled way, so that it would be possible to assess the change in student's maturity after this process. The assessment method should evaluate the student progress towards the characteristics in Table 1.

The evaluation mechanism is a 92-question form that is filled in by last term computer science students. The questionnaire explores cognitive, attitude and skill learning objectives, asking the student to evaluate his or her behavior when developing software engineering projects.

Each discipline inside the Maturity Environment must have its own learning environment which addresses its specific requirements. When developing their projects, students conduct work using a Spiral Model approach. So they plan, implement, test and validate. In the validatation phase, they use the tool S. PERERE, described in the next section.

3 Description of the Simulator S. PERERE

A simulator of human performance, developed by Begosso [6] and named S. PERERE, Simulation of Performance in Error, is a human behavior computational simulator whose main objective is to produce, in a random way, human error states. S. PERERE is a human action simulator that considers the error. Some important characteristics of the simulator are: it is possible to explore human error diversity under interaction with software; and human error is treated as an expression of human variability.

When developing their software, students must consider all possible kind of errors that can happen in the interaction between humans and software. Generally, only the most critical errors are considered or those that take the system to undesirable situations.

3.1 Behavior Units

The definition of a set of elementary behaviors is necessary to restrict the complexity of the human performance simulator. Berliner et al [7] suggested a taxonomy of elementary human behavior and defined a set of verbs to represent perceptive, cognitive and action processes.

The behavior units of the cognitive process were defined by authors as: *Calculate, Choose, Decide, Compare, Interpolate, Verify* and *Remember.* The behavior units of the perceptive process were defined as: *Inspect, Observe, Read, Monitor, Scan, Detect, Identify* and *Find.* Finally, the behavior units of the motor process were defined as: *Move, Hold, Push/Pull, Attach, Give, Remove, Discard, Give back, Position, Adjust, Type* and *Install.*

These verbs are implemented in S. PERERE as the set of possible human behaviors. Any task simulated by S. PERERE must be defined in terms of these verbs.

3.2 Human Error

Several attempts to define "human error" are found in the literature; however, it seems that there is no agreement among the authors on a unique definition for the term.

In this paper, we will use the definition proposed by Reason [8], who considers that erroneous actions include all situations in which a planned sequence of physical or mental activities failed to obtain a result and those errors can not be attributed to interventions of external causes. Reason [8] proposes that the erroneous actions can be of two kinds: involuntary and intentional actions.

Involuntary actions are those that deviate from planned intentions and, thus, don't reach their goals. This can happen in situations when the task, is done in an automatic way: someone misplaces a tool, for example. Those are named *slips* by Reason [8].

Intentional actions occur as planned and still can be considered as erroneous, if they fail in achieving the desired result. The task is performed consciously: the worker selects the right tools but is mistaken about the object to be repaired. Those errors are named *mistakes*.

From Reason's work, Begosso [6] implemented some human errors into S. PERERE, which will be considered in this paper: omission, repetition, inversion and perceptive confusion.

3.3 Specification of S. PERERE

S. PERERE has mechanisms to simulate several kinds of human behavior: it can represent knowledge to perform a task, to be aware of the environment and update its situation awareness, as well as to act on the environment. To reach this objective, it is necessary to use a cognitive architecture that is able to produce elementary human behavior and can be affected by errors.

Cognitive architectures are computational improvements of aspects inherent in the cognitive, perceptive and motor process of human beings. The architecture that supports S. PERERE is the ACT-R, maintained by the ACT-R Research Group from Carnegie Mellon University, used to help the development of intelligent systems.

S. PERERE is made of the trigger module, the disturber module and the pre-processor module. Data input to S. PERERE is a task description, composed of task elements from the Berliner et al [7] taxonomy that translate the correct (expected, assumed) behavior of a person carrying out that task.

Also, the initial state of the mental model is input to S. PERERE. This allows the system to recognize the starting point for the accomplishment of the task. Concerning the output, S. PERERE generates the task affected by the disturbances, as well as a list of disturbances that occurred.

A brief description of each module follows.

3.3.1 Pre-Processor Module

This module reads each part of knowledge stored in the system and understands it as a unit of elementary behavior, according to Berliner et al [7]. Moreover, the relation also enables the pre-processor to read the production rules to generate the task to be simulated in a syntactically correct way for the performance, in the conditions set forth in the cognitive architecture.

3.3.2 Trigger Module

S. PERERE's trigger module must represent the mechanics of triggering the error.

S. PERERE enables the user to configure the trigger mechanism by selecting one type of error for a specific behavior. For example, the error of omission may be selected for a typing behavior. This working option for S. PERERE establishes the random choice of knowledge from declarative memory, one which includes the motor process of typing, obviously, and results in the omission of said task step.

3.3.3 Disturber Module

The Disturber Module is responsible for simulating the task affected by errors. The module has mechanisms for simulating errors in perceptive and motor processes.

As soon as the disturber reads the disturbance chosen by the trigger module, it sends to the pre-processor the disturbance to be included in a certain behavior, and the disturbed task is output. In other words, one can say that the disturber generates erroneous situations that impact the simulated behaviors for performing the task.

For each error that is generated, S. PERERE creates a text file, syntactically correct from the point of view of the ACT-R language, to be run in the environment of cognitive architecture.

3.4 Error Specification

In order to understand the error generation in S. PERERE, a specification, in structured English, of the errors generated by the simulator, follows:

<u>Omission</u>

The disturber chooses at random one of the task elements and omits the production that would execute that task.

<u>Repetition</u>

The disturber chooses at random one of the task elements and repeats its execution.

<u>Inversion</u>

The disturber chooses at random one of the task elements and inverts its order with the immediately next element.

Perceptive Confusion

The disturber triggers the production rule after visualizing the object and selects the next element physically located next to the one visualized.

4 A Project Case

It was necessary to create some cases in which students develop software projects with the objective to evaluate students' maturity growth inside the maturity environment. This session presents an example where a student group developed a project under the rules of the environment and, at validation phase, they ran the simulator S. PERERE, which generated human errors over the developed software. The main result expected in this case is to observe if the students can see how user error can affect the execution of their software, and so how they can improve the quality of their products.

The project was a commercial system for product sales control and this example concerns an operation over an interface where the user must input data to the system and then press the "Confirm" key.

For this case, the simulator will generate two kinds of errors that the user could have undertaken: omission and perceptive confusion.

To illustrate the operation, we have considered the following simple task for the user:

i. The user verifies the initial interface for data input and presses the "New Record" key.

ii. The user types data for product code, name, and price.

iii. The user presses the "Confirm" key to write the new record on the database.

For the generation of omission in typing, the simulator chooses at random one of the typing information items for the specified task. In this case, it omitted the field name and verified whether the software developed by the students accepts this condition. If so, the students are advised about it and they make sure that all required fields are typed.

For the generation of perceptive confusion error, after typing all the required fields the user should press the "Confirm" key. However, the simulator tries to press a neighboring key that is activated. For example, if the neighboring key is "Delete", the user can make an error without wishing to do it. If so, the students are advised about it and make sure that only permitted keys are activated.

The two situations illustrated in this example indicate the presence of a latent error status in the software and contribute to the learning environment.

5 Conclusion

In the development of students' projects, it was possible to observe the generation of errors for the categories omission, repetition, inversion and perceptive confusion, which enabled students to learn about these errors and prevent them in their software.

The mechanisms created in this work have permitted the growth of students' software engineering maturity as intended. The evaluation method was successful in instrumenting this process and indicating that this growth is really happening, and more than that, has succeeded in pointing where changes must be made for the next applications.

Simulations generated over the example task, although very simple, allow us to think positively about S. PERERE's potential in generating errors on the simulated behavior.

The authors believe that this research contributes to creating an undergraduate teaching environment to form a mature professional for the software development process. The process is open and easily reconfigurable, so that it can be used in other disciplines.

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A Service-Oriented Infrastructure for Collaborative Learning in Virtual Knowledge Spaces

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Abstract. Classical knowledge production is an author-centered process. The emergence of cooperative internet technologies such as wikis or blogs shows a shift towards stronger cooperative production and communication of knowledge, closing the gap between readers and authors. The incorporation of such participatory mechanisms into CSCL/CSCW systems raises several new requirements. We present an open service infrastructure that provides an architecture meeting these demands, while integrating itself into a network of already-established services.

1 Introduction

The internet has evolved into an important means of global communication. Email and chat have become common tools of communication, already surpassing their analogue counterparts in some places concerning usage and popularity. Over a long time the web has also become a publishing platform. Hypertext documents have introduced new forms of textual and multimedial contents and structure. Moreover, digital media have enabled users to modify or annotate content within the media itself, overcoming a technological limitation of analogous media. Regarding the internet, this has mainly been an author-centered process, involving feedback or change of the content via interaction through separate media or through up- and download for interaction in separate client software. The emergence of new forms of collaborative publication (e.g., blogs and wikis) offers a different process of media creation and publication with the participation of the reader as an author or co-author. In addition to opening up the publishing process to a collaborative approach, the ability to work and communicate within the digital content medium in the location of its publication helps to avoid further media breaches. Users can modify

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or annotate media in place, overcoming the need to create and submit changes separately. This results in a more direct, easier and quicker means of creation, revising and publishing of common media content. The rapid spread and wide acceptance of these new technologies and processes also brings to attention a new phenomenon with relevance to computer supported cooperative learning: We are experiencing a shift from classical production of knowledge towards a stronger communication of knowledge, supported by technology.

A CSCL system based on the theoretical media functions model [1] supporting collaborative semantic structuring and linking of lecture materials and the production and integration of personal materials into a common knowledge structure enables students and teachers to evolve a simple document management base into an external memory. The ability to structure information from an individual point of view, meeting individual demands, allows the creation of an individual learning environment, adapted to the specific needs and desires of each student. Support for synchronous and asynchronous forms of communication and interaction can enhance the cooperative experience of users, but a persistent environment that can be structured by users themselves allows for location- and time-independent work. This enables students to cooperate with others while still being able to choose their own learning speed.

Support for a tight involvement of students into a common knowledge environment and the ability to structure, annotate or modify this environment imposes strong requirements on a CSCL platform. A concept for individual and common nodes of external memory must be developed. Our approach uses the metaphor of virtual rooms, persistent virtual knowledge spaces, to focus on the collection and structuring of, as well as the interaction with, digital media. To allow for enough freedom in the design of individual and common knowledge spaces, a form of self-administration for students is necessary, enabling them to organize their cooperation.

Taking this demand for communication of knowledge and a continuous, individual, non-disruptive cooperative work on media further, the need for a technological infrastructure for continuous work on digital media emerges. To satisfy this need with a strong focus on time- and location-independent collaboration, adapted to the users' needs, we have developed the sTeam server architecture.

The extension and integration of this architecture into open infrastructures for cooperative knowledge management is an ongoing process of our work. In this paper, we will describe our basic concepts, the server architecture and its integration into an open infrastructure for information technology systems.

2 Basic Concepts

We will first describe several basic concepts of an architecture for cooperative knowledge management and knowledge communication. In section 3 we will then present the technical implementation of such an architecture.

Virtual Knowledge Spaces

An architecture for continuous, time- and location-independent cooperation and learning must support the creation and structuring of individual environments as focal points for knowledge representation, structuring and communication. We are propagating the use of virtual knowledge spaces. These "rooms" are meeting places for users, containing user objects, documents and communication channels in one place [2, 3]. Rooms are nodes for synchronous and asynchronous communication and collaboration. Most importantly, however, they can be used for *continuous* cooperation, independent of location and time. This is achieved through persistent object storage and awareness mechanisms, both implicit (e.g., display of changes made to documents) as well as explicit (e.g., message boards). Rooms can contain links to other rooms, so-called "exits", but they may also contain further rooms, so that it is possible to create hierarchical structures of virtual knowledge spaces, as depicted in Figure 1.

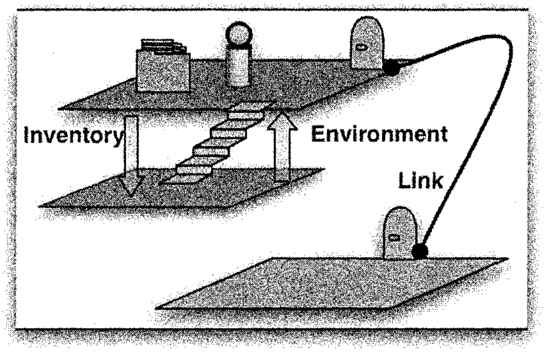

Figure 1 – Structuring virtual knowledge spaces as rooms

Customized Views

To fully exploit the possibilities of virtual knowledge spaces, it is necessary to provide differing, customized views of them. In addition to the common presentation of a room as a list of contents, different views of the same room can be created to match different usage requirements. An example would be a gallery view for a room containing mainly images. Besides the visual representation, views can also provide different interaction methods, e.g. a room where documents can be submitted by a certain group of users but afterwards can be accessed only by a different group. This allows for rooms acting as means for simple workflow mechanisms. Several different views of the same room, the same knowledge space, can exist simultaneously. To recall the example with a room for submitting documents, there could be a "student view", providing only a mechanism to submit or review the student's own documents, as well as a "teacher view" that shows all submitted documents and provides means for annotating and rating them.

With the vast amount of possibilities for document management provided by the system, user and group management, workflow mechanisms, etc., one of the benefits of customized views is to provide reduced functionality for each specific use. This centers the user interface on the task the user wants to perform, hiding data and interaction elements to provide a clear focus on the task at hand.

The web interface, however, can provide only limited means for collaboration, bound by the peculiarities of the HTTP protocol. Once a web page has loaded, there is no means by which the web server can notify the browser of any events, except when the browser requests or reloads a page. Tighter means of synchronous communication and interaction can be reached by client software not limited by the HTTP protocol. We will later describe an open protocol developed for the sTeam server, by which clients can interact directly with the server, allowing for applications such as chat or shared whiteboards.

User Management

The user management of a system with strong emphasis on individual and collaborative creation and structuring of knowledge must provide flexible means for self-administration. Users must be able to regulate who may or may not structure or modify their material. Self-administration requires that users can delegate access rights on rooms and documents, as well as administrative rights to others.

To achieve a clearer administration of access rights, users can be assigned to user groups, which can serve to define roles of access [4]. Groups have special administrator roles which can add, remove or invite users into the group.

This concept of self-administration requires a clear and flexible system of access rights. Access Control Lists [5], an established concept in the field of operating systems, can be applied to match this requirement. A list of various access rights for different users or groups is attached to each object, controlling usage options. Common access rights models of read, write and execute are not flexible enough for cooperative knowledge management and structuring. They need to be further differentiated into *read*, *write*, *delete*, *execute*, *insert*, *move* and *sanction*.

This enables users to regulate the right to change the content of a document (write), delete an object, insert objects into an environment or move objects out of an environment. This allows, for example, for virtual rooms where documents can be submitted by one group of users, then reviewed by another group and finally be moved to another location for publishing.

The sanction right takes a special role. It is used to allow users to assign rights to or remove rights from other users, thus forming the base for decentralized self-administration on an object-by-object or room-by-room base.

Objects inherit access rights from their environment. This means that when an object is moved from one virtual room to another, its effective access rights change. Users with access to the new location of the object now have access to the object, too. Inheritance of access rights can also be switched off for individual objects.

Figure 2 shows how access control lists and inheritance from environments can be combined. The group on the left has access to the folder because access rights are inherited from its workroom. Explicit permissions on the workroom to the right have been assigned to the user on the right-hand side. The group on the upper right has access to all the depicted objects and rooms. Their permissions from the access control list are inherited to the room on the left because of the room structure and to the room on the right because that room explicitly inherits the ACL.

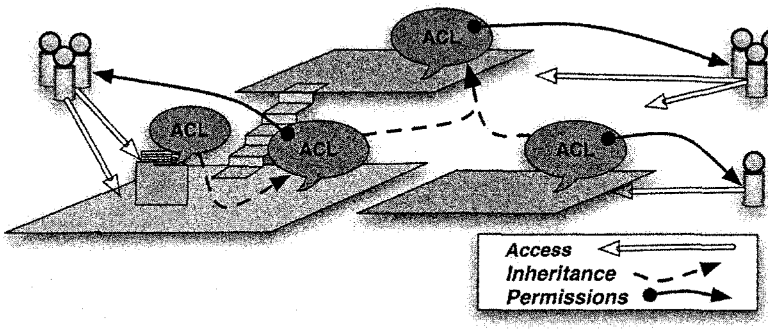

Figure 2 – Object-bound or inherited Access Control Lists

Open Infrastructure

When designing an architecture that is to be flexible, adjustable and at the same time deal with a multitude of digital media and their structuring and linking, it is useful to make it integratable into an infrastructure of specialized systems, ranging from administrative databases over communication channels to content servers. An infrastructure of open protocols for interaction with and between various systems can tackle this requirement.

Another aspect of an architecture that is centered on customized environments for individual users is the demand for support of the users' preferred tools and applications. Being able to use client software that users are already accustomed to lowers the need to adjust to new technology and greatly increases the acceptance by new users.

This approach of opening up to common interfaces also provides a basic level of integration with other established systems. Interaction with the server at this level is very specialized, centered upon the explicit purpose of each supported protocol. To support more generic and flexible modes of access opening up the whole functionality of such an architecture, an open protocol must be defined that provides remote object and method access, or in technical terms, remote method invocation.

3 Architecture

The sTeam server [6] has been designed with a microkernel architecture in mind [7]. This enables a modular approach where the base functionality is provided by modules and services, while the core kernel manages only interaction of its parts. The traditional way of storing all objects in a database has been extended through persistence layers, allowing for different object repositories for storage and retrieval.

One of the main goals of the server development was to provide users with various methods of access to the server, allowing them to connect with different, established tools that they were already accustomed to. This requires the implementation of open, standardized protocols that are supported by various client applications.

Interfaces

The most prominent of the modules dealing with network protocols is the HTTP (Hyper-Text Transfer Protocol) module, which enables the sTeam server to function as a webserver. In combination with an XML/XSL parser module, web pages can be dynamically generated from templates to provide different views on the same data. This is the mechanism used by the server to provide specialized views on knowledge spaces through web browsers.

With wikis becoming increasingly popular on the internet, we have established a wiki component, so that documents written in wiki syntax can be viewed, created and edited in the usual way. Since the main focus of wikis is the quick and easy collaborative editing of text documents, they seem like an ideal contribution to any CSCW system. Because of sTeam's focus on virtual knowledge spaces, we have extended the basic, flat structure of wikis in a way to facilitate the hierarchical structure of knowledge spaces [8].

Another feature that is gaining popularity on the internet is RSS (Really Simple Syndication) feeds. These are usually used as a standardized method for news feeds, though in sTeam every object in the object repository offers its own RSS feed containing a history of changes made to the document. This provides users with an additional means of awareness that can be accessed through established client software (such as email clients or web browsers). In addition, to publish content via HTTP the server also offers secure connections via SSL (Secure Socket Layer) to allow registered users to access an internal web view of the server, again with the option of specialized views.

Apart from HTTP, FTP (File Transfer Protocol) is the most common protocol for the up- and download of files in the internet. The more recent WebDAV (Web-based Distributed Authoring and Versioning) [9] is a common protocol for easier access to remote file repositories. WebDAV enables clients (often the file browser of the operating system itself) to access remote directories in the same manner as local hard disks. In addition to the easy use, WebDAV offers a file revisioning system. Both protocols are supported through kernel modules, so that established client software can be used to access the object repository just like a file server or remote file system.

Other modules provide SMTP (Simple Mail Transfer Protocol) and IMAP (Internet Message Access Protocol) support, so that the server is able to send emails and offer users access to messages received in sTeam. Since these are open, standardized protocols, arbitrary email readers can be used to access the server, meaning that users can use software they already use in everyday work. Every user's and group's name also functions as an email address on the server, so that emails can be sent to single users or to groups, forming simple mailing lists without any additional administrative work [10]. Even knowledge spaces and documents in the object repository function as email recipients. Emails sent to documents are attached as annotations, while emails sent to knowledge spaces place their attachments as new objects into the knowledge space. Likewise, IMAP access to knowledge spaces provides access to the objects stored within.

Synchronous Collaboration

The possibility of using established software for interaction with the server certainly is a great benefit for users, since they are able to use programs they are already accustomed to. However, none of these programs offers support for synchronous collaborative work. To accommodate for this, we have developed Java-based client software, the shared whiteboard.

The shared whiteboard client provides a two-dimensional, spatial view on knowledge spaces. In addition to the location of objects within the virtual environment provided by the server through rooms, containers and links, the shared whiteboard provides a view on rooms where their contents can be arranged two-dimensionally. As on a real whiteboard, text, lines, boxes and other graphical primitives can be used to augment the arrangement. The emphasis of the shared whiteboard clearly lies on synchronous cooperation. In addition to a list of users who are currently in the same room (no matter if through the shared whiteboard client, the web interface, IRC or another client) and a chat channel for that room, the interaction with the whiteboard is immediately visible to other users in real-time. If one user moves objects on the whiteboard, this movement is immediately displayed to users currently connected to the same room via the shared whiteboard. Chat messages written in the whiteboard also appear on the web based java chat or external chat clients and vice versa.

To make the spatial arrangement available to users not working with the shared whiteboard, we have created a new web interface view that displays the spatial arrangement as an SVG (Scalable Vector Graphic), a standardized graphics format that is supported by web browsers or web browser plugins.

Extensibility and Connectivity

The sTeam server offers a variety of external interfaces in the form of different network protocols. In addition to the kernel modules, which are closely integrated into the server core, the sTeam server offers a more high-level means of direct interaction with the server functionality: the COAL protocol (Common Object Access Layer). In comparison to middleware like CORBA, COAL is a lightweight protocol that provides remote method invocation and object access on the sTeam server. Implementations of COAL are available in Java and C++. There is also a simple PHP API with support for sTeam interaction, so that web-interfaces can also be written in HTML/PHP and hosted on a dedicated web server while using a sTeam server as a CSCW backend.

Implementing server extensions as separate services instead of kernel modules allows for greater stability and flexibility. Services run as client programs on the same or a remote machine, not sharing memory or other resources with the core server. Since service communication is usually asynchronous, they cannot block the main server. A search function is an example for such an external service.

To allow for easier extension of the server through standardized means, we are currently developing a service that provides access to the server's functionality via SOAP, the standard protocol for web services [11]. SOAP encapsulates remote procedure calls over a standard HTTP or HTTPS connection in a platform and programming language independent manner. Web services contain a self-description of their functionality in an XML-based form (WSDL -- Web Service Description Language) that can be obtained and interpreted by clients or other services. There are even some approaches to tie semantic information into the web service description to allow web services to automatically find services that provide a desired functionality and use them.

There are already a number of integrated development environments that can create wrapper classes for certain programming languages from the WSDL data of web services, reducing the complexity of their access to simple high-level remote procedure calls. This, and the increasing prevalence of SOAP-based web services and tools, will certainly simplify the integration of external services into sTeam and of sTeam into established infrastructures. For example, we are currently developing a Java-based service that interacts with a SOAP-based web service of the university library. It enables a transparent integration of literature references and electronic media provided by the library into the object repository of the sTeam server. The documents themselves are not copied into the repository since the electronic archives of a library have different demands and capabilities than the object repository of a CSCW server. However, the documents and references can be accessed transparently through the service, as if they were part of the repository itself. Another prominent example of web services that could be integrated are the SOAP-based services provided, for example, by Google, Amazon or Ebay.

Figure 3 illustrates the interfaces of the sTeam architecture. Web pages for browsers can be provided directly by the sTeam web interface or by the PHP interface on an Apache web server. The WebDAV protocol allows direct access to the object repository. Various client applications for email or chat can connect to the server via standard network protocols. The COAL protocol allows for complex operations on server objects. A more flexible approach is the SOAP protocol that is supported by a Java-based service placed, for example, in a Tomcat web service container.

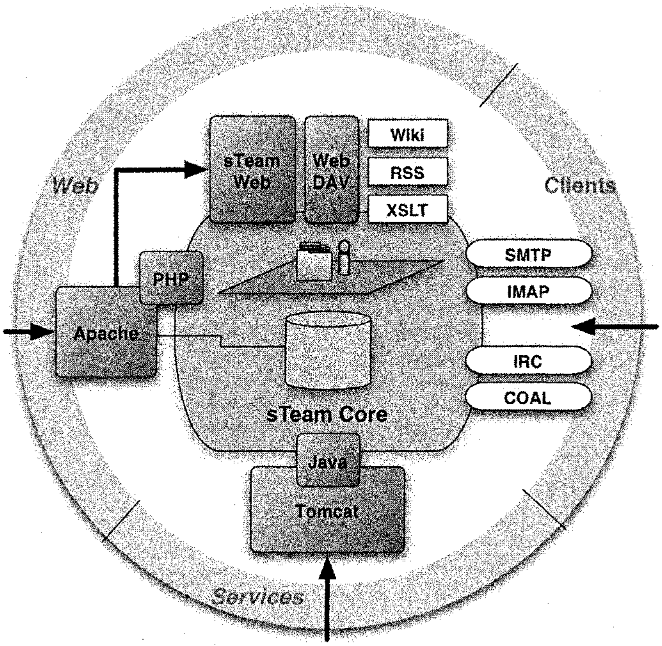

Figure 3 – sTeam service architecture

4 Conclusion and Outlook

In conclusion, the sTeam server has proven to be a solid platform for cooperative learning and working. There have been several evaluations of its practical use in several university lectures and projects [12].

Our current research topics deal with the integration of different information technology systems into a common, flexible infrastructure. We are in the process of fusing the heterogeneous systems at the university, ranging from user directories, administrative platforms, examinations office and email account servers over content management systems, web servers and CSCW/CSCL servers to electronic library archives. Just as we integrated several open, standardized network protocols into sTeam to allow users to keep using their favorite client applications, our vision here is not to replace the various established systems with centralized, monolithic server software, but rather to create an open infrastructure that interlinks the functionality of its specialized components.

Our vision for the next generation of sTeam is an open system that is part of an open, service-oriented infrastructure. User authentication will be valid across servers, and objects can be accessed independently of their physical location. Established servers provide their specialized facilities transparently, augmenting objects with additional functionality.

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Applying New Educational Models in ICT Teaching and Learning

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Abstract. This paper presents a group of elements to improve the teaching and learning in technological education, applied to Information and Communication Technologies (ICT). These elements are based on some contributions issued from contemporary education models, namely, the *thematic approach*, *meaningful learning*, *concept maps* and the *spiral curriculum*. Based on a *thematic approach*, a new way is proposed to select the contents that will be explored in the educational process. We emphasize the benefits of a *thematic approach* in students' motivation. After contents are chosen, we propose the use of the directives of *meaningful learning* and *concept maps*, as a method and a tool, respectively, to organize knowledge hierarchically, from general and inclusive concepts to the specific ones. This may facilitate the learning and understanding of the great bulk of knowledge to be covered in technological courses. A proposal has been submitted for a teaching module in ICT. The *spiral curriculum* was applied during the development of learning, where some fundamental concepts were introduced many times over, increasing more details gradually. A qualitative analysis of the application of these educational proposals, including learning evaluation aspects, is also presented.

1 Introduction

In technological courses the curricula are generally organized by following the classical structure of the programmatic contents of a domain, using a textbook as the main didactic material.

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The rigid use of textbook material and its high complexity and great diversity of content does not motivate students, as it imposes great difficulties on them in the understanding of concepts and how to relate the topics being studied with real applications.

Furthermore, in areas with a continuous change of technological content, as with information and communication technologies (ICT), another problem is the difficulty in selecting and organizing the knowledge to be taught. On the one hand, new knowledge has to be added to the curriculum constantly, and at the same time any other knowledge becomes obsolete. On the other hand, content has to be organized and ordered, relating every concept to others, which is not a trivial task because of their number and how often they change.

With the aim of dealing with these questions, this paper presents a group of elements to improve teaching and learning in ICT education. These elements are based on modern educational models, namely, the *thematic approach*, *meaningful learning*, *concept maps* and the *spiral curriculum*. The second section presents the methodological basis of these educational contributions. The third section presents a set of guidelines to select and organize the content of technological courses. Based on these guidelines, a proposal has been submitted for a teaching module in ICT, which is presented and discussed in the fourth section. Finally, the conclusion presents a qualitative analysis of the application of this educational proposal.

2 Methodological Considerations

This section presents educational models used as elements to improve the teaching and learning of technological education. The models considered in this work are the *thematic approach*, *meaningful learning*, *concept maps* and the *spiral curriculum*.

2.1 Thematic approach

The *thematic approach* was introduced by Freire [1][2] and made some important contributions to the educational process. Although working with alphabetization, his ideas have been applied to general education, including also educational science [2]. According to Freire, learning activities must be developed around *generative themes* that are part of the students' cultural environment. These *generative themes* increase the students' motivation and allow them to extend their knowledge about the subject, including social and political factors, which can contribute to the production of complete professionals and citizens with innovative and critical minds. This work is positioned in this context.

According to [2], the attraction of the new technological systems and the discussion of the relationship between technology and society are two important requirements in the selection of the *generative themes*. For these authors, the *generative themes* present a "rupture" in the way the curricula have been elaborated, which are, normally, strongly based on content and organized in a rigid and

[2] Most books of Freire have been translated into English; see `www.paulofreire.org`.

systematic way. In a dynamic domain, with a lot of changing content, as in technological courses on ICT, the use of *generative themes* is a good criterion for helping in the selection of content.

In a domain related to ICT, the *generative themes* can be issued from applications that people commonly use, like the Internet or mobile systems. For example, to teach computer networks, some Internet applications present in home or working situations match the requirements to be selected as *generative themes*.

Mobile systems and the Internet, their relationship and social consequences, have to be considered as starting points in order to learn about telecommunications and digital convergence, since a new way of life is emerging in all countries, with social inclusion as an important requirement, mainly in developing countries.

2.2 Meaningful learning and concept maps

The concept of *meaningful learning* was first presented by Ausubel [3] and can be considered as a pedagogical theory for classroom learning, which explains how the students learn and understand the formal knowledge that is received in school [4].

For this model, the learning occurs when new information is obtained from a planned effort by the learner to link this information with some relevant concepts already existing in his/her cognitive structure. To accomplish this task, the suggestion is to start learning from more general and inclusive concepts and then to go towards the more specific ones.

When translating this kind of learning into practical terms, one important task is to determine the *conceptual structure* of the domain to be taught. In other words, we have to identify the underlying concepts and principles of the domain and organize them hierarchically. Afterwards, this *conceptual structure* can be used to lend the learning an optimal sequence.

Concept maps, developed by Novak [5-6] in a sequence of research on *meaningful learning*, help in this task. *Concept maps* are a kind of graph used to represent the relationships among a group of concepts. A concept can be associated with each node of the graph. The labeled links between nodes show the relationships among concepts. The links are read from top to bottom, or, if there are arrows, following them. Figure 2 is a simple example of a *concept map* describing a computer network.

In this representation concepts are organized in a hierarchical way, with the most general and inclusive concepts at the top and the more specific ones below. However, for a concept corresponding to a node, it is also possible to build another concept map with the objective of refining it (in section 4, Figures 2 and 3 exemplify this situation). Other characteristics of a concept map are the cross-links that interconnect concepts in different regions of the map. For example, in Figure 1 there is a cross-link relating the concepts "Host" and "Network Applications". Examples can also be included in the map in order to clarify the meaning of a specific concept, as in the examples of "Network Applications" (FTP, WWW, Email) in the same figure.

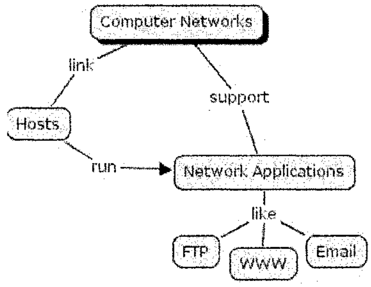

Figure 1. A simple *concept map* describing a computer network.

To construct "good" *concept maps*, Novak proposes some directives, described in [5]. Computational tools, like CmapTools [7][3], which we used in our work, also enable the construction of concept maps.

The use of *concept maps* has increased in recent years, in particular in educational activities[4]. One of the main uses is in curriculum planning. In this activity the *concept maps* help clearly build and present the content organization and relationships between different parts of the course.

Concept maps can also be used during the development of learning in the classroom. They can be used, for example, as a knowledge organizer to introduce a topic or to synthesize a lecture by integrating different concepts discussed earlier. Sometimes, they are also used as learning and evaluation tools, with the students constructing their own maps of the topic they are studying.

In any discipline related to ICT there are many complex concepts and technologies linked in an intricate way. So, tools like *concept maps* can be of great assistance in organizing and structuring the knowledge. They can identify the general concepts prior to instruction and assist in the sequencing of learning in a progressive way, from general to more specific and explicit knowledge.

2.3 Spiral curriculum

From the same epistemological foundations of *meaningful learning*, Bruner [8] concluded that learners acquire new ideas or concepts mainly from their past knowledge.

For this educator, a way to guarantee that the present learning will be useful in the future is learning the *base structure* of the topic in hand. Getting the base structure consists in understanding the stable and fundamental concepts which underline the topic and that can be related to many other things or situations.

Bruner proposes, during the learning process, to return to the *fundamental concepts* many times when following a *spiral curriculum*. The idea is to explore the concepts repeatedly, increasing each time their depth and detail.

[3] Cmap Tool is a tool to construct *concept maps* of the Institute for Human and Machine Cognition, USA. `http://cmap.ihmc.us`

[4] As we can see in the *Proceeding of the First International Conference on Concept Mapping* (CMC2004), Pamplona, Spain. `http://cmc.ihmc.us`

In a dynamic and changing domain such as ICT, our proposition is to use the *spiral curriculum* during the development of learning, to assure a full learning of *fundamental* and *lasting concepts*. These concepts are important to understand, for example, not just current but future technologies as well.

3 Guidelines to select and organize content in technological courses

From the educational models presented in the last section, we recommend some guidelines to help in the selection and organization of content in technological courses.

We propose three steps to be followed by teachers, after the scope of the course has been defined:

1. Set the bounds of knowledge to be taught by using a *thematic approach*;
2. Identify the most *fundamental* and *lasting concepts*;
3. Organize hierarchically the knowledge according to the *meaningful learning* model and modeling it by using *concept maps*.

To set the bounds of knowledge we propose the use of *generative themes*, as the *thematic approach* suggests. The domain to be taught defines the context in which to identify and choose the *generative themes*. These are tools or applications normally used by the students, which can be technological products of the domain. For example, as mentioned in subsection 2.1, the Internet and mobile systems can be chosen as a *generative theme* in the ICT domain.

The *generative theme* is used as a vehicle to teach the underlying concepts of the domain to be studied. The first benefit of this approach is to increase the students' motivation, working with material and applications used by and familiar to the students. Another benefit is the possibility of extending the discussion to subject matter relating to the dynamic between technology and society, increasing the students' general knowledge and preparing them for professional life.

After choosing the *generative theme*, the second step of our proposal requires that the teacher determine the scientific and technological knowledge essential to the understanding of the theme. This time, all the fundamental and lasting concepts must be carefully defined. It is important to observe that not all the contents normally considered in a traditional approach are taken into account when we use a *thematic approach*. The *thematic approach* makes a kind of cut in the group of contents, keeping those related to the theme chosen. Regarding this cut, we consider the full understanding of fundamental concepts more important than studying all the traditional contents extensively. A student who understands a real system or technology well, including all its fundamental concepts and also the aspects related to the impact of this technology in society, will be well prepared to understand any new technology in the future.

The next step is to organize the knowledge hierarchically, by using the directives of *meaningful learning*. For this particular context, the *fundamental concepts* could be listed, and then, from this list a rank order could be established from general and inclusive concepts to the more specific ones, allowing the building of a kind of hierarchical tree.

Finally, the modeling of this knowledge can be made by using *concept maps*. The arrangement constructed previously is helpful in starting the modeling. Now, each particular concept must be related to its parent using a word or a sentence that characterizes the relation. Concepts in different parts of the map under construction can also be interrelated, forming cross-links. As almost all concepts could be related in different ways, we must be judicious in choosing the meaningful cross-links we desire. During the construction of the model, we can also refine a concept in a new map, forming a three-dimensional hierarchical structure.

The resulting knowledge model, formed by the collection of concept maps, can be used for teaching planning, establishing an optimal sequence to develop the content.

To complement these guidelines we also propose the application of *spiral curriculum* during the development of learning in the classroom. The recommendation is to explore the fundamental concepts many times over, going deeper and detailing each time.

The next section describes an application example of these guidelines for a teaching module in the ICT domain.

4 An ICT Application: a teaching module on computer networks

This section describes an application example of our proposal, which was implemented in a teaching module on computer networks in the Federal Center of Technological Education of Santa Catarina, in Brazil.

4.1 Building a knowledge model for computer networks

The pre-defined scope of the considered teaching module consists of a general computer networks course for industrial engineers, including topics such as network services, protocols, architecture and applications.

Different from classical computer networks courses, our *thematic approach* used the Internet applications as a starting point in order to structure the course. All the technical contents of the teaching module were directly obtained from these *generative themes*. The objective was the construction of a structural vision of the Internet, which would include the Internet protocol architecture and its related technologies such as accessing networks, local area networks and wireless networks.

Figure 2 illustrates a *concept map* built from the chosen *generative themes*. In this figure, the labeled link "use vision" points towards classical Internet applications, the link "structural vision" towards layers of Internet architecture. The link "access networks" points towards local area networks and technologies for "last mile" access. Some cross-links were also included in the concept map, showing the relationship between concepts, in particular, relating specific concepts and technologies with the "layers" of Internet architecture.

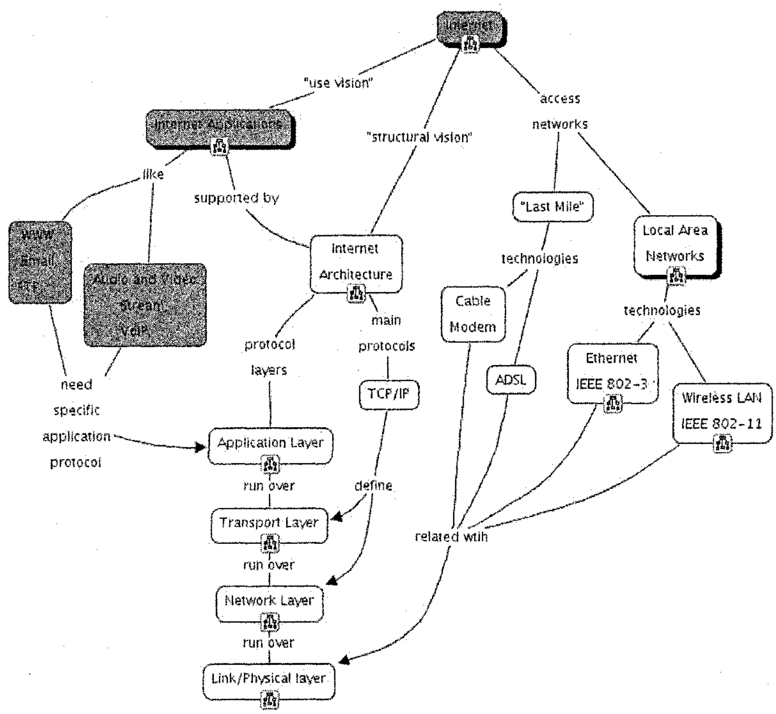

Figure 2. Concept map built from generative themes about Internet.

In the concept map representation, the icons under a concept mean that another map details this concept. As represented in Figure 2, the main concepts and technologies related with the Internet were refined and modelled with other concept maps. For example, Figure 3 details part of Figure 2, corresponding to the organization of the "Transport Layer" of the Internet architecture.

To construct this knowledge representation we considered the classical knowledge of computer networks that supports the Internet and then we organized the concepts from a general to specific way. The complete knowledge model used during the development of this teaching module makes part of a Web environment[5], presented in [9].

4.2 Development of the teaching module in the classroom

During the development of this teaching module in the classroom, two educational activities were included in the course, aiming to introduce the *generative themes*. The first activity was related to a "use vision" of the Internet applications. The objective was to motivate the students and show how useful the network applications were in improving their daily task management. Some laboratory activities were carried out, involving the use of applications like WWW, FTP, Email and remote

[5] See http://www.sj.cefetsc.edu.br/~cantu

login. The second activity was related to the impact of the Internet on contemporary society, researched by the students on the web, and the organization of a classroom debate.

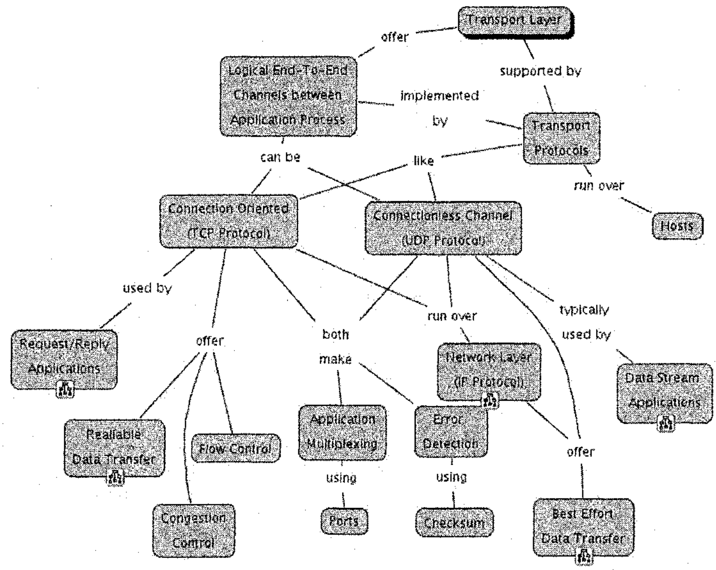

Figure 3. Internet "Transport Layer" organization.

After these introductory activities, we used the previously built *concept maps* representing the knowledge of the Internet in the classroom in different manners: firstly, as an advanced tool to show the content organization and the relationship between different parts of the course; secondly, before the development of a specific topic to show the different concepts involved in the discussion; and thirdly, after the lectures to make a synthesis of the discussed concepts. By putting these activities in practice, the teacher provided and discussed the *concept maps* and the related content with the students.

The *concept maps* helped the teacher to orient his students to use Web materials and technical reports associated with network technologies. For example, when we discussed the "last mile" technologies (ADSL and *cable modem*), we used the existing concept maps and we requested that students carry out a Web search to complete them. We also furnished them with some materials, such as technical manuals of modems and equipments to be tested. The students worked in groups and we required that each group construct a *concept map* representation of the topics. Each group of students constructed its own *concept maps* and we evaluated these maps in a feedback instruction. In this case, we emphasize that the activity of constructing concept maps is a powerful learning tool.

The concept maps were also used as an evaluation tool, complemented by traditional evaluation activities. The *concept maps* built by students allow them to evaluate the understanding of each one and to get individual feedback. We verified that concept maps are very effective in identifying both valid and invalid thoughts held by students, improving the students' continuous evaluation and the feedback.

Although featuring the Internet, we emphasized the *fundamental* and *lasting concepts* of general computer networks, which allow the students to understand any other network technology. To consolidate the understanding of these fundamental concepts, we used the *spiral curriculum* model, presented in subsection 2.3. During the learning process, the main concepts of "packet switching", "protocol layers", and others, were developed many times, exploring them in more detail every time. For example, for the concept of "reliable data transfer", a very important concept used in packed switched networks, we first discussed the topic and its general meaning by using analogies (we used an analogy based on a postal purchase of an encyclopedia made of fascicles). After that, during the presentation of the Internet protocol TCP, we used some simple exchange message diagrams to illustrate how the protocol works. Finally, we dealt with the details of the TCP protocol, its reliability and congestion mechanisms, returning again and again to the fundamental concepts to be learned. The set of *concept maps* modelling the knowledge of computer networks helped us to reach the learning objectives and realize these activities.

5 Conclusion

This paper presented a group of elements to improve teaching and learning in ICT education, which is extensively detailed in [10]. Some modern educational models were applied. A *thematic approach* was used to select the contents to be taught, increasing the students' motivation. *Meaningful learning* and *concept maps* were used as a method and a tool, respectively, to organize knowledge hierarchically, facilitating the learning of the technological content. The *spiral curriculum* approach was applied to consolidate the understanding of *fundamental concepts* of the domain being studied. A set of guidelines to select and organize content in technological courses were proposed. An ICT application using our proposal was also presented and discussed.

We emphasize the benefits of *concept maps* to hierarchically structure the knowledge to be taught, explicitly showing how every concept is related to each other to make the whole, in opposition to the normal organization of textbooks with topics and subtopics, which does not facilitate the development of concepts in a general to specific way. Reinforcing the proposal of [7], *concept maps* and related "computational tools" allow a new educational model, putting into practice in a simple manner some pedagogical ideas that before presented difficulties.

Teachers can use these pedagogical elements in different situations. 1) To plan a course, applying the guidelines proposed in section 3 to select and organize content in technological courses. In the ICT domain, teachers can use the existing *concept maps* about computer networks, available on the Web, as a knowledge organizer to plan a course, or using computational tools such as CmapTools [7], teachers can also make modifications or construct new *concept maps*, following the *meaningful learning* model. 2) During the development of a course in the classroom, teachers can use *concept maps* as shown in section 4, eventually using *generative themes* or other examples to motivate the students, and apply the principles of *spiral curriculum* to consolidate the learning of fundamental and lasting concepts. 3) Teachers can also use *concept maps* as an evaluation tool, giving a continuous feedback on the learning process.

However, the success of any educational proposal depends on the teachers' initiative. There are no ready-made prescriptions. What we intend to do with this work is not to impose a method, but to offer teachers an aid to improve their pedagogical activities.

The environment presented in [9], with a previous set of *concept maps* about computer networks, is available on the Web, including Portuguese and English versions. We are also working to enrich this Web environment with other knowledge models and pedagogical materials.

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Media Stickiness and Cognitive Imprinting: Inertia and Creativity in Cooperative Work & Learning with ICTs

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Abstract. This paper attempts to build a bridge between the fields of Computer Supported Cooperative Work and learning in online communities. Of particular importance is their use of information and communication technologies. Each field has independently developed notions of inertia in the behaviour of users of these technologies. The notion of media stickiness is examined and related to that of imprinting in learning communities. Various suggestions are made of value to both fields and further research identified.

1 Introduction

The field of Computer Supported Cooperative Work (CSCW) has much to offer our understanding of the processes and possibilities for learning in communities using information and communication technologies (ICTs). While the traditional focus of distributed group work research has been in understanding how teams can work together and how to design better tools for them to do so, the tendency to focus on the outcomes and organisational goals rather than learning and conceptual goals has constrained the cross fertilisation of these fields.

This paper identifies one such area of fertile common ground and attempts to articulate the linkages and implications for understanding in both fields. In CSCW technology appropriation examines the basis for technology choice and adoption in virtual teams. Recently the concept of media stickiness [1] has emerged to account for the tendency of groups to stay with their early choice of ICTs. While in the study of learning in online communities the concept of cognitive imprinting [2] has emerged to account for the tendency for online learning groups to repeat early patterns of cognition.

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This study first outlines the notion of media stickiness in CSCW leading to considerations of cognitive development in learning. Secondly the discussion moves to an examination of interactive behaviours and resultant cognitive indicators through an analysis of the discourse from digital archives. Commonalities across the two fields of study are explored and directions for future research advanced.

2 Media Stickiness

Many industries are now global, some have manufacturing sections in one country, research and development, information technology and finance sections in others. With increasing fierce global competition and globalised workforces the need for effective methods for distributed cooperative work have never been greater and are bound to grow further in the 21st century. The field of Computer Supported Cooperative Work (CSCW) has developed to underpin best practices through examining effective interactions in teams and develop better understandings of the design of effective computer tools and of their use. While the advantages of using ICTs to support distributed work groups include speed of communication, flexibility and adaptiveness, the disadvantages include lack of trust, coordination problems and lack of shared background knowledge among others [1]. In a study of six engineering design teams, Huysman et al. [1] show the evolution of communication technology use through a protracted joint design project. The teams were made up of students from Michigan State University (USA) and Deft University of Technology (Netherlands) who were forced by distance to communicate by online means. The technologies included desktop video conferencing, email, chat, shared white boards, real-time integrated audio and video as well as application sharing, a shared file system, calendar and message board. In this qualitative study, the students were allowed to choose the type of tools with which they wanted to work.

The six teams exhibited distinctly different patterns and preferences for these ICTs. Moreover such choices were made early in the design project and remained the preferred practice throughout the design process. This habitual inertia in the use of ICTs was evident in one group who when shown how useful the shared whiteboard could be, returned to their original ICT choices directly thereafter. The authors termed this effect 'media stickiness' because the initial choice of technology was retained despite more useful technologies being available. The study does not quantify the extent of this effect but demonstrates it in the evolution of discourse and practice within the project teams.

A number of explanations are given for this by the authors. One is the lack of feedback about communication processes both internal and external to the team. Another is the deadline for completion that induced a lack of interest in experimenting with styles of communication. Still another is their lack of familiarity and comfort in criticizing one another and expressing their feelings about problems with the team's communication. Finally, the authors considered that gaining mutual agreement for such a change was simply too much effort.

The style of media use becomes so entrenched in the culture of teams that after a while it appears impossible to change it. Tyre & Orlikowski [3] suggest that after initial modification to groupware, the windows of opportunity for users to change the way the tools are used and configured is limited. This suggests path dependency in groupware use.

The media stickiness study is important for the better understanding of online learning communities and the role of student choice. After all, students in the 21st century will have a wide range of ICTs at their disposal. Hence should educators try to constrain this choice or find ways to influence good choice? This will become increasingly relevant both to formal online learning community design and informal but important communications between students.

3 Cognitive development in learning

There is still much to learn about the impact of computer technologies on human actions and cognitive performance. Research into the interactive behaviour and cognitive development in online learning communities is constantly seeking increased understanding. One study using asynchronous online discussion forums identified a number of findings which help to explain the cognitive behaviour of learners. Education for the 21st century requires an understanding of cognition and its relation to the technologies.

Interaction and collaboration are recognized as key ingredients in such environments [4]. However it cannot be assumed that learners automatically know how to interact and collaborate to achieve the desired learning outcomes. Educators must carefully build these experiences into the educational design. Later researchers [5-8] have added to these critical elements with a body of knowledge emerging that identifies additional elements and addresses how individuals learn with the technologies. With constantly emerging technologies educators face the predicament of which technologies are best suited to support the required learning outcomes and how to utilize these technologies which are evolving more rapidly than the pedagogies.

Due to a lack of pedagogical guidance about integrating technologies for collaboration and communication, educators are left with mounting dilemmas and confusion [9]. Currently, the corporate world drives much of the information economy and influences the development of information technologies. Educators require a greater say in the evolution of technologies that will equip students with the cognitive skills that make them successful lifelong learners. Technologies that support greater collaborative activities are emerging slowly, as educators push for more collaborative interactivity. One source for these technologies should be the field of CSCW.

4 Imprinting

Initial communication patterns have been shown to be powerful in determining subsequent interactive behaviours in the learning communities. In a recent study [2] an analysis of the impact of these initial communications has led to the notion of "imprinting" as a means of characterising the serially consistent cognitive behaviour of the students within discussion forums. The effects of imprinting then become a consideration in the formation of discussion forums or online learning communities. From a teaching and learning perspective this implies that the cognitive behaviours that occur in the early interactions therefore need to reflect the desired learning outcomes, if the discussion forums are to shift students cognitively.

In this study, the discourse analysis of 15 discussion forums (275 students) over 4 years and across 4 topics in a first year teacher education course showed consistency in communication patterns across the various topics in each discussion forum. These forums with an approximate size of 20 students provided an opportunity for students to research and discuss authentic and relevant topics relating to the use of technologies in the classroom. An example of the topics was "*In relation to the research literate what are the major issues surrounding the use of the word processor in the junior primary classroom?*" Within each forum students were divided into four smaller groups each of which then facilitated the discussion of one of the topics and presented a summary of the main issues in a face to face presentation. The students were required to respond with at least one 300-400 word contribution for each topic with topics posted at regular intervals throughout the semester.

An adaptation of Gunawardena, Lowe and Anderson's, Interaction Analysis Model [10] for examining social construction of knowledge in computer conferencing, provided a basis for developing an effective evaluative model for analysing archived discourse. Adaptations to this model drew on Garrison, Anderson and Archer's *Community of Inquiry* model [11] and Henri's five dimensions of learning [12]. This evaluative model (Table 1) supported an investigation of the discourse at three levels. The three types of learner orientations (social, individual and group) identified the interactive behaviour of the participants. The phases within each orientation characterised the cognitive activity, while the indicators within the phases showed the approaches to learning that were being adopted.

Table 1. A model for Social Behaviour, Cognitive Development and Interactive Analysis

S. Participation and social behaviour

S1 Individual disclosure
- S1-a Basic introduction.
- S1-b Extended revelation
- S1-c Self evaluation

S2 Social behaviour
- S2-a Courtesy
- S2-b Level of dominance/authority
- S2-c Seeking help
- S2-d Willingness to initiate

S3 Mutual Consideration
- S3-a Identifying mutual interest
- S3-b Willingness to exchange
- S3-c Valuing others' views

I. Cognitive behaviour analysis at individual level:

I1 Elementary clarification
- I1-a Observing/studying a problem
- I1-b Identifying its elements
- I1-c Observing/studying their linkages

I2 In-depth clarification
- I2-a Analysing a problem
- I2-b Identifying assumptions
- I2-c Establishing referential criteria
- I2-d Seeking out specialized information

I3 Synthesis and application
- I3-a Drawing primary conclusions
- I3-b Proposing an idea based on links and relevant information
- I3-c Value judgment on relevant solutions
- I3-d Making final decisions and deciding on the action(s) to be taken

G. Interactive behaviour analysis at group level:

G1 Planning
- G1-a Organizing work/planning group work/setting shared tasks
- G1-b Initiating activities/setting up activities for group work

G2 Sharing/comparing/contributing of information
- G2-a Defining and identifying a problem
- G2-b Stating opinions regarding the problem
- G2-c Asking and answering questions to clarify details of statements
- G2-d Sharing and exchanging knowledge, resources and information
- G2-e Corroborating examples provided by one or more participants
- G2-f Challenging others to engage in group discussion
- G2-g Help and feedback giving

G3 Inconsistency of ideas, concepts or statements
- G3-a Identifying and stating areas of disagreement
- G3-b Asking and answering questions to clarify the source and extent of disagreement
- G3-c Restating the participants' position and advancing arguments or considerations supported by references

G4 Negotiation of meaning/co-construction of knowledge
- G4-a Negotiating or clarifying the meaning of terms, areas of agreement and disagreement
- G4-b Proposing new statements embodying compromise and co-construction
- G4-c Integrating or accommodating metaphors or analogies

G5 Testing and modification of proposed synthesis or co-construction of knowledge
- G5-a Testing against existing knowledge and information
- G5-b Testing against personal experience
- G5-c Testing against formal data collected

G6 Agreement statement(s) and application of newly constructed knowledge
- G6-a Summarization of agreement(s)
- G6-b Application of new knowledge

Using the evaluative model cognitive indicators were recorded for each topic as well as their aggregates for each student against social (S), individual (I) and group (G) orientations. The data as illustrated in the figures below showed a strong level of continuity across the 4 topics in the individual and group aggregates and a weaker but still positive level of continuity in the case of social aggregates across topics based on the indicators from the evaluative model.

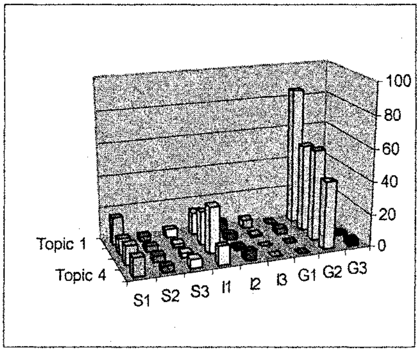

Figure 1. Group oriented forum

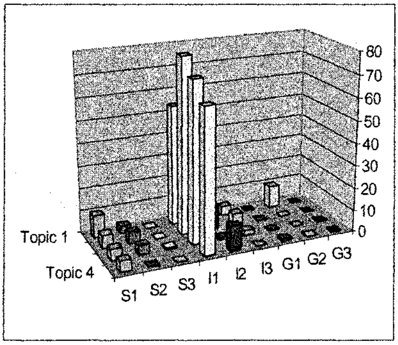

Figure 2. Individually oriented forum

Such analysis provided insight into the cognitive activity of the participants and identified two types of imprinting that were occurring over time, see Figure 3. In some instances one particular indicator may dominate the discussion (such as elementary clarification, I1 or sharing/comparing information, G2) which prevails across the discussion topics (Type A). In these cases the cognitive development remains static across the topics. 'Static' describes the process where there is little or no change in indicators over a period of time. Furthermore, students may demonstrate a set of cognitive indicators for each topic that are repeated for subsequent topics (Type B). Here students show an appreciation of differing cognitive strategies and knowledge acquisition for each topic. Their responses for each topic may demonstrate a cognitive movement through the indicators; such as starting with problem identification which progresses to analysis and the drawing of some conclusions. However, rather than furthering the development of learning approaches, students use the same set of indicators for each topic indicating a broader but static track.

It is helpful to consider the record of cognitive indicators in the course as a cognitive track which may be relatively straight and narrow as students focus on a particular learning approach, such as I1a, I2a or G2a, wavering very little in their approach to each topic (Figure 3). Alternatively it may be a broader track as students explore, investigate and interpret different approaches to knowledge acquisition. These two types of imprinting will be referred to as 'static cognitive tracks' where the cognitive engagement is consistent across the topics. Hence if the aim of the discussion forum is to have students analyse a topic showing cognition phases of say, I2 or G2, then imprinting will ensure that narrow track, Type A, occurs across the topics. However if the intention of the forums is to develop students' higher order thinking then an example of a broad track, Type B, should be evident. This may have implications on how technologies are used by the forums in their discussion. Such static tracks may be a goal of the educator.

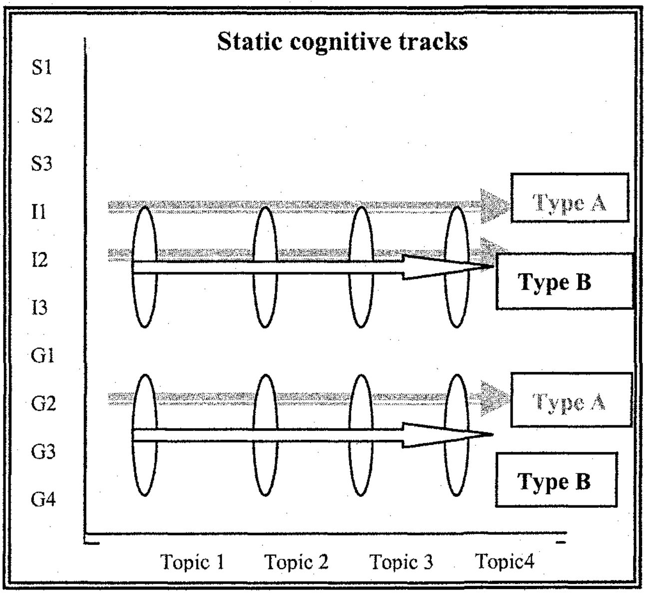

Figure 3. Imprinting of cognition across time

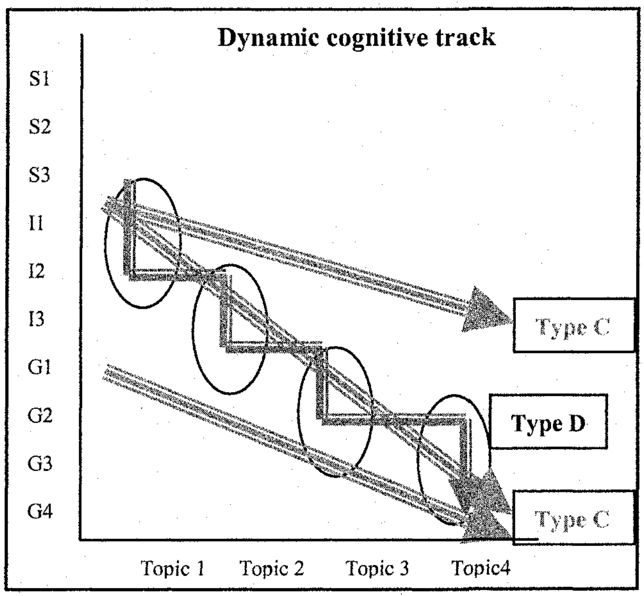

Figure 4. Progressive cognitive development through time

On the other hand, if educators wish to avoid imprinting because they desire students to move progressively rather than statically along various cognitive tracks, then factors that lead to imprinting must be counterbalanced.

The term 'dynamic cognitive track' suggests a change in the cognitive focus where students move through various indicators (Table 1) and perhaps to higher levels of cooperation or collaboration. Again in Figure 4 there are narrow and broad cognitive tracks corresponding to the breadth of cognitive indicators displayed at any one time by the learner.

5 Conclusion

The media stickiness study examined patterns of media use by engineering students as they communicated about a design project with multiple ICT options. The cognitive imprinting study established patterns of cognition in students communicating their understanding about specific topics with a single ICT (email discussion lists). Both demonstrate that the initial patterns can become established and difficult to shift. The imprinting study with its in depth examination of the cognitive concomitants of the discourse is able to reach a deeper level of analysis. Indeed it is legitimate to argue that if a group of indicators similar to those in Table 1 above had been applied to the discourse of the media stickiness study, it would have exposed the cognitive basis of the patterns of media use. The various explanations offered by the authors could then be put to the test. Such an argument would see inertia in both studies as being cognitive in its origins. Media stickiness then emerges as an aspect of cognitive inertia.

An examination of the limited excerpts from student in the media stickiness study suggests that there is a link been social relationships (S1-S3) and learner comfort in being able to express their criticisms. The movement over time between exhibiting simple problem solving to that of testing assumptions (I2a-I2b) would be relevant to such virtual teams and help uncover discrepancies in background knowledge and goals. It is notable that the Michigan students considered that the project was focused on building workable systems in practice while the Delft students were more interested in conceptual issues and model testing (G3a-G3b). It is important to ask whether the cognitive behaviour in the media stickiness study, and in virtual teams in general, is predominantly individual or of group orientation. The later more easily leads to creative cooperation than collaboration.

The use of a set of cognitive concomitants in CSCW might prove useful as an early warning system by giving indications that specific aspects of interactions are or are not occurring, just as it can in learning communities. Indeed both studies point to the focusing on the critical formative periods at the beginning of engagements where resources and interventions may have long term value. Use of such indicators can also help understand when the cognitive concomitants of creativity and original collaboration can be achieved.

This exchange between two disparate fields raises more questions than it answers. What are the best ways to subvert cognitive inertia and advance creative learning and groupwork? In what ways can dynamic cognitive tracks be quickly identified? What semi-automated processes, such as key phrase searches, could support identification of critical changes or lack of them in cognitive concomitants? Students in the 21st century will have much more experience of multiple ICTs. How will personal preferences and habits for ICTs clash with those of the work group or learning community? Can such a model of cognitive concomitants, designed to analyse email discussion, be robust enough to deal with white boards and other visual media? Are there ways to distinguish between cooperative and collaborative interaction in visual media? Indeed the nature of the cognitive concomitants that can effectively characterise interaction in such media is a vital question for the respective futures of both fields.

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Teaching Modern Heuristics in Combinatorial Optimization

The example of a demonstration and research tool employing metaheuristics in scheduling

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Abstract. The article describes the proposition and implementation of a demonstration, learning and decision support system for the resolution of combinatorial optimization problems under multiple objectives. The system brings together two key aspects of higher education: research and teaching. It allows the user to define modern metaheuristics and test their resolution behavior on machine scheduling problems. The software may be used by students and researcher with even little knowledge in the mentioned field of research, as the interaction of the user with the system is supported by an extensive graphical user interface. All functions can be easily parameterized, and expensive software licenses are not required. In order to address a large number of users, the system is localizable with little effort. So far, the user interface is available in seven languages.
The software has been honored in Ronneby (Sweden) with the European Academic Software Award 2002, a prize for learning and research software awarded biannually by EKMA, the European Knowledge Media Association (http://www.easa-award.net/, http://www.bth.se/llab/easa_2002.nsf).

1 Introduction

In numerous areas within computer science, engineering, and operations research, combinatorial optimization problems can be identified whose resolution are of high practical importance. Examples are the traveling salesman problem, knapsack problems, and scheduling and routing problems, to name a few. While the description and explanation of these problems is comparably easy, their resolution is

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not, and in many cases is even NP-hard [7]. Algorithms that have been developed for these problems include heuristics and more recently metaheuristics such as evolutionary algorithms, tabu search, and simulated annealing. These techniques solve an underlying problem through successive modification and improvement of alternatives until a solution is identified which cannot longer be improved.

When teaching the principles of modern heuristics, demonstration tools are particularly useful as they allow a monitoring of the intensive computations performed by the algorithm. In addition to theoretical explanations, the progress of the metaheuristics when solving a problem at hand becomes more visual. For students having to face the difficulty of understanding both the problem *and* the search algorithm, this is of great value in order to quickly progress in this complex field of science.

Numerous implementations of algorithms for combinatorial optimization problems have been made available on the World Wide Web. Prominent examples are:

1. The remote interactive optimization testbed RIOT [10].
2. The GA archives [13].
3. The more specialized EMOO webpage for multi-objective optimization problems [4].

The first example maintains a collection of software dedicated to the demonstration of algorithmic approaches for a variety of problems. It consists of web-based applications that visualize the described problems and allow a basic interaction of the user with the system. While the structure of the problems and the general ideas of the algorithm become easily transparent to the user, a further adaptation of the implemented methods is not possible as this is clearly not the idea of the testbed.

The other two examples of software collections bring together research oriented software packages that may be reused by fellow researchers. They comprise highly specialized as well as more generic programming code in a variety of programming languages. In order to be reused, a thorough understanding of the implemented techniques is necessary, and an adaptation of the techniques to particular problems requires in many cases a close examination of the source code. While this does not present a problem to rather experienced researchers, it limits its use in higher education to some extent.

Bringing together research and teaching is especially crucial in this context, as knowledge progresses at a fast pace. In an ideal setting, a system would be available that allows the user not only to study predefined algorithms but also to parameterize own settings and test them on individual problem instances. The current article describes the proposition and implementation of such a system. It is organized as follows. In the following Section 2, the general concepts of local search heuristics are reviewed. A system demonstrating the application of modern metaheuristics to scheduling problems is presented in Section 3, and conclusions and discussion are given in Section 4.

2 Concepts of modern metaheuristics

As sketched above, metaheuristics aim to solve optimization problems through successive modification/improvement of alternatives. While the general principles of the metaheuristics are rather simple, complex interactions of the parameter settings conclude from a variety of operators used within the search algorithms. The main concepts are here illustrated using the example of a flow shop scheduling problem with the data given in Table 1.

Table 1. Example of a flow shop scheduling problem

Job	Operations	Precedence constraints	Processing times
J_1	$\{O_{11}, O_{12}\}$	O_{11} π O_{12}	p_{11}=3, p_{12}=2
J_2	$\{O_{21}, O_{22}\}$	O_{21} π O_{22}	p_{21}=4, p_{22}=1
J_3	$\{O_{31}, O_{32}\}$	O_{31} π O_{32}	p_{31}=2, p_{32}=3
J_4	$\{O_{41}, O_{42}\}$	O_{41} π O_{42}	p_{41}=1, p_{42}=4

The problem consists of four jobs J_1, ..., J_4, each of them comprising two operations $J_j=\{O_{j1}, O_{j2}\}$ with given processing times p_{jk}. It is assumed that all operations O_{jk} have to processed on machine M_k. The objective of the scheduling problem is to find a schedule, assigning starting times S_{jk} to each operation O_{jk} such that a single or a set of objectives is minimized while all side constraints of the problem, such as the precedence constraints of the operations, are respected. A prominent example of an optimality criterion in this context is the maximum completion time (makespan) $C_{max}=\max(S_{j2} + p_{j2})$.

A closer examination of the problem structure reveals that a schedule may be represented as a sequence of jobs, which on the other hand can be transformed into a schedule by assuming earliest possible execution of the operations with respect to the given job sequence [6]. Figure 1 gives an example of the job sequence 1 → 2 → 3 → 4 for the problem instance of Table 1. The Gantt chart [16] of the schedule is produced by decoding the particular sequence.

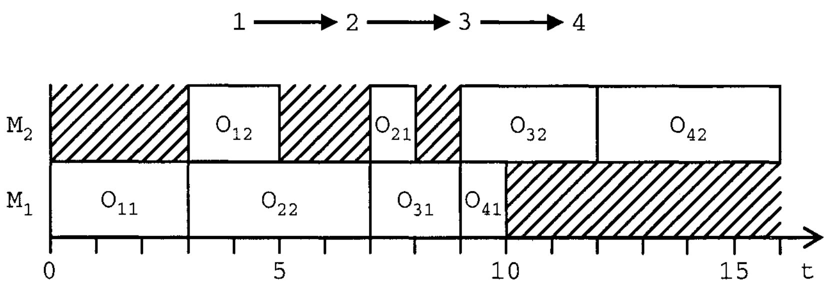

Figure 1. Representation (permutation) and corresponding alternative (schedule)

Metaheuristics work with representations of alternatives as described above, on which operators are executed that perform modification steps to generate new solutions. For the example of representing an alternative as a permutation, operators are used that modify this permutation in a particular way:

- Simple local search operators/mutation operators [12].
  - Forward shift operators, removing a job from position j of the permutation and reinserting it at position k, $k > j$.
  - Backward shift operators, removing a job from position j of the permutation and reinserting it at position k, $k < j$.
  - Exchange operators, exchanging the position of two jobs.
- Crossover operators, recombining the information provided by two permutations and returning two new alternatives on that basis [15].

Due to the limited availability of memory, some of the alternatives generated during search have to be discarded, leading to the necessity of a selection step in the process. Most metaheuristics consider in each step of the search either a single alternative or a set of fixed cardinality, to which sometimes is referred to as a *population*. Especially in the case of multi-objective optimization problems the heuristics need to be able to maintain a set of solutions as due to often conflicting objectives not a single optimal alternative exists but rather a set of Pareto optimal ones [5]. Archiving strategies of identified best solutions play here a particular role and add to the complexity of the search algorithms.

It can be already seen from the brief explanations above, that despite their simplicity, metaheuristics require an extensive setting of parameters. The correct choice of operators is crucial for the performance of the search algorithm, and depends on the problem as such as well as on the particular instance. Experimental investigations have been performed on almost any optimization problem, and approximate recommendations of how to configure a particular metaheuristic are available in the literature. In higher education however, an interactive demonstration of the resolution behavior is still useful as it allows the students to gather hands-on experiences with the algorithms. How such a system has been made available will be the content of the following section.

3 A learning and decision support system for scheduling

3.1 Components

A learning and decision support system for scheduling has been implemented, allowing the resolution of machine scheduling problems under multiple objectives. Its main components are given in Figure 2.

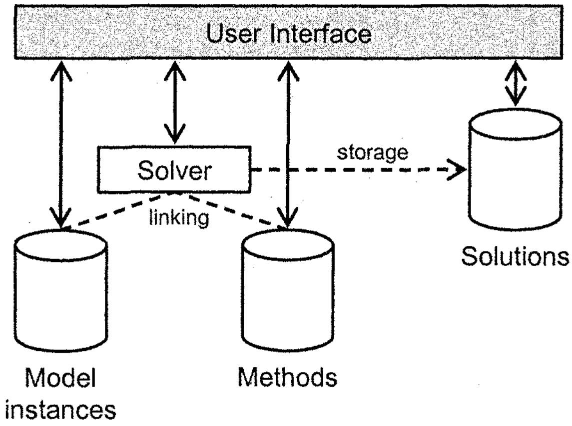

Figure 2. System architecture

The system already includes a database of scheduling benchmark instances taken from the literature [2, 3] while individual data sets may be created by the user, too.

A range of implemented metaheuristics allows the resolution of the scheduling problems. Model instances are linked to methods via a solver which also keeps track of the obtained results. Implemented methods include:

1. Priority rules [9], based on the early work of GIFFLER and THOMPSON [8] for generating active schedules.
2. Local search neighborhoods [12] within a multi-point hillclimber.
3. Multi-objective evolutionary algorithms [1], incorporating elitist strategies and a variety of crossover neighborhoods such as uniform order based crossover, order based crossover, two point order crossover, and partially mapped crossover.
4. The multi-objective simulated annealing algorithm MOSA of TEGHEM et al [14].
5. A module based on the aspiration interactive method AIM [11] for an interactive search in the obtained results.

The whole functionality is made available to the user through a graphical user interface.

3.2 Visual user interface

Both the interaction of the user with the models and algorithms, as well as with the obtained results is possible through a multilingual user interface. Figure 3 shows, on the left, the window allowing the definition of the problem data and on the right the window giving access to the functionalities of the metaheuristics. New configurations of search algorithms may be derived here and tested on the benchmark instances. Necessary parameter settings of the search algorithms can easily be parameterized by selecting the corresponding objects in the window and changing their attribute values.

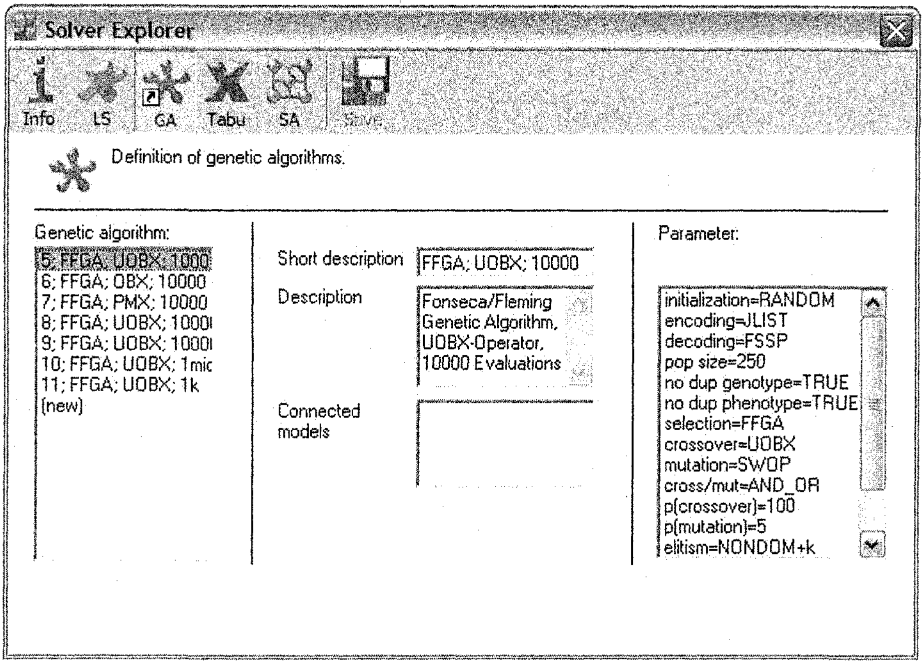

Figure 3. User interface allowing the definition of search algorithms

By providing a graphical user interface for the configuration of the underlying search algorithms, no source code needs to be written nor adapted or recompiled.

3.3 Problem resolution

After the definition of the parameters of the metaheuristics along with the model data, a solver executes the search algorithm on a problem instance and produces results that are stored in a database. It is possible to store split results obtained during search in order to monitor and analyze the progress of the metaheuristic depending on the amount of computations.

The visualization of the results is supported both in outcome and in alternative space:

1. A two-dimensional plot in objective space gives the outcomes of the best found alternatives. On the vertical and on the horizontal axis, one objective of the problem may be plotted at once. An example of such a visualization is given in Figure 4 on the left. Each schedule appears as an object in the outcome plot, with a position depending on its objective function values. The user is enabled to navigate through the plot by either selecting an alternative with the mouse pointer or following an interactive procedure based on the aspiration interactive method AIM [11]. In this procedure, aspiration levels are introduced for each objective function that narrow down the set of alternatives. Only solutions that fulfill the

aspiration levels given by the decision maker are considered to be of interest while the others are successively removed from the decision making procedure.

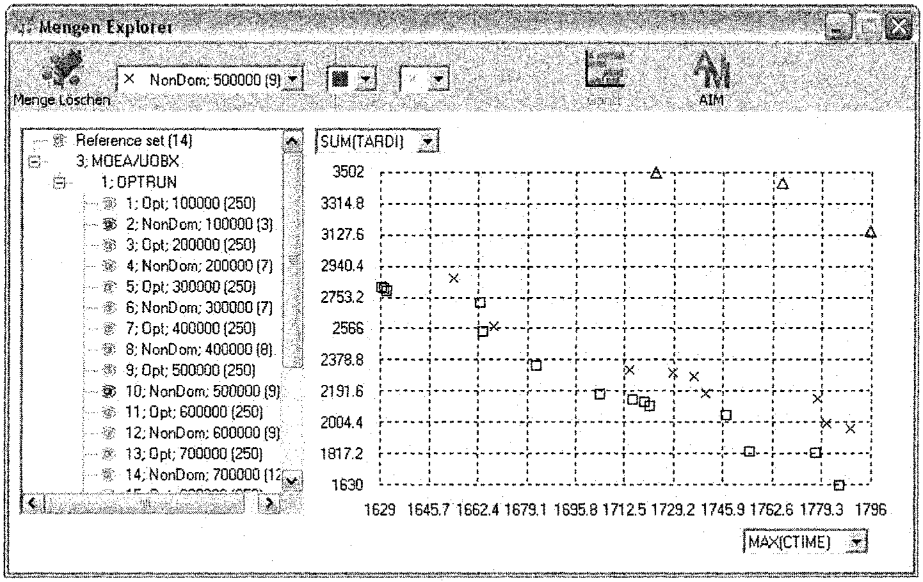

Figure 4. Monitoring the outcomes of a search run after 100,000, 500,000, and 1,000,000 evaluated alternatives. The different stages of the approximation are visualized in outcome space by means of different symbols

2. The second visualization gives a Gantt chart of a selected alternative. Figure 5 gives an example of a schedule. Here, the visualization is job-oriented, plotting the jobs and their corresponding operations in rows, but the orientation may also be changed to a machine-oriented chart. A detailed monitoring of the starting times of all operations is possible, and graphical indications of tardy jobs are given.

The outcome plot may also be used to analyze the progress of the metaheuristics and compare the results of different search algorithms. Figure 4 gives for a test run of an evolutionary algorithm the obtained approximations after 100,000, 500,000, and 1,000,000 evaluations. Each approximation is visualized using some symbol (e.g., $\times$) which may be changed by the user.

It can be seen, that the front of the approximation gets closer to the true Pareto front with increasing number of evaluations. Also, the number of identified alternatives and their coverage of the Pareto front increases, giving the decision maker more alternatives from which to choose from.

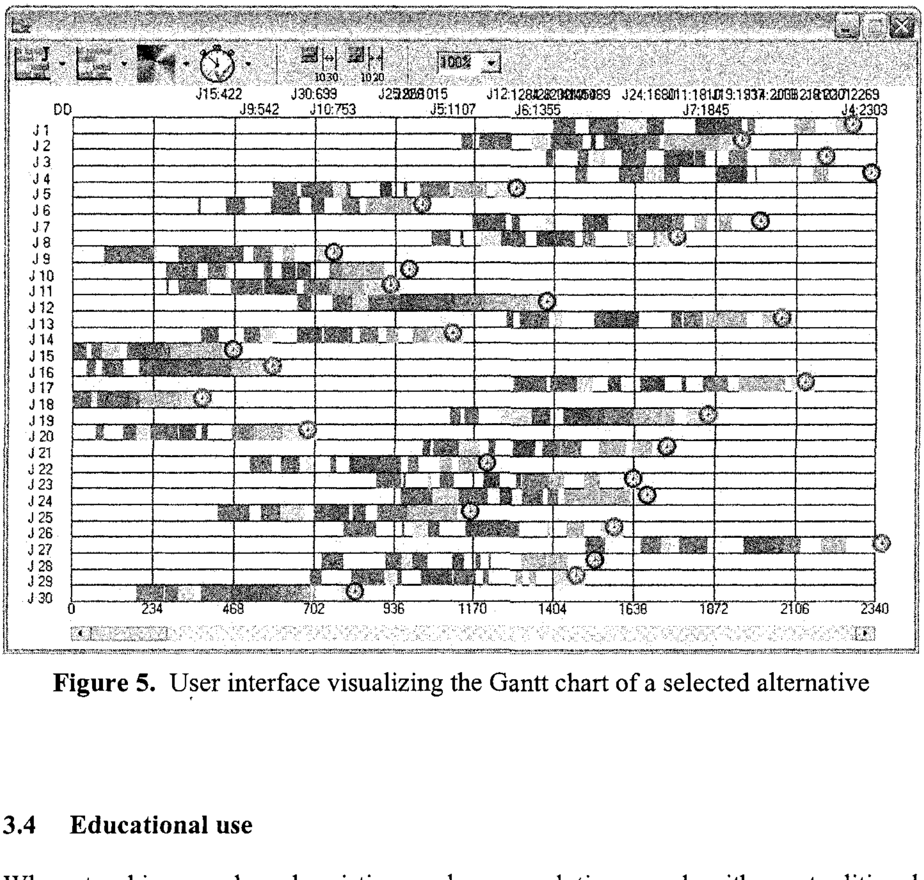

Figure 5. User interface visualizing the Gantt chart of a selected alternative

3.4 Educational use

When teaching modern heuristics such as evolutionary algorithms, traditional educational methods are of limited applicability. While textbooks describing the approaches are available, a thorough understanding of the methods by means of theoretical explanations only, e.g. by stating the corresponding pseudo-codes, is difficult.

Many metaheuristic approaches require an extensive setting of control parameters, and an important resulting aspect is the fact that their behavior can be best studied by experimental tests during which different parameter settings are systematically tested. Consequently, demonstration software is needed that allows such investigations. Ideally, an available system is equipped with a graphical user interface for the direct manipulation of the underlying resolution approaches.

By implementing such a system for the problem domain of scheduling, we enable teachers and students to interactively explore the capabilities of different metaheuristics for the resolution of corresponding problem instances. The understanding of the techniques is further supported by the visualization of the results. Contrary to other class libraries, the output of the results is possible in a visual way, visualizing the Gantt charts of schedules (see Figure 5) and plotting the outcomes of the optimality criteria in an outcome plot (see Figure 4).

In addition to the visualizations of the results, teachers and student may easily modify the data of the investigated problem instances. This includes the data as such, e.g. the processing times of the operations, as well as the set of optimality criteria.

4 Conclusions and discussion

A system for the resolution of scheduling problems under multiple objectives has been presented. It allows the definition of problem instances and modern heuristics on the basis of an implemented library. Adaptations are possible by setting parameter values. Therefore, no source code needs to be recompiled or changed in order to make the system work. The results may easily be visualized and compared to each other using different plots in alternative and outcome space.

As the system is aimed at end users in higher education and research, all interactions of the user with the system are supported by a graphical interface. So far, seven languages are available for the items of the user interface, namely English, French, German, Hungarian, Italian, Polish, and Spanish. The presented system is freely available for educational and research oriented use. It is accompanied by a 103-page printed manual, and a first chapter containing a tutorial of how to use the system quickly introduces the prospective user into its functionalities.

The presented system is a useful tool for demonstrating the capabilities of metaheuristics for the resolution of scheduling problems under multiple objectives. The flexible architecture within the problem domain makes it usable for a wide range of problem instances with different characteristics. On the other hand however, it is bound to the problem domain of scheduling, and adaptations to other problems are not permitted to the end user. We believe however, that this disadvantage is outweighed by the provided functionalities in the particular problem domain.

The software successfully competed in the finals of the *European Academic Software Award*, held in Ronneby (Sweden). It has been evaluated by an international panel of experts and honored with an award.

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An e-Learning Application Based on the Semantic Web Technology

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Abstract. The paper describes a framework for the implementation of an e-learning system based on the Semantic Web, using software agents and Java Web Services. Hopefully we have elucidated the enormous potential of making web content machine-understandable. One of the killer applications for the Semantic Web might prove to be related to e-learning, considering the amount of research in this sector and the advantages those applications bring to the table compared to existing web-based learning courses.

1 Introduction

Increasingly, The World Wide Web (WWW) is used to support and facilitate the delivery of teaching and learning materials. This use has progressed from the augmentation of conventional courses through web-based training and distance learning to a newer form of WWW-based education, e-learning [11]. E-learning is not just concerned with providing easy access to learning resources anytime, anywhere, via a repository of learning resources, but is also concerned with supporting such features as personal definition of learning goals, synchronous and asynchronous communication, and collaboration between learners and between learners and instructors [2] [13].

Researchers have proposed that in an e-learning environment the educational content should be oriented around small modules (or *learning objects*) coupled with associated semantics (or metadata) to be able to find what one wants, and that these modules be related by a "dependency network" or "conceptual web" to allow individual instruction. Such a dependency network allows, for example, the learning objects to be presented to the student in an orderly manner, with prerequisite material being presented first. Additionally, in an e-learning environment students must be

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able to add extra material and links (i.e., *annotate*) to the learning objects for their own benefit or for that of later students [10] [15] [17].

This framework lends itself to an implementation based on the *Semantic Web*, incorporating cooperating software agents, which additionally make use of appropriate web services to provide the functionality. We are developing an e-learning application using these technologies. The facilities that the application will provide include allowing the e-learning content to be created, annotated shared and discussed together with supplying such lecture notes, student portfolios, group projects, information pages, discussion forums and question-and-answer bulletin boards. The application will allow students to benefit from more interaction with their peers {for example, sharing the resources found on the web), as well as with the instructors. Students will see more ideas, more depth to those ideas, and a faster turnaround time in getting them. They will be able to learn from each other's notes, the questions that are asked and the answers given. It will provide an easy way for students to share and archive information, whether of general interest or specific to a group project they are involved in.

This paper describes the important and strategic role that the Semantic Web will play in this development – how Semantic Web concepts can support facets of e-learning and describes an e-learning application framework based on these concepts.

2 Semantic Web

The current WWW is a powerful tool for research and education, but its utility is hampered by the inability of the user to navigate easily the nefarious sources for the information he requires. The *Semantic Web* is a vision to solve this problem. It is proposed that a new WWW architecture will support not only web content, but also associated formal semantics [4]. The idea is that the web content and accompanying semantics (or metadata) will be accessed by web agents, allowing these agents to reason about the content and produce intelligent answers to users' queries.

The Semantic Web, in practice, comprises a layered framework: an XML layer for expressing the web content; a *Resource Description Framework* (RDF) [8] layer for representing the semantics of the content; an ontology layer for describing the vocabulary of the domain; and a logic layer to enable intelligent reasoning with meaningful data [18].

XML was designed as a simple, flexible way of transporting structured documents across the web. With XML, "tags", or hidden labels may be created – such as <address> or <title> - that annotate web pages or sections of text within a page. XML is machine-readable, i.e., programs can read and understand it, but the program developer has to know what the page writer uses each tag for. In other words, XML allows users to add arbitrary structure to their documents but says nothing about what the structures mean [5].

The meaning of the document content is expressed with RDF that is simply a data model and format that allows the creation of machine-readable data. It comprises a set of triples, i.e., three *Universal Resource Identifiers* (URIs) that may be used to describe any possible relationship existing between the data – subject, object and predicate [7] [16]. Thus, all data stored in the system is easily readable and processible. It is important to note that RDF provides the syntax, but not the actual meaning of the properties we ascribe to the data. For example, it does not define what data properties such as Title or Category or Related-To mean. Properties like these are not standalone; they come in packages called domain vocabularies. A learning object, for example, may include a set of properties such as Course, Sub-Section, Author, Title, Similar-To, Difficulty-Level, and Rating. Thus, for every domain there is a need for a specific ontology to describe the vocabularies and to make sure they are compatible.

Ontologies in the context of the Semantic Web are specifications of the conceptualization and corresponding vocabulary used to describe a domain [12]. Any semantic on the web is based on an explicitly-specified ontology, so different Semantic Web applications can communicate by exchanging their ontologies. Several representation schemes have been defined for the ontology layer. The most popular one, the Ontology Interchange Language (OIL) combined with the DARPA Agent Markup Language (DAML), DAML+OIL, provides a rich set of language structures with which to create ontologies and to markup information so that it is machine understandable.

The logic layer part of the Semantic Web is not fully developed yet. Its implementation will allow the user to state any logical principles and permit the computer to infer new knowledge by applying these principles to the existing data. Since there are many different inference systems on the web that are not completely interoperable, the vision is to develop a universal logic language for representing proofs – systems will then be able to export these proofs into the Semantic Web [1].

Within an e-learning framework, the Semantic Web provides the technology that allows a learning object to be (i) described with metatdata, and this description to be extended indefinitely (by anyone, not just the creator); (ii) annotated with personal notes and links by anyone; (iii) extended in terms of content, allowing multiple versions to exist; (iv) shared by, and communicated to, anyone who has expressed an interest in such content; and (v) certified, for example, as a quality learning resource; and more [16]. The e-learning application described in [16] embraces this functionality.

3 Application

The e-learning application framework is organized around a learning object repository that exclusively contains metadata [10]. In fact, it is a repository of the URIs of learning objects, such as Web sites, word documents, PDF files, PowerPoint presentations, etc., plus descriptions about these objects. No actual objects are stored in the repository, only links (i.e., UPLs). A most important aspect of the application is the metadata stored regarding each and every URL. The addition of such semantic information to the URLs will be done via RDF, using dynamically-generated Web pages, personalized for every user. Since the information is stored in the form of machine-understandable RDF statements, it can be used by the application agents. In order to give meaning to these RDF statements, we are developing our own e-learning ontology (vocabulary) to be used within our application. It is designed using *DAML* (DARPA Agent Markup Language) and will ensure compatibility of the metadata attached by various users.

In this section we describe some of the main features of our e-learning application that are enabled with Semantic Web technologies.

A main concept of our application is that it enables dynamic course creation and extension/modification, i.e., the contents of the course are extremely flexible. Most of the content will initially be provided by the instructor in a form of links to small learning objects. All of these links will be annotated with RDF statements that will provide a description about the document/URL linked. Researchers have proposed three forms of annotation: concept annotation, context annotation and structure annotation [Stojanovic]. For the e-learning domain, annotations might include the context in which the document is placed, links toward other similar objects, the relationship to other documents (some learning objects might be prerequisites for access to others), rating (which will be updated with other users' ratings), etc. Importantly, however, the student will also be able to add his own, further annotations to personalize and enrich the learning material. Moreover, these annotations are not necessarily collected in one document – they may be dispersed throughout the web.

An important feature of the application is the use of e-protocols for assessing student performance, a feature that, additionally, significantly enriches the learning potential of the system. Since a portfolio simply represents an organized collection of completed work, the items in the portfolio can be thought of themselves as learning resources. Hence, the e-portfolio collection provides yet another repository of learning objects that may be used later by other students. For this, the e-portfolios will need to contain RDF descriptions of their metadata. So, when submitting a document to his portfolio, the student will be required to annotate the document through a template-driven Web page. Using Semantic Web, e-portfolios become content management systems, allowing not only the publishing of documents, but also the dissemination of metadata about these documents and the structure of courses, as well subjective annotations of e-resources [16].

If there is an abundance of learning objects available for the students, there needs to be a way for them to distinguish quality ones. Again, annotation of the learning objects supports certification/rating – instructors are able to certify a specific content as being a quality learning resource.

An intriguing future extension being investigated is the inclusion of context-aware links. Imagine a student who has opened some learning object to study. If it is advanced material, the student might have problems comprehending some of the terms. The browser, after querying metadata servers about such terms, may automatically place links for the more difficult terms/concepts in the learning object, connecting them with other learning objects that might make the student's understanding easier. Even though such browsers exist today, the application of this technology using the Semantic Web is still in its nascent stage. One of the first steps toward context-aware browsing has been the introduction of a concept browser, Conzilla, which creates an overview of the different concepts under study by supporting a separation of their context and their content [9].

4. Implementation

There are two types of agents used in the application. *Student/Agent* and *Instructor/Agent,* both of them implemented as Java classes. Users are served by the appropriate agents, which parse the metadata and tailor the user interface to satisfy the user's needs, whether student or instructor. For example, if a student encounters difficulties with a section of a course, he may notify the *Student/Agent* of this fact, and whenever a new resource related to a section appears on the web, the agent will insert a link to this resource on the student's personal page. The agents interact and communicate between each other by means of *Java Web Services* using the *Simple Object Access Protocol* (SOAP). The general structure is illustrated in Figure 1.

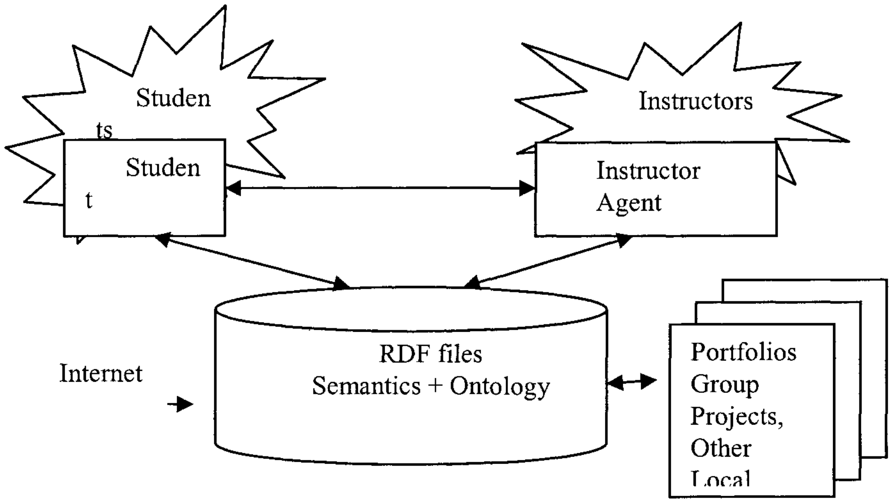

Figure 1. The general structure of the system

Users will add any metadata (whether it be personal annotation, certification, etc.) to a document referenced via the RDF learning object repository through dynamic (Java Server) web pages. For the end user, this process of annotation is identical the action of filling out fields in a web form. After the user submits the form, the application automatically converts this additional information to a set of RDF statements using the Jena API (see below) and then adds them to the existing RDF statements for this document in the repository. Because the RDF specifications provide XML syntax for writing down and exchanging RDF statements (called RDF/XML). The repository is implemented as a set of RDF/XML files. However, the RDF/XML syntax is quite complex, and developing an RDF parser is not a trivial task.

Motivated by the need for an RDF parser, we are using a Semantic Web toolkit called Jena for developing our application. Jena is a Java API for manipulating RDF statements, capable of parsing RDF statements and storing them as graphs (or models), thereby allowing straightforward manipulation of the RDF [14]. Additionally, Jena provides support for converting DAML-specified ontologies to an RDF form, and also implements a Resource Description Query Language (RDQL), an SQL-like query language for RDF statements.

To illustrate the Jena RDF API, consider the following simple example of an RDF statement describing a learning object. The main component of the statement is represented with the Resource class in Jena, and is always a URL. For instance, let http://some.site/DiffGeometry be the URL for an e-book about differential geometry. This resource will be represented as a node in the graph model, whereas the properties it might possess are marked as edges. One of the properties for the e-book resource may be "Title", and the name of the property is also a URL. The property has a value, "Elementary Differential Geometry", in this case and this value is again marked by a node in the graph. Another property may be "Similar To", which points to another resource (URL) holding similar information as http://...//AnotherGeomethryBook. The following is the Java source-code required to create this RDF model in Jena:

```
Static String objectURL = "http://some.site//DiffGeometry";
Static String similarToURL= "http://...// AnotherGeomethryBook";

//create the empty model
Model model = new ModelMem();

//create the resource
Resource learningObject = model.createResource(objectURL);

// add first property (title)
learningObject.addProperty(propertyURL, "Introduction to Differential
Geometry");

//add the second property (similar to)
//the property does not have a literal value, it is a resource
Resource secondLearningObject = model.createResource(similarToURL);
LearningObject.addProperty(anotherPropertyURL, secondLearningObject);
```

A list of the technologies used in the implementation of the e-learning application includes Java 2 Platform, Enterprise Edition v1.3 (J2EE), Java Web Services Developer Packv1.1 (Java WSDP), JBuilder v6.0, Jakarta-Tomcat Server v3.2.3, Microsoft SQL Server 2000, and Jena Semantic Web Toolkit v1.6.1.

5. Related work

Stojanovic et al [18] describe an e-learning scenario based on the Semantic Web, in particular concentrating on ontologies for e-learning objects. This group is associated with the Learning Lab Lower Saxony, which itself is a partner in the Wallenberg Learning Network.

Naeve et al [16] describe an e-learning framework, again based on the Semantic Web, that discusses Semantic Web technologies and peer-to-peer services for the search, consortium comprising Swedish and German universities developing a P2P network for the exchange of educational resources.

6. Conclusions and future work

We have described a framework for an e-learning application based on the Semantic Web technology, incorporating cooperating software agents that additionally make use of appropriate web services to provide the functionality. With our paper, hopefully we have elucidated the enormous potential of making web content machine-understandable. Just as in the case of the present web, the potential of a globally-linked Semantic Web network will slowly become realized as the number of active users increases. One of the killer applications for the Semantic Web might prove to be related to e-learning, considering the amount of research in this sector and the advantages those applications bring to the table compared to existing web-based learning courses.

We are currently developing the application. Additional features will be included in the application as we gain experience with this new technology. This is a relatively young field with the promise for enormous growth.

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Linking Communities of Practice with Learning Communities in Computer Science Education

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Abstract. MoKEx (Mobile Knowledge Experience) is an international project in cooperation with universities and industrial partners. The project focuses on didactical, organizational and technical problems with regard to blended learning and knowledge management scenarios. In a project-based learning approach students of two different universities are being prepared for their future work. They are working on real-world problems in an interdisciplinary team and are collaborating within a geographically and temporally separated team. Therefore means for communication and collaboration over the Internet must be provided. From the didactical perspective the aspects of autodidactic education and team learning are playing an important role, while teachers are acting primarily as coaches. In the meantime the results of the first execution of the project have been enhanced and put into operation by the companies and a second execution has been started.

1 Description and Intention of MoKEx

MoKEx consists of two projects, which started one after another each lasting one year. MoKEx I started in October 2004. It was a general task of the project, given by all industrial partners, to develop and implement software in order to improve e-learning within the companies. A major curricular task of the MoKEx project was to improve computer science education (CSE) on a higher-education level by embedding informatics seminars at universities in real-life scenarios. The paper

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describes the accordance of the curricular concept of MoKEx with demands of international CSE-curricula and current learning theories and outlines the organizational and collaborative structures of the project.

1.1 Partners

The MoKEx project is an interdisciplinary project of the following scientific and economic partners: *University of Paderborn*, Germany, *University of Applied Sciences Northwestern Switzerland*, Switzerland, *STEAG AG*, Switzerland, *Magh & Boppert*, Germany, *SBB AG*, Switzerland, *Swissmem*, Switzerland, *Swisscom Mobile AG*, Switzerland, *SAQ Qualicon AG*, Switzerland and *Stahl Gerlafingen AG*, Switzerland.

1.2 Expectations, Objectives and Content

With regard to constructivist theories and their application in CSE [1] students' learning activities in the MoKEx project are situated, self-directed, investigating and oriented to the practice of computer science. Students learn not only to develop informatics systems as a subject matter of software engineering but also to use them as co-operative media (e.g. IDE, CMS) that support collaborative working in a distributed learning group.

The informatics competencies students should achieve in the project must represent the handling of an existing software product of a customer as well as the process of software development. We have to take into consideration the process of the systems' construction and its modeling as well as the process of re-engineering of an existing system for the needs of the industrial partners. Therefore, requirements analysis, including the analysis of business processes of the industrial partners, is an important issue of the project.

The MoKEx project combines practical education with up-to-date research in information technology and knowledge management. The industrial partners of MoKEx are active in the knowledge-intensive service sector. Because of market dynamics they have to undergo permanent changes and adaptation in order to react to their customers needs and to be competitive. Organizational structure, processes and service supply (customer care, retail sales, corporate business sales) are constantly adapted. This demands high standards for knowledge management, professional training and controlling of training activities.

From this, research questions arise that are both highly interesting and extremely relevant in practice. Through their project work the students, on the one hand, get insights in the everyday demands of customer-oriented service companies and, on the other hand, are contributing to the development of both science and economy.

Thus, the MoKEx project meets the demands of various international computer science curricula with regard to the subject areas, the informatics methods and last but not least the teaching and learning methods. Denning, who analyzed current CSE-curricula defines "Great Principles of Computing" scaffolding for a curriculum [2]. They include "Design Principles" such as complexity and performance, and of "Computing Mechanics" such as computation, communication or coordination.

They also include "Computing Practices" such as programming, engineering systems, modeling, innovating and applying, as well as "Core Technologies" such as architecture, algorithms, databases and networks. Students in the MoKEx-Project have to deal with parts of all these subject areas of informatics when they solve project-oriented problems (see Section 3.2).

Denning, as well as the various CSE-curricula, also emphasizes the importance of "working with practitioners in application domains to produce computing systems that support their work" [2, p. 4].

Also the IEEE /ACM–curriculum stresses that CSE-curricula "must include exposure to aspects of professional practice as an integral component" [3, p. 14]. Besides technical skills the IFIP/UNESCO-Curriculum intends to achieve "personal and interpersonal skills" such as "communication, team work, critical thinking, leadership, working with users, interdisciplinary environments, written specifications and documentation, dealing with ambiguity" [4, p. 33]. Furthermore, the IFIP-curriculum requires broadening the perspectives and context by linking informatics with other disciplines. These are also relevant issues of the didactical concept of MoKEx.

1.3 Organizational structure

The integration of this educational element in the curricula of the participating universities slightly differs:

- At the *University of Paderborn* (UPB) the project is embedded in the last two semesters. Students are working for one day per week in the project. In parallel they have to attend regular courses. The aim of the project work is to integrate, apply and strengthen competences, the students already have acquired during regular lessons and in smaller projects.
- At the *University of Applied Sciences Northwestern Switzerland* (FHNW) the project starts after three semesters. During 16 weeks the students are engaged for four days a week directly at the involved companies. As the students are in the middle of their education, acquisition and development of specialized knowledge and new competences are important aspects of project work. Another very important objective is to gain practical experiences in project management, a topic the students already know from former lessons. In the project, however, they have to cope with real-world problems like interview partners not being available, changes in schedules, modification of requirements etc. FHNW provides a coaching day once per week, where the students can ask for support from the lecturers.

MoKEx is applied as an interdisciplinary, geographical and temporally separated project. While scientific and applied scientific competencies are split to the German *University of Paderborn* and the Swiss *University of Applied Sciences Northwestern Switzerland*, all project partners are Swiss businesses. Magh & Boppert arises as technology provider for German and Swiss students. The organization of both, MoKEx I and MoKEx II is shown in Figure 1.

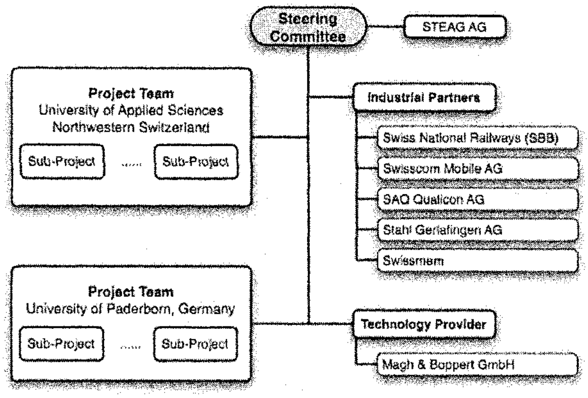


Figure 1: Organization Chart MoKEx of the Project

The Swiss STEAG AG supervises the steering committee. Each participating country has to contribute to the steering committee with a scientific leader and an overall team leader. The project group is split in two teams: the project team at the UPB and that at the FHNW. Each team has to meet the demands of the industrial partners.

The time flow of both projects is organized in six consecutive stages:

- *Initial stage:* The initial phase of MoKEx I and II is characterized by the build-up of competencies by all parties involved in the project. In this initial stage all project partners are to define their expectations and hopes of what the project will deliver.
- *Evaluation stage:* This stage has changed its importance from MoKEx I to MoKEx II. Whereas this stage was of nearly no importance to the students themselves in MoKEx I, it is one of the most significant stages in MoKEx II. During this stage the students have to make requirements analyses at the industrial partners' sites and build up communication networks in personal responsibility. Furthermore all students have to present their findings in a group workshop.
- *Specification stage:* This stage deals with the development of solution approaches to meet the industrial requirements. All approaches and findings are written down in a document of specification, which is delivered to the industrial partners.
- *Realization stage:* A prototype that meets the requirements of the industrial partners and the approaches of the preceding stage is developed in this phase.
- *Test stage:* The deliverables are tested and afterwards presented to all project partners.
- *Outcome and Presentation stage:* In this phase all outcomes of the project are embraced in a final presentation with the Project Partners. At a showroom, members of all sub-projects are to speak about their work and outcomes.

1.4 Collaborative Structure

Due to the geographical and temporally separated teams, it was necessary to place great importance on assembling a well-working communication network for both industrial partners and the particular teams. For the external presentation of the project and the industrial partners the FHNW set up a project platform on which final documents and protocols were stored. The steering committee used this platform for organization and objectives balancing.

The local work of Swiss and German students was assisted by CVS systems located at the technology provider Magh & Boppert. The students made all responsibility assignments in the particular sub-projects with complete personal responsibility. This was made to simulate real-world scenarios and to engender competencies in project management with the students. Information exchange between German and Swiss students in different dependent sub-projects was realized using standard instant messenger tools, e-mail, IRC and phone. For the actual running project MoKEx II, the application of groupware tools as shared whiteboards is envisaged.

As in any project, documentation is one of the most important things to think about in MoKEx I and II. For any academic project it is necessary to evaluate the individual effort of each participant. In the case of MoKEx I this means that every student had to write down what he or she did in the project period. Since it was difficult for the students in MoKEx I to reflect their effort over a past year, the scientific head decided to use weblogs in MoKEx II. With the help of these individual weblogs the students are forced to reflect their own learning processes and to deal actively with occurring problems in the project work.

2 Educational Concept

MoKEx follows a project-based learning approach. This didactical concept allows students to gain competencies that cannot be obtained by traditional lectures or seminars. According to [5], project-based learning situations are characterized by authentic questions or problems and investigations that enable students to formulate and refine specific questions, based on original data. Moreover, project-based learning is result-oriented (artifacts, system implementations) and usually a community of learners and trainers collaborate. In MoKEx additional aspects extend the project-based learning approach:

- The team members exhibit *interdisciplinary* skills. The project partners from UPB provide computer science competencies in system development and technical implementation. The core competencies of FHNW are more application oriented; therefore the FHNW team focuses questions of integration and interaction with the industrial partners. The combination of theses competencies, complemented by the educational knowledge of STEAG AG and Magh & Boppert, builds an interdisciplinary team, which assures an integrated solution.

- The project team covers the whole spectrum *from research to practice.* UPB as a university is on the research side of the spectrum, and the industrial partners represent practice. FHNW as a university of applied sciences is a kind of mediator between both extremes. Regular meetings and information exchange between sub-projects stimulate comprehension and consideration of both theoretical and practical aspects in the project results.
- The project asks for specific professional competencies. Among others, skills in programming distributed systems, database management, mobile communication and screen design are required to solve the problems of the industrial partners. Part of this knowledge is provided by antecedent regular courses. In addition missing knowledge has to be obtained in a "Continuous and Cooperative Self-qualification and Self-organization (CoCoSS)" learning process [6]. This includes the independent planning and execution, as well as the continuous renewal and implementation, of learning. In MoKEx students use workshops as one important method to develop knowledge in a cooperative way.
- Due to the involvement of the industrial partners, methodological competence in project management, user requirement analysis and presentation skills are applied in the context of a real situation. Moreover the project offers the possibility to develop the student's social competence, as they are forced to negotiate not only working conditions and incentives but also solutions with the industrial partners. In order to fulfill theses ambitious tasks, periodical plenary sessions are organized to exchange experiences with colleagues from other projects. In addition teachers are available on demand for coaching.
- The MoKEx team is working geographically and temporally separated. Therefore the requirements regarding documentation of the project and knowledge transfer within the team are quite high and adequate means for synchronous and asynchronous communication must be provided.

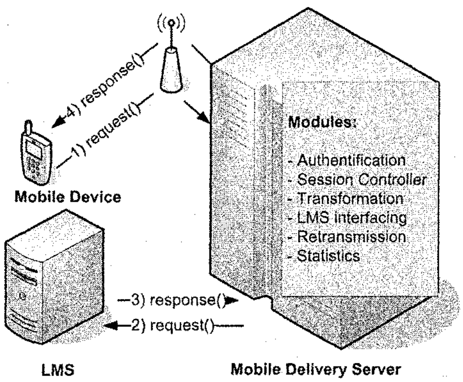
It is the goal of all these measures to create a real-world scenario in which the students gain important competencies for their future work. Similar goals have been focused by the CommSy project on the University of Hamburg, described in [7].

3. Project Outcomes

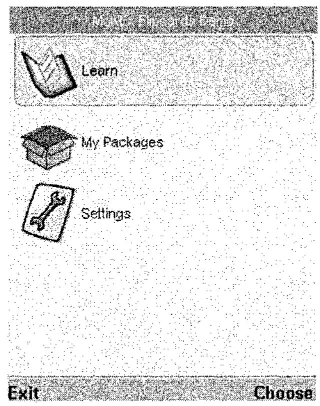
3.1 Technical Outcomes

3.1.1 Mobile Delivery Server

Traditional e-learning scenarios are based on client/ server architecture and are not primarily designed for mobile scenarios. To offer e-learning in mobile scenarios, difficult technical challenges involving platform heterogeneity, wireless communication protocols, screen resolution and other usability matters must be dealt with. Ultimately, e-learning objects have to be dynamically converted and customized according to the target platform. This applies to multimedia content, as well as to the native format (e.g. XML) in which the content is stored. The "Mobile Delivery Server" (MDS), is our advanced software approach to resolve some of the problems and limitations described above. The MDS (cf. Figure 2(a)) introduces a new middle layer service for the technical needs of mobile e-learning scenarios. The MDS also provides compatibility of learning objects with a broad variety of mobile clients and allows the distribution of platform-dependent players.



(a) Architecture of the MDS



(b) Screenshot of Flipcard-Player

Figure 2: Developed Mobile Delivery Server and Flipcard-Player

3.1.2 Flipcard-Player

The Flipcard-Player is mobile client software for the use of special e-Learning contents. The learning objects to be used with this software are simple flipcards as known from traditional learning scenarios. Each flipcard contains a question on the frontside and the corresponding answer on the backside. By walking through the deck of flipcards delivered by the MDS, the player enables students to learn factual knowledge (e.g. vocabulary words, scientific formulas or sales arguments). One possible application of our developed technology within the educational area is student training, which will be evaluated by Swissmem. During the evaluation, the students of different vocational schools will receive the Flipcard-Player and the learning objects via WAP, Bluetooth and IRDA. Swissmem will provide content via an e-tutor LMS. The learning objects will cover exam-related materials the students are responsible for learning. The evaluation will provide us with information about the technical and educational aspects of this specific mobile learning scenario. The MDS was successfully tested by using a prototype of a Flipcard-Player for cell phones. A second field test will be carried out by Swisscom Mobile, and will also involve students (cf. Figure 2(b)).

3.1.3 Knowledge-Database

Another sub-project of MoKEx dealt with the development of a knowledge database. Furthermore the integration into an electronic learning management system (LMS) e-tutor provided by Magh & Boppert was realized. Using the knowledge database, every user of the LMS has the ability to contribute to a business internal compilation of explicit knowledge. During the specification and realization of the architectural concept an extensive authoring process for knowledge database articles was developed and realized. Figure 3 shows the authoring process mentioned above.

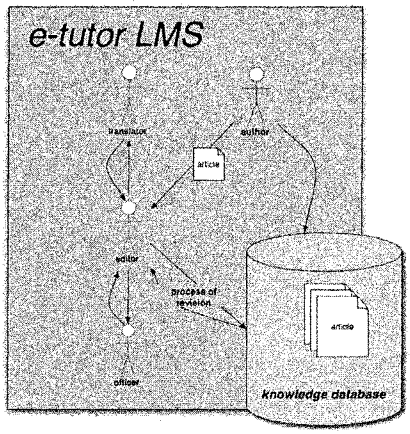


Figure 3: Authoring process for articles in the knowledge database

The developed knowledge database knows four types of users: authors, editors, officers and translators. To assure high-quality articles in the database, all new or modified articles go through an authoring process. The articles are, based on the taxonomy path they are in, sent to an editor who reviews the article concerning syntactic problems and faults. Subsequently the article is passed to an officer with specialist knowledge who reviews the article concerning textual correctness and thereafter returns the reviewed article to the editor. Following this, the article is passed to one or more translators who produce several multi-lingual versions of the article. Finally the editor releases all multi-lingual versions of the article to the public view of the knowledge database. Every user can make annotations and extensions to the public articles, which leads to a new authoring process that follows the same process.

3.2 Individual Outcomes

A lot of the informatics-related knowledge and interpersonal skills mentioned above were imparted by the MoKEx project. According to the criteria of an IFIP Working Conference on "Information and Communication Technologies (ICT) and Real-life

Learning" [8] the MoKEx project realizes several interesting concepts of practice-related learning in CSE with regard to individual and institutional aspects:

- The institutional outcomes mainly affect the improvement of teaching and learning in computer science courses, but they also are relevant for the student's competencies. The project offers integrated working and learning in real-life situations, which was highly motivating for the students. Tutors and teachers got a more advisory role focusing on the project management and supporting the process of knowledge acquisition. Interdisciplinary knowledge exchange was enabled by co-operation between students of different universities and faculties.
- Individual outcomes for the students include the following: The students have gained a broad understanding of project management issues, as well as competencies in communication and documentation. The interaction with our partners from industry fostered the development and practice of social skills. Competencies in autodidactic learning and knowledge transfer were enforced with workshop and online collaboration sessions. Technical skills have been well trained by software design and the implementation of prototypes.

As already mentioned in Section 1, the students deal with all subject areas according to Denning's principles of computing [2]:

- Design Principles: The MoKEx project provides industrial partners with software products for professional use and fosters international co-operation with business and industry. In comparison with traditional teaching, the students obtained a more decisive and managing role in the project because they are responsible for the project outcome with respect to both time schedule and software design. Co-operation between students from both technical and business faculties was valuable in requirements engineering and systems design.
- Computing Mechanics: The project uses Information and Communication Technology (ICT) to enable collaborative learning in a distributed working group and provides the students with experiences concerning the effective use of ICT-environments for these purposes.
- Computing Practices: Co-operation between universities and business partners leads to a more practice-oriented concept of teaching software engineering.
- Core Technologies: Technical skills involved distributed systems, database management, mobile communication and usability matters of mobile devices.

3.3 Evaluation of outcomes

During the project the progress of the students is assessed using weekly progress reports and in coaching sessions. Periodic presentations permit knowledge exchange between students and give evidence on student progress for the lectures. In addition, new forms of ICT-supported project assessment like weblogs edited by the students are tested. The evaluation of the project outcomes differs between UPB and FHNW:

- At UPB each student group has to deliver the software system together with a specification and design document and make a final presentation.
- The students of FHNW have to keep an account of the project issues. This project handbook together with a final report is evaluated by two lecturers who give grades for technical and project management outcomes, respectively.

4. Conclusions and further work

Based of the experiences from MoKEx I, some improvable points were discovered from the pedagogical perspective:

The directives for the assessment were synchronized for the second execution of the project. For MoKEx II, we introduced an initial requirements analysis phase (see above), in which students start by interviewing the industrial partners and exposing potential problems. For internal communication and purposes of self-reflection of their learning processes, a BLOG-Server is introduced in the second execution.

Real-world projects bring along a complexity in planning and execution that cannot be conveyed by traditional education methods. MoKEx combines established existent principles from CSE with new educational methods. Cooperative and self-organized work in an interdisciplinary team within the existing fields of research and application and the involvement of industrial partners are key elements of the didactical concept of MoKEx. The comparison with international concepts has shown that the project meets the various demands of modern CSE. Moreover the connection between higher education and industry generates a win-win situation, where students get insights in everyday working situations and on the other hand they contribute to the development of an organization and the economy as a whole.

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Some Experiences in Using Virtual Machines for Teaching Computer Networks

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Abstract. Laboratory practice is a fundamental aspect of computer network learning. Experiments tend to be very specific, frequently demanding changes in the local network topology and privileged access to the operating system configuration. These features impose a specific and exclusive laboratory for network teaching experiments. However, it is not always possible to provide such laboratory; the reality in most institutions is to have shared laboratories, used by different students and disciplines. This problem can be alleviated by the use of virtual machines, allowing each student to build his/her own network experiment, using the appropriate topology, and thus not disturbing the other activities running in the lab. This paper presents some experiences in using virtual machines to teach advanced aspects of computer networks, such as IPSec, firewalls and network services. Also, some key points are highlighted in order to show the benefits of virtual machines for pedagogical practice.

1 Introduction

Laboratory practice is a fundamental aspect of learning computer networks. Experiments that are more complex usually demand changes in the local network topology and privileged access to the operating system configuration on each host. For instance, in an experiment aimed at implementing a firewall architecture, students need to a) organize the laboratory network topology, putting computers on the external, internal, and DMZ (Demilitarized Zone) networks, b) install additional network interfaces on the machines that will route and filter packets between the networks, c) configure their respective routing and filtering tables, and d) configure the network addresses and other attributes for the machines in the three regions.

This unconventional characteristic of computer networks laboratory classes implies a specific and exclusive laboratory for teaching network experiments. This

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problem also appears in other system-related disciplines, such as operating systems. However, it is not always possible to provide such a laboratory; the reality in most teaching institutions is to have computer laboratories shared among several students and disciplines. This limitation makes it impractical to have complex experiments that demand laboratory exclusiveness. This problem can be alleviated by the use of virtual machines. The VM technology allows each student to build her own virtual computer network, connected according to the topology demanded by each experiment, without interfering in the laboratory physical structure and thus not disturbing the other activities running in the laboratory.

There are several ways to use virtual machines to teach system-related disciplines; this subject has been studied since the 80s [7]. However, the recent advances in virtual machine technology [17] explain the growing interest in using it as an important tool in the learning process. Today, most students have enough computing power in their home computers to execute several virtual machines simultaneously, allowing them to reproduce the class experiments at home.

This paper presents some experiences in using virtual machines to teach advanced aspects of computer networks, such as IPSec, firewalls and network services. The text is structured as follows: section 2 presents the virtual machine technology, enumerating its possibilities, advantages, and limitations; section 3 discusses the possibilities of using virtual machines to teach computer networks; section 4 presents the virtual machine monitor User-Mode Linux, which was used in this work; section 5 presents the context in which the experiments presented here were developed; section 6 shows and analyzes some of the experiments realized; section 7 discusses relevant related work; and finally, section 8 concludes the paper.

2 Virtual machines

A virtual machine (VM) is defined in [16] as an efficient and isolated duplicate of a real machine. A virtual machine environment is created by a *Virtual Machine Monitor* (VMM), also called an "operating system for operating systems" [8]. The monitor creates one or more virtual machines on a single real machine. Each VM provides facilities for an application or a "guest system" that believes itself to be executing on a standard hardware environment. VM monitors build some properties that are useful in system security, such as isolation (a software running in a VM cannot access or modify the monitor or other VM), inspection (the monitor can access the entire VM state), and interposition (the monitor can intercept and modify operations issued by a VM) [8, 16]. Typical uses for virtual machine systems include the development and testing of new operating systems, simultaneously running distinct operating systems on the same hardware, and server consolidation [17].

There are two classical approaches to organize virtual machine systems. In Type I systems, the virtual machine monitor is implemented between the hardware and the guest system(s); the Xen [3] and VMWare ESX Server [21] virtual environments are good examples of this approach. In Type II systems, the monitor is implemented as a normal process of an underlying real operating system, called the host system. The

VMWare Workstation [21] and User-Mode Linux [6] virtual machine systems adopt this architecture. Both approaches are depicted in Figure 1.

Standard PC processors provide no adequate support for hardware virtualization. Consequently, virtualization overhead can be as high as 50% of total computing time [4]. However, recent research significantly reduced such costs to under 10%, as shown in [12, 17]. For instance, the VMware system [21] uses an on-the-fly rewriting technique in which the binary code loaded by the virtual machine is dynamically modified to better adjust it to the virtual environment, improving its performance. After completely rewriting the logical interface between the monitor and the guest kernels, the Xen project [3] obtained average computing costs under 3% for virtualizing Linux, FreeBSD, and Windows XP. These research results open many perspectives on the use of virtual machines in production environments.

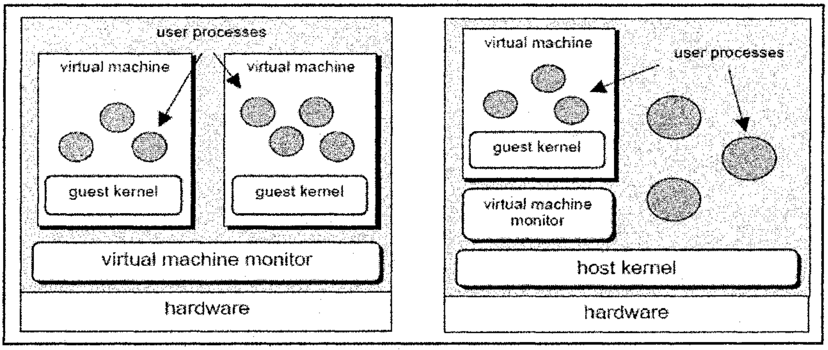

Figure 1. Type I (left) and type II (right) virtual machine monitors

3 Using virtual machines to teach computer networks

There are several ways to use virtual machines to teach system-related disciplines; this subject has been studied since the 80s [7]. However, the recent advances in virtual machine technology [17] explain the growing interest on using it as an important tool in the learning processes. Today, most students have enough computing power in their home computers to execute several virtual machines simultaneously, allowing them to easily reproduce the class experiments at home. Therefore, the virtual machine technology can be adopted with concrete benefits in system-related laboratory classes, such as computer networks and operating systems. Among those benefits, one can mention [4, 12]:

- it is possible to create more virtual hosts than the number of physical computers available in the laboratory, allowing each student to create complex scenarios involving several hosts;
- the number of network interfaces in each host and their interconnection are defined in the virtual context, with no restrictions related to the laboratory physical structure or the local computer's hardware configuration;

- the student is the administrator of her virtual hosts, allowing her to change their configuration and to install the software required by each experiment;
- the student can save on the real machine the configuration and state of each virtual host; allowing her to develop more complex, longer, or incremental experiments;
- finally, the student can reproduce the experiments at home.

A first approach for using virtual machines in computer network teaching would be to provide a specific laboratory, in which each computer would have locally installed a virtual machine monitor, like UML [6] or VMWare Workstation [21]. Such a system could be configured to allow virtual hosts to interact with the real hosts in the lab or with virtual hosts running on other real hosts. This approach, used in [1, 13, 18], is simple to implement, but is not flexible, because it demands a specific (yet not exclusive) laboratory. Furthermore, when deploying longer or incremental experiments, the student remains "tied" to the same computer on which she started it. Also, this structure is harder to reproduce at home and makes it impracticable to work remotely on the experiments.

Another approach consists of installing the virtual machine monitor on a central server, accessible to the students through the network, as proposed in [5]. In this case, the student connects to the server, starts the virtual machines needed for the experiment and interacts with them locally (in the server) or using real hosts on the local network. Although this approach is more flexible, it demands a central server for the virtual machine's execution, which can be very demanding in processing, memory and disk space.

An important aspect to discuss here is the adequacy of the distinct types of virtual machine monitors for the teaching environment needs. A type I monitor executes directly on top of the hardware (or is embedded in the host operating system). In this case, creating a new virtual machine is a privileged operation, only accessible to the system administrator, making it impracticable to create virtual machines on demand. Furthermore, access to low-level resources (such as drivers) and network configuration are also privileged, limiting the configuration possibilities. Examples of using type I monitors as a teaching tool are presented in [16, 20]. On the other hand, a type II monitor is seen by the host system as a user process. Thus, the creation of virtual machines based on user demand is restricted only by the availability of resources such as memory and disk space on the host system. Moreover, each student has full control over the hardware and software configuration of each virtual machine for the deployment of more complex experiments. The papers [1, 5, 13, 18] use type II monitors, exploring the on-demand creation of virtual machines.

4 The User-Mode Linux monitor

The experiments described in this work were accomplished using UML - *User-Mode Linux* [6], a type II virtual machine monitor that allows Linux guest systems to execute on top of a Linux host. This monitor was chosen due to its main features, which are:

- it is open source software, which can be adapted and customized to user-specific needs; being free, it allows any student to reproduce the experiment environment at home;
- the monitor is embedded in the guest operating system kernel code; monitor and kernel are seen by the host system as a single executable file;
- the guest kernel executes unmodified native Linux applications, allowing the user to install software packages already available to current Linux systems such as RedHat, Debian, etc.;
- the number of disks and network interfaces of the virtual machine can be defined at the command prompt, when the virtual machine is launched;
- it allows the use of predefined disk images, shared through a copy-on-write policy (COW), which results in efficient host disk space usage;
- several network interconnection mechanisms are available, from virtual isolated hubs to virtual switches connected to a host interface, allowing the virtual machines to interact with other real hosts.

5 The teaching environment

In our institution, computer network teaching laboratory activities are carried out mainly in a specific Network Laboratory. This laboratory is composed of 25 computers, distributed on five rows and interconnected by two local networks. There are also hubs, switches, routers, wireless adapters, patch panels and other connectivity equipment available to students. In addition, they have full access to the machines' configurations. The motivation for using virtual machines in this environment emerged from these observations:

- the students should come to the university to do their extra-class work; as the laboratory usage is intensive, they have some difficulty in having the lab free enough time for their experiments;
- the frequent changes in the machines' configuration needed by each experiment are a source of headaches and difficulties, mainly for beginner students;
- very frequently, an ongoing experiment was deleted by someone else.

Based on such evidence, we started to devise a solution using virtual machines, which allowed us to solve the problems found and offered other benefits, such as the possibility to carry out experiments remotely, even when graphical clients were needed (browsers and e-mail clients). A major concern was the privacy of the experiments: we would prevent one student from observing, interfering with, or even deleting another student's work. The solution found consisted of offering a type II virtual machine system on a medium-size server that can be remotely accessed by the students using text terminals (SSH) or graphical terminals (X11 or VNC). Each student has an account on the server and can launch on-demand virtual machines, configured to meet the experiment requirements. Figure 2 depicts the architecture of the deployed teaching environment.

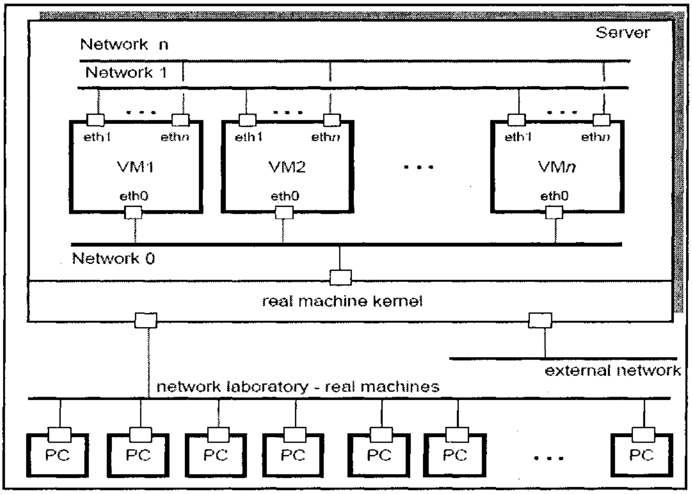

Figure 2. The teaching environment

This environment allows students to create on-demand, user-configured virtual machines, offering also the following benefits:

- as the server is integrated into the laboratory network, the virtual machines can interact with the laboratory computers, allowing a more real and convincing environment, if needed;
- the server offers remote access to user accounts through text terminals (SSH) and graphic terminals (X11 and VNC); the graphical interface is important when making experiments using popular network services like WWW and E-mail;
- the virtual disk images and other configurations are stored in the student disk area on the server, allowing the student to deploy long duration or incremental experiments;
- predefined images containing specific configurations and/or software are available in a public directory;
- graphical applications such as protocol analyzers and web clients can be run inside each virtual machine (their windows will be sent to the user graphical desktop session).

The current server configuration consists of a dual PIII Dell PowerEdge 1500 server (1.1 GHz), 2 GBytes RAM and a 100 GByte SCSI disk. The host system runs Fedora Core 3 Linux and the guest machines run RedHat 9 Linux. This server normally supports up to 40 active users; during a usage peak, up to 55 virtual machines simultaneously active were observed (monitoring statistics can be found at *http://espec.ppgia.pucpr.br*).

6 Sample practical experiments

The use of virtual machines provides a great flexibility for activities related to computer networks teaching. It allows easy implementation of experiments that would be much harder to do without an exclusive lab (or virtual machine), going from simple host configuration tasks to more complex ones such as network services installation, configuration and operation. Students can be challenged with scenarios and problems typically observed in computer networking. Such scenarios can be deployed individually or by groups of students, allowing them to interact, collaborate, and better understand. This section presents two examples of experiments that represent practical situations in network security.

6.1 Firewall architecture - DMZ scenario

The DMZ (De-Militarized Zone) network is a usual solution for firewall architecture. It is based on the isolation of an internal network from an intermediate network to which the externally-accessible hosts are connected. During this experiment, students propose a solution for a typical scenario where the use of a DMZ network is required, for instance:

> A business company provides a web-based application to its customers. This application runs in one of its web servers. In addition, the company has an internal network from which external web access is allowed. Finally, the company maintains a DNS server to keep its name service.

From the above scenario, students perform the network topology planning, which is followed by procedures related to IP addressing and routing schemes. Finally, they start to implement their proposed solutions using the infrastructure provided by virtual machines. Figure 3 shows a typical network topology to implement this scenario. It shows the use of six virtual machines (VM 1 to VM 6). From the point of view of the learning process, two aspects justify the importance of using virtual machines in this context. First, this scenario could be implemented by one student or by a group, giving conditions to all of them to exercise the practical procedures. This is a key point for enhancing the practical skill that is being taught, which is sometimes limited by the resources available. Second, the implementation of this complex scenario would be impractical without the use of virtual machines, because it would require a large number of hosts and network devices to be available to students. Also, these equipments should have a suitable configuration for this particular practice, sometimes a difficult task in shared and frequently busy teaching laboratories.

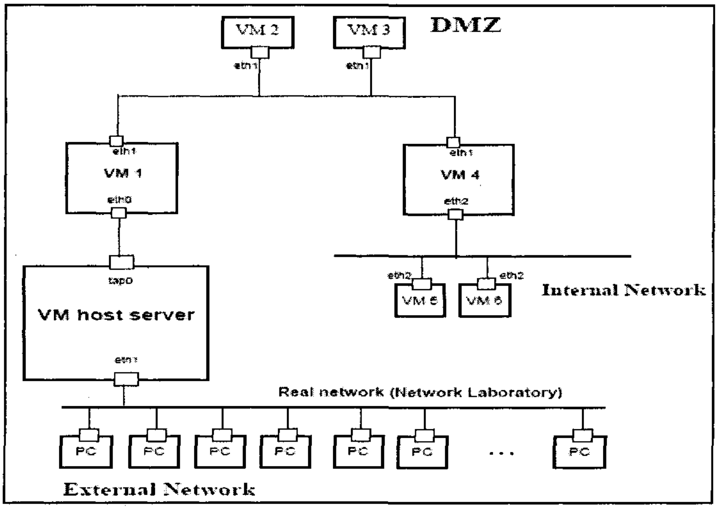

Figure 3. Typical DMZ network topology using virtual machines

In this scenario, the following network services should be installed:

- WEB Server, on VM 2: students usually adopt the open-source http server maintained by the Apache Http Server Project (httpd.apache.org).
- DNS Server, on VM 3: the Bind DNS server is used (www.bind.org);
- Packet Filtering on VM 1 and VM 4, using the IPTables package, from the NetFilter Project (www.netfilter.org).

After installing and configuring the services, students should define and apply the packet filtering rules on virtual machines VM 1 and VM 4. Below, some rules are presented in order to illustrate this scenario:

- Rule 1 - VM 1: Accept all traffic destined to VM 2 on port 80/TCP entering on interface eth0;
- Rule 2 - VM 1: Accept all traffic destined to VM 3 on port 53/UDP entering on interface eth0;
- Rule 3 - VM 4: Accept all traffic on interface eth2 destined to external hosts or to VM 2 on port 80/TCP coming from hosts which IP addresses belong to the internal network IP addressing range;
- Rule 4 - VM 4: Accept all traffic on interface eth2 destined to VM 3 on port 53/UDP.

Some other interesting experiments can be performed in this scenario. For instance, real machines located at the real network laboratory can be configured to access the virtual machine network. Doing so, students can simulate access to DNS and Web servers from external customers, allowing the investigation of possible attacks and vulnerabilities due to their configurations. In addition, browsers can be launched on VM 5 and VM 6, in order to access the Web server on VM 2 or even external Web servers.

6.2 IPSec Virtual Private Network scenario

A Virtual Private Network (VPN) consists of using a public communication infrastructure, such as the Internet, to connect securely to private networks. It provides a cost-effective solution for private network interconnection. The private network interconnection is created using techniques based on packet tunneling, encryption and authentication procedures.

The IPSec (IP Security) framework [11] is one of the most common solutions for VPN implementation. It is available on the majority of modern operating system distributions. IPSec security policies are defined based on rules providing a list of conditions and the corresponding list of actions to be performed. These actions are typically specified in terms of parameters that will be used by the communication of peering entities during the VPN session. For example, two sample rules are presented below in order to illustrate policy definition:

- Rule 1: If traffic packets use the TCP protocol and are destined to the WEB Server on port 80, then data encryption is required, otherwise reject the VPN connection;
- Rule 2: If traffic packets are coming from the 10.0.0.0/8 network then packet authentication is required, otherwise reject the VPN connection.

The IPSec framework provides two protocols for use during a VPN session. First, the AH (Authentication Header) protocol [9] defines a mechanism for packet authentication, while the second, the ESP (Encapsulating Security Payload) protocol [10], allows data encryption aiming to provide information confidentiality. A typical scenario adopted in practical experiments is presented in Figure 4. This scenario is a net-to-net VPN, where students should create a secure channel through to the Internet for network interconnection of a hypothetical company that has two computer networks located remotely one from the other, respectively, Local Area Network 1 (LAN 1) and Local Area Network 2 (LAN 2).

In Figure 4, six virtual machines are shown. The {VM 1, VM 2} and {VM 5, VM 6} pairs act as internal hosts from both local area networks. VM 3 and VM 4 are VPN gateways. Students should install IPSec packages on these gateways (e.g., the Kame IPSec Tools package available in http://ipsec-tools.sourceforge.net) and configure required policy rules for establishing the secure interconnection between networks using both eth_1 interfaces. The following are usual policy rules for this scenario:

- Policy Rule 1 - VM 3: All traffic from LAN 1 destined to LAN 2 must go through the VPN connection established between peering VPN gateways VM 3 and VM 4. This VPN session must use the ESP protocol;
- Policy Rule 2 - VM 4: All traffic from LAN 2 destined to LAN 1 must go through the VPN connection established between peering VPN gateways VM 4 and VM 3. This VPN session must use the ESP protocol.

After this configuration, students evaluate its efficiency by analyzing the captured traffic between the networks, where it is possible to examine tunneling and encryption techniques and the importance of virtual private networks for secure communication.

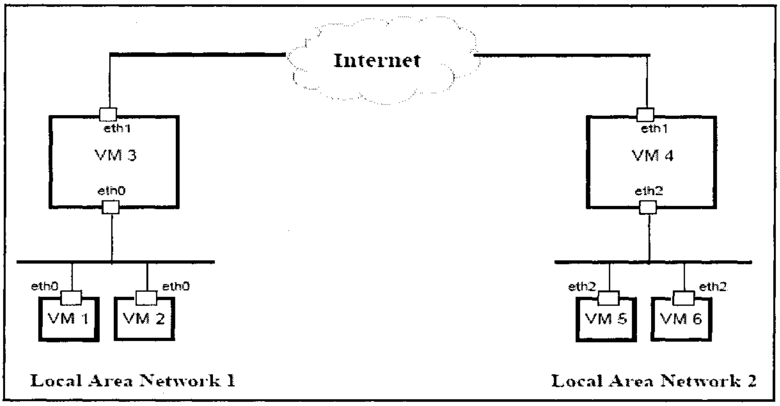

Figure 4. Example of IPSec VPN using Virtual Machines

7 Related Work

Several works present some experiences in the use of virtual machines for disciplines related to operating systems, computer networks and distributed systems learning. The work [5] presents some possibilities of the use of the UML environment for Unix server administration teaching, showing some examples for DNS service configuration on IPv4 and IPv6 environments, LDAP service configuration and routing configuration. A set of three servers hosts students' virtual machines, which can be created on demand. Real servers' access is made only through SSH (Secure Shell), which can limit the use of graphical clients by novice students. The paper [13] implements an environment, named *Velnet,* for computer network teaching. This environment is formed by a set of virtual machines using VMware and running on each student host. The communication between these virtual machines is done through virtual networks, without the possibility of communication between virtual and real machines. A graphical tool to support virtual machine creation based on pre-configured schemes was provided: routers, file servers, web servers, etc.

A different experience was presented in [15], where an IBM S/390 computer is used to run hundreds of Linux virtual servers, one for each student. These servers can be accessed from the Internet and are used for development of academic work related to operating systems and Web programming subjects. A similar solution was presented in [20]. The paper [1] shows a comparative study about the UML and VMWare environments. The configuration presented there differs from the one shown in our work because it is based on local installations on each network machine located at the laboratory, which requires exclusive access and cannot be accessed externally.

In [18], researchers propose a mixed approach, where virtual machines run locally on laboratory hosts using remote access technologies (e.g., VNC and Windows Remote Desktop) for 1) allowing teachers interact with students' desktops for supporting practical experiments, and 2) allowing students to view the teacher's desktop to get information about required configurations.

The main feature of monitors is the isolation of virtual machines from the real machine. This feature allows the configuration of each virtual machine as an autonomous host. However, another strategy, named virtualization, allows the creation of isolated and autonomous contexts under the same operating system. For example, Solaris Zones [19], FreeBSD Jails [14] and the Linux Virtual Server [22] adopt this strategy. The work presented in [2] explores the Jails functionality under the FreeBSD environment, creating an isolated replica of the user space in the operating system, each one having its own IP address. Such an approach has a better performance than virtual machines but restricts the students to user-space operations: they cannot configure or modify the network stack or the system drivers, because such structures belong to the real machine kernel and require root privileges to be managed. This restriction prevents experiments on package filtering and routing, for instance.

8 Conclusion

This paper presented some experiences in using virtual machines to teach advanced aspects of computer networks. It showed some important concepts of virtual machines and some scenarios for practical experiments, such as the setting of Virtual Private Networks and firewall architectures. Results showed several benefits of this use during the practical experiments, notably students' motivation and engagement, as well as a better utilization of the allocated time for classes. In addition, the attenuation of existing restrictions was accomplished due to the flexibility given by the use of virtual machines. This can be seen in the definition of several possible scenarios, such as network services and applications installation, configuration and operation. This rich set of possibilities allows a unique environment for computer network teaching in which students can maximize their learning experience.

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Trust in Virtual Teams: A Performance Indicator

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Abstract. This paper aims to analyze how virtual teams deal with the process of trust among the people who are part of it. The research is characterized as descriptive. The survey data techniques that were used were questionnaires via Internet and interviews by telephone. The participants of this research were eight managers from Embratel, a telecommunication company in Brazil. The results of this research pointed out that, for its participants, trust is a significant performance indicator for the collaborators and that reciprocity, positive expectation and foresight are base concepts so that all may feel secure when it comes to the risk of a negative consequence and vulnerability. The clear definition of the objectives, the emphasis in internal communication, the manager as an example and model, and the worthiness of the people become the main care and practice in order to obtain better trust in virtual teams.

1 Introduction

Virtual teams are groups of people whose work is inter-related. Despite the fact that they perform their activities geographically apart, they portray the present-day moment marked by the adaptation of available technology and administrative concepts to all scattered teams. This is present day reality since increased speed forms a competitive advantage to an organization. He who works with teams realizes that, to compensate for the fact that they work apart, the placement of some rules is important in order to be efficient. It is essential for the group to have the scope of the work clearly defined, through the necessity of vision, the mission and team objectives, comprehending what is each and everyone's contribution by the end of the job. Besides the resources, qualification, and structure for teamwork, the trust relation was one of the most contemplated variables when we developed our research with virtual teams [1].

Trust in organizations is something that operates simultaneously in different levels between the high administration, leaders, present or virtual working teams,

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collaborators, commercial partnerships, etc. Kelley [2] makes a comment on the success of global virtual teams that is specifically focused on inter-relations based and built on trust and partaking something that inefficient teams do not have.

Cufaude [3] states that the issue on trust has been discussed by many authors, mainly in the organizational area, due to the importance of this concept as an essential element of work. When it comes to organizational environment, there is a lack of completeness of the concept that people have in mind concerning trust, the conditions that make a trust relation hard or easy, the practice of virtual teams to win and maintain trust at work, and on how the lack of trust may interfere in the process and results. The emphasis in this study is to understand the different approaches by authors that deal with the subject and comprehend in a practical sense how a trust relation occurs in a team.

The issue here is: how do virtual teams deal with the trust process among those who take part in it? Thus, the objective is to analyze how virtual teams handle the trust process among themselves. The specific aims are: identify people's concepts on trust in virtual teams in the organizational environment; verify what are the conditions (dimensions) that ease or make difficult the trust relation in virtual teams and what are the cares and practices that the people and the leader adopt in order to gain and maintain trust; identify what is missing in the ambience among the people to improve and attain good results when it comes to reliability that can increase team productivity; and verify the lack of trust or a problem that might reduce trust and on how it may interfere in behavior in the virtual teams process of work.

2 Theoretic Reviews

2.1 Defining Trust

Research on updated literature lead to several authors who find interest in the trust concept as in a relevant factor in the intra and inter-working teams relationship. The foregoing definitions on trust imply three basic concepts: 1) vulnerability [4], 2) reciprocity [5], and 3) expectation [6]. Commencing from this research, trust may be defined as a disposition to diminish vulnerability in a team based on positive expectation as a result of mutual positive interactions in the past. This definition reflects on the three basic concepts of trust and the dynamic ambit of the trust cycle as well. To be vulnerable means the possibility of impairment and potentially face negative results [7].

Trust, as a concept, is the point where several organizational research disciplines inter-relate. Despite the great quantity of research on trust by scholars, there is no definition that gathers all the ideas about it [8] [9] [10]. Different areas, such as inter-organizational and interpersonal, have different operations of trust as the object differs [10].

According to Zand [5], trust is related to actions that increase vulnerability to one another. Trust behavior, therefore, involves the growth of someone's vulnerability to others whose behavior cannot be controlled. This apparently guarantees to organizations and/or individuals that they may indeed take similar risks in exchange [11].

In the organizational context, as situations become more complex, vulnerability to the authors becomes more common and predominant, given the increasing incapacity to foresee action [12]. It appears to be that trust is intimately tied to a future indefiniteness as long as this indefiniteness is human and not purely out of natural origin. Nevertheless, the trust behavior that involves disposition of taking risks is not a risk factor of its own as demonstrated by a person who plays in a casino with his likely knowledge and probabilities. On the contrary, trust behavior contains more than that: there is not always knowledge on probabilities, and vulnerability is at stake.

Another necessary condition on trust is the incapacity to monitor and control a team member's behavior due to inaccessibility [5] [9]. The interdependence of a situation on trust points out the importance of a positive and mutual interaction among confidant people. For this reason, reciprocity rules have a great importance in trust behavior and are additional characteristics that are common in it [5] [8] [11] [13]. When we speak of reciprocity rules, we mean a positive interaction case between teams and not only a foregoing experience as an object of trust [8]. The positive mutual interactions among these authors conduct to another mutual dimension of trust: expectation throughout time.

Expectation throughout time is a key factor in various definitions on trust [14]. Lewicki, McAllister and Bies [14] defined trust as positive and trustful expectations concerning each other's conduct. They use the term conduct of each other in a generalized expectation that a word, promise, written or verbal declaration of another individual or group may be trusted. The result of the expectation of another team brings up a central element in the definition of trust by Mayer, Davis and Schoorman [9]. They suggest that the disposition to take a risk is based on the expectation that the other team will fulfill a specific action to which it is trusted [9]. For most theorists, trust includes an expectation in relation to the other's reaction [15] and this expectation is naturally the awaited answer [6].

To trust, when it comes to behavior and emotion, is to have positive and reliable expectations and act as if the uncertain future acts by the others are for granted. The violation of these expectations results in negative consequences to those involved [8] [14].

The comprehended probability of loss, for example, when acknowledged by a decision-maker, is a key factor in trust behavior [16]. This highlights an indisputable historical knowledge that exalts positive expectations upon the team. A good collection of specialized books also raises the importance of positive interaction among teams, which increases reliance [5] [11]. Finally the research links interpersonal and behavioral history with changes on reliability.

2.2 Virtual Teams

Trust here is treated like a dimension of organizational interrelations. However, it can be said that in virtual teams these are interposed to peculiarities as innovating as technology that it gives support and implicates to think over specifications. The relationship environment can exist at any time and any place and among people of any part of the world. All that is necessary is that this "meeting" becomes mediated through technological resources (computers, telephone, etc.) to promote the virtual contact. However, such function with "no boundaries" attested in terms of time and space (physical environment) demands some limits that refer to the human interrelation aspect.

Zimmer [17] defined virtual teams as working groups formed by people who interact by distance in a permanent or temporary way. Proceeding from a company and/or net, by using advanced technology to maintain contact or carryout tasks they aim to achieve common purposes.

Some authors, such as Lau, Sarker and Sahay [18], indicate that the accomplishment in virtual team communication is related to social and technological aspects that complete the Social and Task dimensions. The Social Dimension refers to the personal ambit interposed by attributes of relationships that will support communication between team members. The Task Dimension involves efficiency of communication in the framework of actions and in the interchange of information for the accomplishment of terms and goals.

2.3 Relationship between Virtual Teams and Trust

Trust may contribute in the discussion about virtual teams, but exactly what kind of trust are we talking about here? In a first understanding, it is a personal characteristic, an attribute attached to education that comes a long way from an individual's personal development. This kind of trust takes a while to reach the surface and requires care to be maintained. Here we refer to the organizational environment where it is not always possible to have a long period of time to initiate a project. Also, there are possibilities such as people entering the group in the middle of the process. There is also the chance of working with people that make it impossible to get to know better as in most virtual team cases.

In an interrelationship mediated in a virtual way, the control over actions of another is even more difficult than among "real" team members. Expectation by reciprocity is great and relative frustrations to such expectation may occur. Repeated frustrations might cause fragile interrelationships among the teams and lead to encumbrance in the execution of tasks and objectives. Such consequences occur due to fear of facing new situations of failure. Thus, the promotion of trust among virtual team members has a fundamental role. According to Tzafrir and Harel [7], the probability of failure, when taken by a decision-maker, is a crucial element in trust behavior. This requires a "positive history" from all parts, which elevates positive expectations over another team. Specialized literature hints at the importance of positive interaction among teams to increase and reinforce trust [5] [11], which promotes performance improvements in these teams.

According to the literature, it is pertinent the approximation of the concept on trust to contribute in the discussion on interrelationships in virtual teams and the probability to assert the role of confidence as a significant performance indicator. Trust, as presented in [7], implies disposition in diminishing the vulnerability in the involved teams. That is, trust promotes a better power of resistance to possible frustrations, taking as base positive expectations of a team over another. Such expectations, finally, are based on positive experiences in the past in the interaction of teams.

3 Methodological Procedures

The developed research is characterized as descriptive. The survey techniques of data were questionnaires via Internet and interviews by telephone. Access to the interviewees was facilitated by the fact that one of the managers was already familiar with the researchers and accepted to participate, stimulating others to do the same. The research, from July to October of 2004, was held at Embratel, a company that offers solutions in the telephone business besides data and Internet. The participants were a total of eight managers, all between 37 and 52, among technicians and engineers. Research data analysis was interpretative.

4 Result Discussions and Analysis

For the result analysis, specific established objectives at work should be regarded.

Concepts that people who are involved with virtual teams have concerning trust in organizational environments and that trust can be considered as a performance indicator:

The research participants regard trust as a significant performance indicator for the team and attest aspects like: all energy and time will be invested in search for results; indispensable to maximize performance; energy becomes concentrated for the final objective contributing to improve the organization's fulfillment; interpersonal and inter-group trust as an essential performance indicator for the organization despite difficulties in evaluation; and without it each member's energy increases, thus diminishing efficiency.

The concepts of some participants involved sharing and reciprocity. Others indicated the foresight of actions referring to earlier situations. These concepts affirm the definitions by Zand [5] concerning reciprocity as a base concept for trust. Expectation has been mentioned by several authors like Lewis and Weigert [8]; Mayer, Davis, and Schoorman [9]; Lewicki and Bunker [6]; Lewicki, McAllister and Bies [14]; and Bhattacharya, Devinney and Pillutla [15].

Conditions that facilitate the trust relationship among people that form part of the virtual team in an organizational environment:

All participants mentioned competence and/or knowledge and technical ability as conditions to facilitate trust. Mayer, Davis and Schoorman [9] reinforce the ideas that trust behavior deals with the capacity of the team to be trusted. Cook and Wall [19] and Buttler [11] equally affirm that competence, power, ability and knowledge to do what must be done in an adequate and sufficient way will incrust security and trust in mutual relations.

Loyalty was the second most mentioned condition: it is fundamental that people should be honest and grab hold of loyalty values defined by the team;

comprehension, dedication, faith in their missions, values, and objectives in the group within the society. Loyalty is a disposition to protect and defend another person. Trust requires that you believe that the person will not be an opportunist. The participants, in this case, refer mostly on values in a team and the organization. Zucker [13] brings up base expectations to define a similar construction. Mayer, Davis and Schoorman [9] identified similar characteristics of harmony among his reliability factors. It was stated how important it was for a team to adhere to an assemblage of principles that he who trusts finds it acceptable in order to build-up trust. Harmony indicates acknowledgement, adhesion and acceptability. Disposition to take risks, in harmonic situations, increases dramatically as well as trust in positive expectations.

The third condition recalled by the researchers was on how receptive people are for compliments and criticism as well in daily situations. This makes growth possible and generates learning. Other conditions were: ease of communication, desire to help, contention, patience, emotion, power of criticism, and analysis to react with intelligence and creativity in administrative situations. Just the fact that the person works in a company is enough to believe in his own competence, loyalty, etc., and consequently in the result that the group will achieve and the compromise.

Conditions that make the trust relationship between those who are part of a virtual team hard in an organizational environment:

The participants, in general, do not explicitly express what is wrong in a trust relationship between people. One may conclude that the lack of the described conditions that ease things off may make it harder. That is, lack of competence and loyalty. One manager said that what sometimes might happen to make trust harder is mainly related to lack of accessibility to some people.

Care and practice by the leader and people in order to gain and maintain trust:

The participants show consciousness when it comes to the need to maintain the scope of work clearly defined. This includes the necessity of vision, the mission and objectives to be team domain, understanding each and everyone's contribution in the final result

Other concerns emphasize internal communication: sharing info; show concern with one another; trust behavior maintenance and group acceptance; establish and let be known the values that lead to the actions; realize and encourage the actions that reinforce common values; share positive and negative views for the future with the team; recognition of achieved results and word that all the people are important for the organization and, more than that, they are responsible for the good or bad result of work; maintain clear channels of communication.

Practice and care contemplate the evaluation of each other and the example of the leader: evaluation of the many members of the team and their competence; intense use of the practice of the delegation of the attributes and maintenance of informal environment and sense of union; act and think with honesty based on principals; be an example and take care so that the formal and informal process of communication respects the people and their differences; show respect to abilities and peoples knowledge; make sure that the action is coherent with the discourse; when deciding upon occurrences, till you can prove the contrary, act admitting that the other person acted accordingly. For the leader to maintain confidence, he must be consistent and be an example, fulfill promises and share future sights with both positive and negative aspects with the team. There is still the incentive in participation, recognizing the original source of ideas and/or true effect of certain feats; eliminate dishonest members in a team through autonomy and the delegation of decisions. These results complete the affirmatives by Kelley [2] that a virtual team's success is focused on interrelations based and built on trust and sharing, which is the differential upon teams that do not.

What is missing in an environment among people to improve and attain better results when it comes to trust that can meliorate the team's productivity:

Some consider that individual attitude is an obstacle for the improvement of team results. Aspects such as too much concern with one's self are detrimental to the group. Personal vanity and unmeasured ambition are a hindrance in the establishment and cultivation of a reliable behavior in the ambit of a team.

Others say that there is a lack of time for people to get to know each other better. It becomes an obstacle to productivity. One manager mentioned the need of events for such purposes. Even if the team is virtual, they could have a chance to make direct contact by meetings, courses, parties, etc., and attain a greater bond of trust. Direct visual contact, most typical of human senses, is indeed important. Another is the lack of knowledge concerning the executed task by another person, including lack of information and accessibility.

Lack of trust or a problem that weakens trust and interferes in the people's behavior at work in virtual teams:

The question had the intention to verify the lack of confidence among the people in teams or a problem that reduces trust or interferes in the behavior of people in the process of work in virtual teams. The participants, in a general sense, understood what factors were generated by trust and observed aspects such as doubt in people's minds, questions and thoughts that increase preoccupation at an additional cost of energy under supervision. This is enough to make items of verification and additional controls. One said that the lack of trust or a problem that causes it interferes with our behavior causing longer cycles to execute activities (standard process); demand of greater formal relationship, sometime through writing; interruption on normal flux to evaluate the exchange process. There is a reduction in sharing knowledge and information, a waste of energy that does not result in increased volume of production nor in better quality production. In truth this fact lifts up defense barriers and brings forth isolation. It was also stated that dynamism and fluidity that should exist gives way to resistance and defense in a way that if more members break down in trust, group quality falls and mission, values and objectives of the organization end up in poor standing with the customers. Lack of trust causes the energy wasted by each member to increase. When there is trust, the tasks are better distributed, the necessity of control (check-list) is smaller, and the action procedures are more internalized and integrated. This factor is determined for success at work in virtual teams.

5 Final Considerations

This work was an opportunity to analyze how a virtual team deals with trust among those who make up a group.

The participants of this research make it clear that they consider trust as a significant performance indicator and that reciprocity, positive expectation and foresight are base concepts that make the participants feel secure about the risk, negative consequences and vulnerability.

They relate interpersonal and technical competence, loyalty and receptiveness as important conditions to facilitate trust relation among people. Competence is defined in the sense of capacity, abilities, technical and interpersonal knowledge of the individual. Loyalty refers to agreement, adherence, and the acceptability of values of the team and the organization. Receptiveness is related, in this case, to be open to receive criticism and praise. They also consider that the lack of mentioned conditions harden a trust relation.

The main care and practice regarded by the participants are related to clear definition of goals, emphasis on internal communication, spread out, repeat and communication (formal and informal) of the objectives, values and aims of the group, and being an example and model giving people rightful value.

The participants believe that an emphasis on individual thought may impede improvement in productivity in the group. All agree with the abrading results of lack of trust that may occur among people in the group.

With these results the suggestions are:

Adopt trust by involving base concepts (reciprocity, positive expectation and foresight) as the team's performance indicator;

Talk with the team about their values and that of the organization with the intention to verify if people are understanding each other the same way;

Check on how each person deals with receptivity in order to accept criticism and praise, and to qualify people to give and receive individual feedback in a group;

Adopt a system that may accompany and verify that all participants are understanding the objectives of each process;

Adopt a system to determine people's perception in relation to the evaluation of the collective results and each one's role in the final result.

Work brings a subsidy so that the team may perfect their performance and reflect upon their behavior individually in a team.

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"Aquatic Metaphors": an Innovative Interface for Virtual Learning Spaces

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Abstract. Virtual learning environments are widely used in distance education as the learning space of choice, mainly for interaction and collaboration. However, they generally don't provide means to integrate easily other learning spaces. This paper presents and explains a new interface which can unite information spaces - such as the web or online learning materials - with interactive spaces such as virtual learning environments (VLEs). Originally developed for an online course offered by a network of Brazilian universities, the interface was inspired by what we call the "aquatic metaphors" (navigation, surfing, diving and others) widely used on the internet. This interface is flexible enough to accommodate traditional teaching methods centered on instruction and written materials, as well as more open methodologies and active practices based on discussion, team work and collaboration.

1 Introduction

Interface design for virtual learning environments and other digital resources for distance education often start with a metaphor to provide a recognizable representation of the computer system being employed. This widespread trend in interface design has an established tradition, dating back to the first interfaces claiming to be "user-friendly", with the ubiquitous desktop metaphor as the best example.

"It is not hyperbole to suggest that without metaphor, interaction design today would be severely limited, especially in the digital realm. After all, no one addresses his computer without some metaphoric mediation; we do not speak machine language. Metaphor provides us with the means to understand our complex digital devices." [6, p.7] A metaphor is "a device for seeing something in terms of something else. It brings out the thisness of a that or the thatness of a this". We

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need a common ground to "conceptualize one domain in terms of the other". Therefore, a metaphor is always grounded in culture and language.

The seminal work on metaphor is the book by Lakoff [3], in which he challenges the traditional vision that took metaphor merely as a figure of speech. He states that metaphors work as "cross-domain mapping" and that because our mind is essentially associative, the use of metaphors and comparisons are an important part of our day-to-day experience.

In distance education, when we try to minimize the difficulties brought by the spatial and/or temporal separation of the educational agents, a well-chosen metaphor can be part of the necessary bridge between the familiar environments and the new setting, through sharing a common referential that is recognized and valued by all.

"Having a shared metaphor helps to maintain a common understanding of a project and makes it easier to negotiate compromises as the pressures ... increase throughout a project" [9]. The metaphors we present below [7] were the starting point in the design of the interface linking information and interaction spaces in an integrated virtual learning environment for distance education courses and activities.

2 Aquatic Metaphors

To navigate the internet, to surf the web, to dive into the ocean of data: these are aquatic metaphors that reveal something about the fluidic nature of the new information and communication media.

We meet those metaphors in various kinds of texts (in newspapers, academic journals, web sites and even popular songs), showing that this imagery helps us in some way to make sense of the internet and its multiple levels and components, surfaces, connections, fluxes, refluxes, and currents.

To surf suggests a promenade on the surface, when we let ourselves be conducted by a force that carries us in a pre-defined, unquestionable direction. As when we follow links, we click on buttons and image-maps that take us to other pages, through ways that have been laid out for us beforehand. Surfing is a movement a bit loose, without the pressure of making important decisions all the time. It is enough to know how to enter the wave and use its impulse, enjoying the ride until the wave weakens. We return then to engage with another wave. We surf the web following interests and motivations triggered or instigated by the information we find and by the forms in which it is presented to us.

To navigate - when we think about navigation, old explorers, bold sea-farers come to mind, moving from known harbors to discover new lands without knowing for sure if they would succeed or even if they would manage to return. To navigate is to dare, to investigate, to explore, to follow moving paths on changing, fluid surfaces. On the internet, navigation is the movement par excellence since the volume of hyperlinked web pages began to grow until - drop by drop, page by page - this vast ocean of data and information was formed.

To dive is to deepen our point of vision, to change our relative position to the surface, descending towards levels which were not visible when we surfed or sailed.

To dive is to penetrate the ocean of information with purpose and care, to move with a certain degree of planning, going beyond the upper level, the surface.

The proposal we will present next is based on the aquatic metaphors. It was developed to meet certain challenges and demands in a specific context. In this paper, we will first present the context, with the demands we had to address, and then we will move on to lay out the design components and pedagogical foundations of the proposal with which we intend to meet those challenges.

3 The context

The motivation for the creation of an interface capable of uniting two different (although complementary) virtual learning spaces came from two directions.

First, from the Distance Education Centre at the Pontificial Catholic University of Parana, Brazil (PUCPR) which was re-organizing into the course-based, business-minded PUCWeb, offering extra-mural, diploma and post-graduate courses as well as corporate and professional training. Second, from the invitation received from the management committee of the Virtual Learning Community of the Network of Catholic Universities (CVA-RICESU), which challenged us to develop a course on technology in education, to be offered to all the institutions of the network, future multipliers of the course in a regional level. The course, however, should be designed in an innovative way, innovation in distance education being one the major objectives of the network, which is organized as self-managed virtual learning communities.

Teachers engaged in preparing distance education courses often own teaching materials they have developed themselves, either as support to their face-to-face lectures or as independent study materials. It is quite understandable, then, that those teachers may want to use their materials, in a direct or adapted form, in their distance learning courses as well. However, online courses should not be a direct transcription of ink-on-paper texts into pixels-on-screen ones. The internet medium demands less linear, more interactive forms of communication.

The transition from classical ways of teaching to new learning practices is, for many teachers, a difficult and painful process. We wanted to find ways to make this transition easier and less frightening, bringing more teachers to participate willingly in the educational transformations our institutions are struggling to implement.

It may be reasonable to assume that educators agree about teaching not being merely the act of "exposing students to contents". In these days of constructivist fashion, it would be very difficult to find a written defense of traditional expositive lectures as the best teaching strategy.

Nevertheless, when we look beyond the introduction and justification parts of a DE project, when look attentively to what is actually happening in the VLE, we are prone to find conservative attitudes, mostly supporting (not always explicitly) traditional instructivist, information-passing, teacher-centered practices.

This contradiction reveals that the major "distance" to be found in distance education is the distance between discourse and practice.

4 Virtual learning environments and the issue of content

The majority of the virtual learning environments developed under the inspiration of constructivist or interactionist ideas offer few tools to deal specifically with the "content". Emphasis is on communication and interaction tools, not on resources for systematically organizing and displaying information.

On the other hand, there are many VLEs which are basically a set of content pages, grouped under a home page with a graphical interface. Even with the addition of a few communication tools, they are as far from being a learning environment as, say, a book or a film.. The design of content "pages" (a revealing expression...) tends to be excessively linear and static, treating information in a single-level way, therefore missing the chance to explore the potential of digital media for non-linearity and non-sequential display of information. Besides, classical interfaces are not known for their flexibility and adaptability, facing many difficulties to grow in sync with the course and with the needs of the educational agents involved in it.

Even when we have some resources for dealing effectively with information in DE courses, our teaching experience shows us that the average student is the one we tend to address in our face-to-face lectures and in our printed study materials. We find it very hard to give proper attention to those students who have the potential to go beyond the average as well as to the ones who are not managing to follow the average group. The important issue here is that if we aim for just the average, we should not be surprised if we get back only the average, and afterwards we should not complain when we need the above-average and we don't have it. Digital technologies can help us in our effort to address all students, not only the average, making distance education truly innovative and significant in its contribution to pedagogical change.

5 Learning Spaces

We understand virtual learning space as the social, cultural, intellectual locus where learning takes place, mediated by digital technologies.

Our proposition involves two complementary, integrated virtual learning spaces linked by an interface designed under a structuring metaphor.

The first of the two spaces is the information space. A space for content, required and complementary reading, organized and systematized knowledge, references, material for further analysis and discussion, cases and examples, made available to the students in written and multimedia materials, conceived and prepared (initially) by the teacher/author. Students access these resources via our interface, using a computer connected to the internet.

The second is the interaction space. A space for communication, discussion, debate, collaboration, cooperation, collective construction, open to all educational agents in interaction - teachers, authors, tutors, invited participants. University-developed or commercial virtual environments can be used for this purpose, as long as some basic technical specifications are met.

The integration between the two learning spaces is done through the activities. It may be said that this proposal is activity-based, even though, at first sight, it may give the impression of being either content-based or discussion-driven, if the first or the second space is seen in isolation. In our understanding, the activities (tasks, questions, challenges and problems) are the heart of the course, although the interface brings to the front-end the information space.

The design of the activities is central to this proposal. Being the main link between the information and the interaction spaces, the activities must be designed following a set of guidelines derived from an overall pedagogical strategy which includes specific strategies for developing, coordinating and assessing activities according to the degree of interaction, cooperation and autonomy of the participants of the course in focus [8].

6 The interface for the information space

Metaphorically compared to a shifting ocean of information and multimedia, the internet comprises a diversity of movements, such as the ones the aquatic metaphors refer to: movements over a line (surfing), on a surface (navigation) and in depth (diving). As we wanted to treat course contents as information, we were attracted to the possibilities of the main structuring metaphor, which could help us to meet the challenges mentioned earlier and even go beyond them, creating an innovative learning environment where different teaching and learning styles could co-exist.

The areas of the interface

1. Map of the Journey (planning your trip). This icon, once clicked, drops down a list of the study themes of the course. Study themes or study units are the major course components and can be modules, chapters or even lessons. They are designed, both technically and pedagogically, as learning modules, similar to learning objects, so it would be possible to reuse a module in other courses.

When a study unit (one "leg" of the voyage) is chosen, a screen with the first page of the corresponding "Navigate" area is automatically opened. In it, a short story, taken from day to day life, focusing the main subject of the study unit, is used both as a teaser and as a case from which the "content" of the unit begins to flow.

2. Navigate. In this area, the teacher-author offers the basic text (we use here the word "text" in a broad sense, including audiovisual and multimedia texts) corresponding to the study theme chosen by the student.

The content here must be the one the teacher considers as the necessary minimum for the students to obtain an acceptable understanding of the subjects grouped under the chosen study unit. Being so, what we find in the "Navigate" area is the product of a deliberate, conscious choice of the teacher and precedes contact with the students. It corresponds to the latitudinal cut in the information universe.

Navigate corresponds to what the teacher would select for his/her written material, tutorials, study books or face-to-face lectures. In the "Navigate" area the students must find the essential content, the base reading and viewing material for the module being studied. This means that if a student does not have the time or the will to expand or to deepen his/her studies on that theme, he/she can go forward in the course without being penalized in any way and without the risk of missing something crucial for latter studies, as long as the readings and activities in the Navigate area are completed satisfactorily..

Pre-existing material, written or prepared for other media, can be re-used here, but we advise teachers to re-write them in order to take full advantage of the medium and explore all the possibilities opened up by the new interface.

In fact, re-thinking the materials that were used in face-to-face classes in order to produce a distance education course presented via our multi-level interface is a great exercise and may well be one of the important outcomes of the whole process we are experiencing in this project. Face-to-face classes may, hopefully, benefit from the recreation of the study materials, balancing information, discussion and action.

It was said before that the **activities** are the main bridge between the information space and the virtual learning environment. They are the pedagogical artifact which should instigate the students to start discussions and debates that motivate them to engage in collaborative practices and other forms of interaction that the environment may support. For this course, the strategy suggested by [8] was followed. This strategy lays out a series of layers, beginning with task-based learning and moving towards learning based on processes, aiming to achieve the necessary conditions for the developing of collaborative learning.

Complements of the Navigate area

- Rowing...

This mark is shown beside the text presenting an activity, setting it apart from the main body of text. It contains a link which points to the appropriate area of the VLE where the activity is expected to take place, such as the chat room or a forum topic. Rowing implies moving by our own strength and will in a chosen direction, without the help of wind and sails, an effort the participants will have to make (individually or collectively) in order to accomplish the activities being proposed.

- Synthesizing...

Students are expected to produce a synthesis of what was read, discussed and experienced in each stage, sharing it with the other participants in the learning spaces being used by the course. This activity can become an essential part of the evaluation process..

- Clarifying...

This icon signals annotated reading references, audiovisual aids, new activities and other forms of presenting the information in different ways than the one used in the Navigate area and its complements. The objective here is to provide students that are, or may be, facing difficulties, with the opportunity to engage with the course material in new, refreshed, ways. Sometimes through the use of different media, sometimes with a different kind of activity, examples, cases and other resources meant to clarify central ideas of the study unit.

3. Sailing. Here the teacher has the opportunity to expand the horizons of the study unit, bringing connected subjects for which there was not enough time (in face-to-face classes) or space (in printed materials) to present and discuss properly.

In the Sailing area the surface can be extended or enlarged to cover subjects which are connected to the study unit main theme. To sail, then, is to expand, to amplify the surface defined in the Navigate area, allowing the teacher/author to bring into the course subjects which would not fit into the tough constrains of time (in face-to-face courses) and space (in printed or sequential media).

4. Diving. In many occasions we face the frustrating situation when a student comes to us after class and asks us for more information or comments about the subject we have just presented. Often on these occasions, pressed by the short time we have for such interactions, by other appointments or tasks, or even by tiredness, we give the student one or two references, tell him/her to send us email asking for more stuff and walk away, with the unpleasant feeling that we failed to respond as we should - and would, in more favorable conditions. Only in a few opportunities do we have the time, the resources and the will to give an inquiring mind the attention it deserves.

In other occasions, when we are preparing printed study material, we have to conform not only to the limited space we are allotted, but also to the way study units should be dealt with. We cannot - at the same time, in the same material - write in a way that is both appealing to the majority of the readers and complex enough to satisfy advanced students. We have to opt between covering the whole surface or to dive in some spots, reaching new depths. In other words, the choice we have to make - taking the subject matter in a broad way or in depth - defines the form we are going to give to the subject and eliminates the other possibility. There is no compromise, unless we are given more space or time, both of which we rarely get.

In a digital media like the web, this is not an eliminatory choice. We can treat a subject matter with the degree of complexity we want, while still retaining the choice to enlarge and expand the surface we covered in the basic text. In this way, the Diving area is where the teacher/author introduces topics and subjects prepared for the students who want to go deeper into the study unit's main subject. They can (at any point of their navigation) plunge into the information and reach deeper levels, augmenting the complexity of what is being discussed in the Navigate or Sail areas.

Dive and Sail both lean on one of the main potentials of the digital media: that of establishing non-sequential connections between parts of given material. This, in turn, opens up the opportunity to address the whole range of students, including those who wish to go further or deeper than the average: in properly designed digital material they can also find information, opportunity and guidance to do so.

5. Anchoring. Here is where students may stop at a calm bay to reflect on the journey made so far, linking previous experiences to the new landscapes seen in each leg of the trip. Authors of many different streams agree that one of the more important conditions for learning is the establishment of meaningful connections between what we are trying to lean and our previous knowledge and life experiences. Placing the newly constructed knowledge in the broader context of our professional and personal lives is essential for significant learning. The Anchoring area is where we provide the stimulation and the opportunity for the students to make those connections and to share them with fellow crew members, who may find in those reports a rich source of ideas, views and inspiration.

6. Orientation. In this area the students can find general information about the course, such as its syllabus, timetable, methodology, assessment and other components. Future versions will include a personal map (a "Chart"), in which each student's trip can be dynamically represented, and used both as a record of visited places and as a planning tool for future movements. Guidance and advice about the process of learning at a distance are also offered in this area.

7. Diary. This area is where the students keep their records of their own trip. According to the pedagogical choices of the teacher, these records can take a variety of forms, ranging from a simple description of the student's chosen path of studies to a full portfolio.
8. Interact. Clicking on the Interact icon takes the student immediately to the virtual learning environment, where he/she can start a new topic in the discussion forum, contact other participants via email, open a chat session and so on. This can be done at any point whenever the students feel the need to engage in conversation, synchronous or asynchronous, with other participants.

We explained earlier that all activities demanding interaction among crew members have an accompanying icon (Rowing) that takes the student directly to the area of the VLE where the specific activity may be carried out. However, Rowing is a teacher-centered action (at least at its start) and so the choice of the interactive tool to use with it rests with the teacher. The Interact icon allows the students to decide what to discuss, when and with which VLE tool, at any given time of their trip.
9. Help. This is a standard area where the student can find information and advice on how to use the interface and its elements through a guided tour of the interface that uses an exploratory approach.
10. Crew. This includes a list of all the participants - students, teachers, tutors, support staff - who are actually engaged with this specific course and group. Multimedia self presentations by the group members are encouraged. This is an important feature of the interface, not just a nicety. Social interaction is one aspect of face-to-face classes that students would like to keep, even in a different format, in distance education courses. A dynamic page soon becomes a meeting point. An open notice board enriches the page.

New elements can be added to the interface, following the main metaphor, as new situations and learning needs arise. The interface is flexible enough to incorporate new features without loosing consistency.

7 Benefits of the proposal

The proposal is expected to help students to establish the essential connection between what is being studied and their previous knowledge, life experiences and practices, which are not usually considered as they should be in distance education It also considers students as active learners, capable of learning in many ways, accessing and re-signifying information, discussing ideas and concepts, constructing knowledge individually and collaboratively, developing cognitive, practical, affective and social skills and competences.

This proposal was firstly conceived as a helpful resource for authors of online teaching materials and instructional designers of distance education courses. As such, it allows authors and teachers:

- to organize information in different levels (from the more basic to the more complex, from the more panoramic to the more focused) in accordance to the non-linear potential of the web.

- to structure each course around modular components, which can be re-used in other courses and situations and to combine study units in new ways.
- to address students with different degrees of motivation, commitment, available time for study, experience and learning styles.
- to address the whole range of the students, from the ones who are not up to the average to the ones who want to and can go further or deeper into the subjects being studied.
- to treat course content as multi-level information.
- to use, in the digital media, teaching materials previously developed for print media, as long as they are adapted to the logic of the interface and the language of the new media.
- to amplify the study themes with more information, questions and discussions then face-to-face classrooms or printed materials allow.
- to incorporate future growth and development, adding new areas, functions and tools, following the central metaphor of navigation.
- to integrate activities, information and interaction in the same environment under the interface designed.
- to promote individual and group practices, seen as necessary steps towards collaborative learning.
- to follow a less abrupt transition from teacher-centered practices based on information transmission, to student-centered practices based on interaction among learning agents and continuous (re)construction of knowledge, with support of interactive technologies.
- to develop collaboration, progressive discussions, communicative exchanges, meaningful interactions, the building of common references and repositories, self and group evaluation, and other collective actions.

8 Closing remarks

The "content" pages of the information space can, of course, be considered as being still teacher-centered, and as such, affiliated to a transmissive-instructionist model, because it focuses on ready-made content. We take this criticism as an alert for authors developing such teaching materials.

We must stress the importance of the metaphors employed as orienting ideas for the design of the interface presented above. They are not a mere background or a holding place for pages that are not substantially different from book pages. They offer recognizable references for the establishment of an organizational space which encourages teachers/authors to think about their areas of specialization from different angles. Preparing a course following the guidelines embodied by the interface is a challenge that includes treating content as information, and information as a multiple-level universe. It also stimulates the teacher/author to conceive and develop engaging activities, which should be designed in such a way as to foster reflection, critical thinking and the individual and collective reconstruction and re-signification of knowledge.

Our experience showed that the decisive aspect for the success of such proposition is the design of the activities meant to bridge the two learning spaces. Metaphor, interface, information pages, and VLE, used as they were in such an integrated form, permit the development of motivating, enriching activities, but it is in their conception, design, implementation and follow-up where the greatest challenges reside. Being so, we point out the importance of the innovative interface we designed for bridging information and interaction spaces in virtual environments and distance education courses, but it must be emphasized that without good, appropriate activities, creatively designed and competently developed, interfaces, metaphors and virtual environments will be of little help in surpassing the limits of the face-to-face classroom and the shortcomings of traditional pedagogies.

This proposal, although centered on aquatic metaphors, was conceived with feet on the ground. In a certain measure, it is quite pragmatic, taking into consideration the need to facilitate, for the teachers/authors, the exercise of their teaching practice in this modality, which is a new one for many professionals and uses technologies and media with which not all teachers are familiar with. It is a provisional proposition and so is open to modifications which may lead, more than to its improvement, to its overcoming. It is a transition proposal, and, as such, doomed to be transitory. In a certain way, the success of this interface will be judged by the degree of its mutability...

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Influence of Individual Learning Styles in Online Interaction: a Case for Dynamic Frequently Asked Questions (DFAQ)

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Abstract. Although current literature on learning styles shows that matching a teacher's instructional style with the learning styles of students affects performance in a classroom environment, little is known about the influence of learning styles in online interaction. The paper argues that students' individual learning styles influences how students interact online and that rather than adapt to user's learning styles, online environments tend to force behavior change on users' learning styles. The paper discusses a project in which students with varying learning styles used an online consultation (DFAQ) tool for collaborative knowledge sharing, and reports on how learning styles influenced online interaction and the use of DFAQ changed rather than adapted to users' learning styles. The paper concludes that for online environments to be educationally efficacious, sensitivity to different learning styles is desirable though the implementation of such sensitivity is non-trivial.

1 Introduction

While technologies are increasingly used as teaching and learning tools, not much is known about how users adapt their learning styles when using technology and how technologies may adapt and change to meet diverse learning styles of users. Although online learning environments "provide an environment for differing learning styles" [1], working in online environments requires that learners "change behavior" [2], and different learners follow different "patterns of learning" [3]. It seems reasonable that understanding how students' learning styles influence patterns of online learning would lead to designs of "equitable" [1] and "culturally inclusive"

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[24] learning environments. Learning styles have been associated with cultural inclusion [1], cultural amplification [25], belief systems [25], social values [10] and academic performance [5][20] but the influence of learning styles on how learners interact online has not been investigated; hence this paper. The Internet is reported to affect learner-teacher relation [23], and online conversation affects dialogue [21] thereby influencing interaction and learning style. In this paper, learning is used in Argyris' way which is "the detection and correction of error. An error is any mismatch between our intentions and what actually happens" [8]. It follows that a learning style is a technique used by a learner to detect and correct his/her own misconceptions or misunderstandings. The paper does not distinguish learning styles from "learning preferences and learning strategies" [9], as these tend to converge in an online interaction.

The rest of the paper is organized as follows: section 2 and 3 discuss why the project focused on online interaction driven by questions and related work, respectively; section 4 discusses the theoretical framework which provides lenses used to analyze the artifacts of online interaction; in section 5 the methodology including the case study is described; findings are discussed in section 6 and the conclusion in section 7.

2 Focus on questioning

We also can't learn without asking questions, and merely recognizing that an object is different, and not as we first thought, presupposes the question whether it was this or that [11]. A child who asks questions about fire would have a richer and broader learning experience, including the purposes of fire, its dangers, and its benefits, when it is used and how; than one who asks no question but only touches.

In online consultation "textual meaning is not viewed simply as an assertion about a state of affairs but as something to be responded to" [12]. Text is an invitation for discourse. To ask a question (text) is to bring whatever is in question "into the open" [11]. A question is therefore a vehicle through which its contents are brought into the open. However, what exactly is brought into the open, in what way it is brought into the open, and the depth with which it is brought into the open differ depending on individual learning styles. Thus the focus on questioning was partly motivated by the need to teach students questioning skills and use of questions as an online conversation catalyst to foster knowledge sharing among peers.

3 Related work

Miller's [5] study compared two instruments, the Gregory Style Delineator and the Kolb Learning Style Inventory, while evaluating the effects of learning styles on performance when using computer-based instruction system; Montgomery [6] investigated ways in which multimedia can be used to address the needs of a variety of student learners; Liu and Reed [7] measured patterns of learning by the frequency of student access to different functions in a hypermedia environment. Some of the instruments used to measure learning styles include: Honey and Mumford's Learning Styles Questionnaire [15]; Direktor's Learning Style Instrument [16]; Soloman's Inventory of Learning Styles [6]; and the Group Embedded Figures Test [3]. None of this work focuses on online interaction, and influence of learning styles has not been applied to self reporting empirical materials.

4 Theoretical framework

An investigation of learning styles in online interaction is sandwiched between individual approaches to learning on one hand and technology mediation on the other hand. There are two approaches taken to unravel and gain insight into the phenomenon. We gathered data on individual learning styles through self reporting. Analysis of online interaction was achieved through artifact (content) analysis. The tertiary goal of artifact analysis is to determine whether users of different learning styles ask different types of questions and in what ways does a mediating medium shape learning styles? The challenges lie in finding evidence [10] of learning styles from online artifacts. The word "evidence" is used loosely in that an interpretive research paradigm is applied.

Thus, rather than attempting to extract evidence from artifacts, we sought to use self reporting as an evidence base. The underlying thesis in this paper is that in online interaction the way that users process and post messages and the meanings that get associated with the messages alter individual learning styles and influence online interaction. To investigate this, McLoughlin's [9] forms of information presentation to match cognitive style were adapted because of their focus on processing and conceptualization of information. McLoughlin [9] postulates four forms of information presentation to match cognitive styles:

Table 1: Forms of information presentation to match cognitive style

Style	Learner characteristics	Text presentation
Wholists	Tend to see the situation as a whole	Advance organizer to indicate parts and structure of material
Analytic	See collection of parts	Overview to provide a picture of the whole
Verbalisers	Represent knowledge verbally (speech and text)	Verbal versions of pictorial material
Imagers	Represent knowledge pictorially (images)	Pictorial form verbal material

McLoughlin argues that this categorization is useful as it suggests that learners differ in terms of two fundamental dimensions:

(a) Wholist-Analytical: this dimension describes how individuals process information. Analysts tend to process information into component parts, while wholists prefer to keep a global view of the topic.

(b) Verbaliser-Imager: this dimension describes how individuals represent information during recall. Thus, verbalisers tend to present information in words, while imagers tend to present information in pictorial form.

Accepting McLoughlin's two fundamental learner dimensions, it follows that learners interact online differently and that the tool of interaction may have varying impact on interaction depending on a learner's cognitive style and the learner's interpretive logic of dialogue. An interpretive logic of dialogue in "the creative play of question and answer, whereby what is stated about the subject matter may be understood productively as an answer to a question" [12].

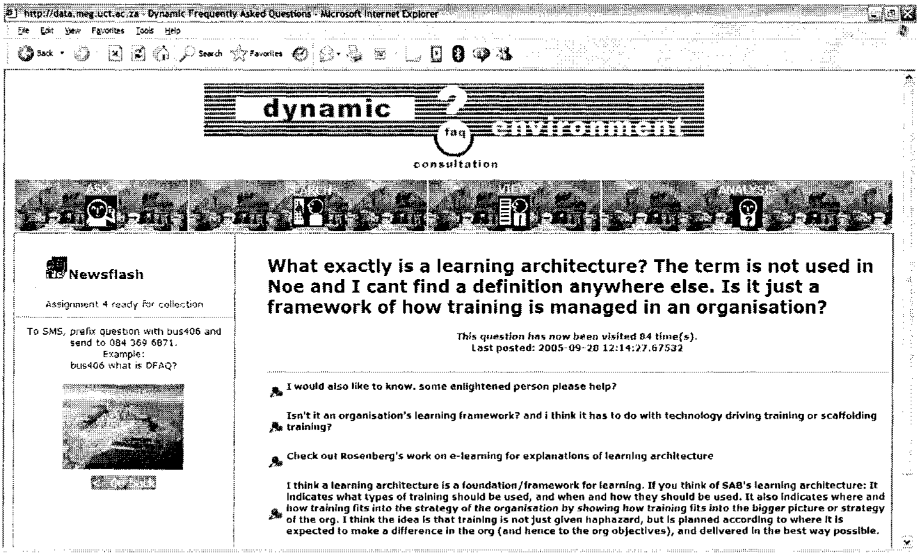
5 Case study description

In this study, honors students in a semester course in Organizational Learning at the University of Cape Town (UCT) engaged in an online knowledge-sharing experience. UCT is a medium-sized contact institution and ICTs (Information and Communication Technologies) form an important part of teaching and learning but do not necessarily dominate the contact character. Students in the honors class were from diverse socio-historical, cultural and economical backgrounds. In view of this, the class had learners with multiple learning styles, the diverse backgrounds meant rich and diverse opinions, came from multiple locations (were not all resident on campus) and used different mediating tools for communication (such as networked computers and cell phones). Learning tasks were designed to encourage collaborative learning. Dynamic frequently asked questions (DFAQ) was a medium of interaction.

DFAQ is an asynchronous knowledge sharing tool [18] whose artifacts provide insight into how students detect and correct errors through anonymous posting of questions and responses. Sims [19] rightly observes that little is known about the way people learn with technology and therefore there is no guarantee that creation of an automated complex interaction would accurately adapt to the individual student's learning styles. DFAQ (see Figure 1) served as a medium through which students accessed a shared information resource created from artifacts of interaction. The users post questions using a web interface or the SMS from their mobile phones. The artifacts (questions and responses) of interaction become visible to other students who lookup or reference the resources (questions and responses).

At the end of the semester (six-month course), students were invited to volunteer to be part of a focus group to discuss their learning styles and their experience with the DFAQ knowledge sharing tool. This approach is pragmatic in view of other studies that used psychometric tests [9] and questionnaires [3].

Figure 1. DFAQ User Interface



6 Findings and discussion

This section is divided into two parts. The first part analyses transcripts from a focus group in which learners reported on their individual learning styles. The focus group discussion was held after a six month session in which learners engaged in an authentic online knowledge sharing activity. In the second section, an analysis of the influence of the tool on online interaction is presented.

6.1 Learning styles and information presentation

Our assumption was that student forms of information presentation (mental process) influences online interaction (outward actions). Following an online experience, we asked students a self-reflection question on how they generally learn. One student said:

a) I found in school I learnt to practice cross reference, cross reference, cross reference, now if I can see something from a map review and I can almost picture what we study but in the sections in my mind and I understand it much better and also with colour – in my notes with colour because I can picture the colour in my head and I am thinking about that and in terms of honours I found it great in terms of understanding what you have learnt in application

The above statement suggests that the student is a wholist (inferred from a "map review") and advance organizer (suggested by cross referencing). The use of colors for representation shows that the learner is an imager. A similar learning style was mentioned by another student:

b) I am a colour child, I love highlighting everything I learn in colour and in pictures and mind maps are the best, if I can see an overview of what the material is that I need to learn it is fantastic, picture it and remember it and regurgitate it at any time.

Suggested in the words "mind maps are the best" and "overview" is that the learner is a wholist. Another student reported that,

c) I am quite an open learner, I do a lot of research, I love reading so I go and get lots of information and I try to sort it out in my brain and do discussions with people.

In this statement the student uses discussions with people as a means of filtering information gather from research. This "filterist" approach is not one of McLoughlin's categories as the student in this case is a late organizer as opposed to advance organization. However, the "doing of discussions with people" suggests a verbaliser learning style. Another learning style that did not fit neatly in the McLoughlin's categories was a "practical" learning style.

d) I have always been a very practical person so I like to apply what I learn to different parts of my life or be able to make associations with what I am learning in other areas of my life, otherwise I really struggle to just understand concepts without having some practical application.

For a "practicalist" the need for practical application of knowledge is critical and it's the application that provides the structure in which text is represented. However, sorting information in ones brain (see student comment (c)), presumes that a student has memory. The problem is that not every student has memory as this student testifies:

e) I have a strange way of learning because I have no memory whatsoever. I have to read everything until it is common sense to me. I read anything that I can get my hands on and eventually the things start making sense in terms of the assignment that we have to do, those are the kinds of things that I can remember, everything else should go... I can't make notes... I don't have a memory so it is very much just read until it is general knowledge and work from there and also keeping things organised in my head.

The assignment is used as a structure base and the "reading until it is common sense" could be a way the student sees the collection of readings becoming part of a picture of the whole. This approach indicates that a student is an analytic. This is how one student said works for her/him:

f) And also reading and writing, not just reading in isolation but writing it down even if it is just scrap notes, just to write it down is a second way of getting it through your brain and then I also find that I compartmentalise my learning and my courses which is great for an organised point of view but also I find for me I tended to sometimes lose sight of a bigger picture and that all the six courses that we have done are all tied together and sometimes you lose sight of those links.

The learning approach of writing down and compartmentalization of learning suggests the treatment of information as a collection of parts hence an analytic style. Taking notes is a form of interrogation of text and the learner is therefore a type of Verbaliser. While note taking works for some learners others adopt approaches that would help them forget.

g) I think I am quite a strange learner because I like to get as much information as possible and then try to decide what I need so I get everything, I read everything I can, I cram it all in and then I decide what is important and I forget what is not important and I only take what is important – I keep the important parts if it is very important.

Although the learner is assumed to have a reference point in determining what could be important, the fact that the learner deliberately chooses to forget is an important characteristic. Thus, this "forgetist" learning style does not fit in any of McLoughlin's categories.

In the next section we discuss how a mediating tool (DFAQ) influenced learning styles.

6.2 Effect of DFAQ interaction on learning styles

The underlying premise of this section is that a mediating tool (DFAQ) models behavior of users in ways that influences learning styles. Students reported adapting their learning styles to fit with the design of the tool. One student compared face-to-face interaction with DFAQ mediated interaction as follows:

h) I found that you had to express yourself quite clearly because when you are in a conversation, the person will say to you that they do not understand the question or can you say more, you have got to put everything out there straight away and make your questions as clear as possible so that they know exactly what you are asking instead of just like "can you help."

The statement suggests that DFAQ encouraged learners to "put everything out there straight away" whereby fostering advance organization of thoughts (suggesting that a tool modeled an Analytic learning style). The realization of a need to post messages with a reader in mind suggests an inclination towards "conversation" further implying that DFAQ may have orientated learners towards a Verbaliser learning style.

i) I think sometimes you feel like you can't express it properly... it will be too much of a conversation, too long rather and also I thought I would not be able to express it properly.

As a text based tool, interaction for learners who use pictures in their learning styles may have found it difficult to effectively communicate in text. The use of text created artifacts which other learners accessed and this may have impacted on learners who are wholists as they needed to understand a big picture before making a contribution.

j) grabbing all kinds of ideas, thinking about them, still thinking how I can interlink them and how they make a picture and how they apply, you see I am still in the process of doing this, so in other words to ask a question about all these different thoughts that I have, to ask one question, it is difficult because I am still in the process of forming my opinion, forming my ideas, so I did not find like I could ask what I wanted to ask sometimes.

While access to a deluge of information could have created difficulties for this learner, other learners (see (g)) found this useful depending on the learning style. It appears that Wholistic learners may have tended to post few messages but well thought out messages as time was spent "in the process of forming opinions".

k) there were so many responses towards the end that you get more used to it, more people use it, you get comfortable with it and the more that you use it...

Reference to "...more people use it...the more that you use it" suggests that through the provision of access to the way other students asked questions, DFAQ had influenced the online interaction and strategies of learning. Although learning styles are individualistic, access to peers' thought processes provides a way of self detection and correction of misconceptions or misunderstandings. Hence DFAQ provided a way of affirming students through passive engagement (lurking and reading a deluge of postings) and by active engagement (posting questions and receiving responses from peers). A student reported that,

l) DFAQ is a very nice resource for me in the Organizational learning filing cabinet I could use that resource to add to my learning. It is almost like when I need it –when you need to be affirmed in what you are doing because often I felt like I did quite independent stuff – I would get all this information and then I would go to DFAQ – and say "OK I am on the right track or No I am going down the garden path" – so it was a nice resource in that way.

It can be inferred from the above statement that DFAQ modeled behavior of learners into a particular way regardless of their individual learning styles. The external factors, such as deadlines, may also influence the learning styles. McLoughlin's forms of information presentation do not acknowledge the impact of context and environmental factors on learning styles.

m) I was driven by panic because it would often be a question that would be related to something that we would have to hand in so it would be a panic stricken question – "O my word – how many pages – can we do this – can we that – is it alright to this – it is alright to do that."

Another external factor is that of the confidence that learners have in the medium of interaction and the community (peers).

n) I think of the six months that we have used it people were getting more and more comfortable with it and using it more freely to the point where near the end students were replying to students questions and I think that if it was a resource that we had maybe for 12 months it probably would have gotten to a more interactive point...

Suggested in the comment "...would have gotten to a more interactive point" is that DFAQ may have influenced learning styles.

7 Conclusion

In this paper we set out to show that the way that different individual learners interact online is partly influenced by individual learning styles, and that the medium of interaction or the mediating tool shapes online interaction, hence modeling behaviour of users. To investigate this phenomenon, a text-based anonymous tool facilitated online interaction in a six-month course. Learners reported on their own learning styles and how they experienced the online engagement. McLoughlin's forms of information presentation to match cognitive style were used to guide an interpretive analysis because of their distinction between learner characteristics as embodied in the mental state and text presentation as an outward act. The paper has shown that some learning styles (for example, the "practicalist", "filterist", and "forgetist") could not neatly fit in McLoughlin's taxonomy. It has also shown that while some features of the tool may have effectively supported certain learning styles, other learners adapted their learning to the way the tool was designed. It can be inferred from the diversions of learning styles that learning style is a complex phenomenon and could be dynamic depending on context. One of the design challenges of learning environments is how to design for diversity of learning styles and understanding the impact of design choices on various learning styles.

Finally, we make the following recommendations:

- Online interaction requires that a sender construct messages in ways that allow the receiver to understand. A user's learning style influences online interaction and determines whether a user is likely to be an active or passive participant. Design of tools ought to cater for users who need detailed information, summaries, text formats and visual representations. Providing windows to information in these various forms would serve the needs of diverse learning styles.
- Learning styles are complex social phenomena which cannot be categorized using superficial and deterministic taxonomies. Learning styles analysis should form part of user requirement.
- An online mediating tool is not neutral but models learners' behavior including how learning styles are used to accomplish tasks. Systems or tools are usually embodied with design biases and preferences. Successful mediation of online interaction presupposes that individual styles are provided for, if they are to be successful.
- Taking recognizance that students learn differently whether online or face-to-face and that a single pedagogical design cannot fit all learning styles should lead to designs of online learning environments that are educationally efficacious. Further research is required on the effect of social awareness in online learning styles.

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Instructing with Advanced Collaboration Technology:

Lessons Learned and Unexpected Transformations

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Abstract. This paper provides lessons learned and some unexpected transformations in the learning process when advanced collaboration technology was used to overcome limitations of a popular, existing collaboration technology. The activities pursued in these advanced undergraduate and graduate computer and information sciences courses replicate many of the activities in collaborative knowledge work in organizations. Therefore, the lessons learned should be applicable to transforming other kinds of joint knowledge work in general.

1 Introduction

New technology that is not adopted fails! Prospective users of new technology are experiencing "new tool fatigue" [1]. Teachers, like corporate uses of new technology, are wary of unfulfilled promises of new technology and increased burdens to learn and use the technology. Teachers need enhancements to their instructional processes that integrate "naturally" into what they do. The best technologically-based solutions entice by leveraging existing skills and knowledge in such a way that instruction improves, learners excel, and the technology presence fades, i.e., successful adoption of technology-enabled transformational instruction demands stealth! Increased capability to instruct should emerge as needed during the instructional process while the fact that the capability is technology-enabled fades, i.e., enhancements should be integrated incrementally and available on an as-needed, just-in-time basis. Awareness of transformation should only occur upon reflection of where one was and how far one has come in the employment of advanced technology to develop more successful learners.

While many feel collaborative learning to be an innovation whose time has come, problems persist [2]. This paper describes the use of advanced collaboration

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technology that transformed the learning process in unexpected ways. The activities pursued in these advanced undergraduate and graduate computer and information sciences courses replicate many of the activities in collaborative knowledge work in organizations. This paper discusses the limitations of a popular, existing collaboration technology which propelled us to try something new; reviews the notion of Collaboration Envelopes™ that wrap around group processes as a way to build more cohesive architectures to fully support collaborative processes; discusses the co-development of joint artifacts; describes the new technology used; and explores lessons learned and some unexpected transformations in the learning process which should be applicable to transforming other kinds of joint knowledge-work in general.

2 Problems with Current Collaboration Technology

While there is overlap in functionality in collaboration technology, and these technologies can be used in a complementary fashion, it is useful to divide collaboration technology into three functional categories:

⇒ **Technology that overcomes the limitation of people not being in the same time at the same place** where they can meet face-to-face and can share common artifacts, such as documents. This includes real time technology such as Instant Messaging; web-, video- and tele-conferencing; and application sharing, such as Microsoft's Net Meeting. This also includes asynchronous technology such as email, email and attachments; shared folders on LANs and the WEB; and chat and threaded discussions.

⇒ **Technology that assists in the co-development of artifacts**. Specifically, technology that helps to overcome the social, cognitive, and procedural complexities in planning, creating, evaluating, negotiating, and consolidating joint artifacts.

⇒ **Technology that assists in the coordination of tasks** that can be completed independently but are interrelated to others. This includes workflow and project management technology.

Overall, current e-learning technology focuses on content delivery, as opposed to supporting students to solve more complex and open-ended tasks [3]. Most collaboration technology seems to be stuck in trying to overcome the limitation of people not being in the same place at the same time [1, 4]. Blackboard™, an electronic version of a blackboard, is a popular collaboration tool used in education that fits within this category. Blackboard™ is the typical portal-based architecture that is mostly used to store various artifacts, such as syllabi, class documents, and presentations; and has little-used add-on tools, such as chats and threaded discussions. In Blackboard™, if one wants access to a document for displaying to and updating by a class, one must typically do the following: 1) navigate to the document through a series of Web pages; 2) download it; 3) navigate to the downloaded location; 4) open it up in the application; 5) modify it; 6) save it to the file system; 7) delete it in Blackboard™; and 8) re-add it to Blackboard™. While the document is available for viewing, the document cannot be jointly edited. This makes it all but useless in real-time and asynchronous interactions. In addition, Blackboard's functionality reinforces a prevailing notion that course documents are static. Is there something limiting in Blackboard's conceptual view of collaborative support as essentially providing a common depository for static artifacts that affects its design and usefulness [4]?

3 Collaboration Envelopes™

> Incorporating collaboration functionality in a piece-meal approach in different ways as add-ons within a portal-based architecture can place heavy demands on users to learn, organizations to train, and ultimately limit the potential of collaboration technology to achieve organizational goals [4].

There must be an intellectual break away from the notion of individual tools that incorporate collaboration functionality in a non-integrative fashion [4]. The notion of a Collaboration Envelope™ is introduced as a way to envision technology that seamlessly wraps around socio-cognitive work. For the most part, existing technologies focus on sharing data and not on supporting the sensemaking activities of participants engaged in a collaboration. Human and non-human agents may participate in multiple collaborations with different participating agents in parallel, switching among various collaborations. In some sense, an agent may even engage in a collaboration with himself. For example, during reflection on an issue, one's perspective and understanding may have changed since the last time the issue was visited. Collaboration Envelopes™ help build and maintain understanding by each member of the group. They must support the process of working within a collaboration and then shifting attention and working effectively within another collaboration.

3.1 Co-development of Work Products within a Collaboration

Joint work products that evolve as part of the sensemaking process include such things as plans, reports, budgets, specifications, architectures, contracts, designs, and software code. Collaboration Envelopes™ must support all phases [5, 6]:

- Planning. Collaborators establish the objectives, structure, and divide up parts of the shared work product to be created.
- Creation. Collaborators compose their portion of the joint work product. Although they may work alone, it is important that they are aware of what the other collaborators are doing.
- Evaluation. Collaborators review, propose changes, and add comments to each other's work.
- Negotiation. Collaborators discuss proposed changes with one another and decide on what changes should be made.
- Consolidation. The collaborators resolve conflicts and merge changes into the shared work product.

It should be stressed that these phases are normally not sequential. There is continuing cycling through these phases for different sections of the shared work product. For example, while negotiation is occurring for one part, creation could be occurring for another part. Dealing with these social, intellectual, and procedural complexities, collaborators work asynchronously and synchronously as they navigate through these phases [7]. They must establish and maintain a common understanding of the situation and solve problems such as work product structure, while adopting procedures that will enable them to get their work launched, circulate drafts, circulate comments, and incorporate changes in order to finalize the joint work product [7]. Collaborators usual work synchronously when planning, negotiating, and consolidating and asynchronously when creating and evaluating, but this could be because of inadequate asynchronous technologies to support all phases. Maintaining situational awareness of what others are doing is especially difficult yet critical to effective joint development of shared work products [8].

4 Augmenting Collaboration with SenseMaker™

SenseMaker™ integrates the following collaborative functionality into existing work processes and products. The current enhancement is to Word, but could be extended to all of Office and many other Windows-based products:

1) **Word processor:** The most common word processor is Microsoft Word and exists on over 90% of client computers. MS Word users possess extensive semantic and syntactic knowledge of Word.
2) **Subdivision of work-products.** Word documents can be dynamically subdivided into hierarchical subsets as small as one character while the system automatically maintains a perfectly formatted, complete higher subset or full work product. This avoids consolidation errors, time, and tedium.
3) **Work on Subsets.** Subsets can be opened separately or as part of a document and the full features of Word is available to work on the subsets. Benefits:
   a) True parallel development. All the augmentation facilitation described in this section works equally well on a subset as the whole work product.
   b) Bandwidth - can download a fraction of the document. Especially important to mobile users
   c) Display limits - some displays would be overwhelmed with a full large document, but could handle a few words or a sentence.
   d) Input limits - there may be limited input devices that make it difficult to deal with large documents.
4) **Control.** Each subset can be controlled by a single user.
5) **Security.** There can be different levels of security on each subset - controls viewing, writing, downloading sections etc.
6) **Asynchronous/Synchronous.** Work can be conducted by any number of users synchronously or asynchronously.
7) **Online/Offline.** When possible, it is beneficial for work to proceed when not connected to any active server. Work can be performed online or offline and then synchronized automatically with others who work online or offline.

8) **Undo.** For use during current editing, there is use of extensive, existing Word features.
9) **Versioning.** Versioning can occur for any document or subset and is separate from any document or subset. Extends undo to states between sessions.
10) **Compare operations.** Can be done between any previous and current version.
11) **Suggesting Alternatives.** Use mostly when artifacts or subdivisions of artifacts are not under one's control, one can suggest an alternative of any subset of the artifact.
12) **Argumentation Facilitation/Rationale Building using DrillDowns.** Dynamic labeling of conversations, arguments, or supporting material that can be associated with any subset and exists separately from any subset.
13) **Notification - Situation Awareness.** Notification of changes to any aspect of the joint work-product development process, including subsets, alternatives, drilldowns, etc.
14) **Cognitive Support to Quickly Achieve Work-Product State for Each Collaborator.** For each collaborator, knowing what has changed since the last time a collaborator evaluated the joint work-product.
15) **Recording Awareness.** Recording when users become aware of changes.
16) **Management Reports.** Providing reports as needed to understand what work has been accomplished, by whom, and when others become aware of such work.
17) **Generalized Ability to Construct and Maintain Relationships among Files.** Currently files of work products are stored and relationships implied by users in the way they may be stored. Providing a general means to store files and relationships can provide powerful augmentation of file management.

5 Transformations to Instruction and Learning

One class is a senior-level, two-semester undergraduate course where groups of students create real information systems for real-world clients; the other class is a graduate course in human usability design. Much of the instruction focuses on experiential learning and deals with the co-development of information system artifacts for a given problem scenario over the course of the semester. Students are then tested in skill-based practical exams and teams apply these skills to design and develop real-world systems. This section describes the evolution of a better understanding of the process of co-development of joint artifacts and the unexpected transformations in the learning process that occurred as a result of using SenseMaker™.

5.1 Assessing Progress and Individual Contributions

SenseMaker™ enhances co-development of project submissions and facilitates assessing progress and individual contributions. When first advocated in the literature, collaborative learning focused on group participation to enhance learning. Assessment of learning was always done at the individual level. The group exercises were relatively simple, many times accomplished within a single class, and the outcome of the group was not assessed. However, the value of groups manifests in difficult, novel, complex projects. Students must learn to work in groups on such projects and are graded on the joint outcome of the effort. Universally, instructors who employ demanding group projects find assessment of group progress and individual contributions within the projects difficult. SenseMaker™ can help mitigate these assessment issues. For example, one student questioned her grade for her contribution to the group effort, which was partially determined by peer evaluations. In SenseMaker™ we reviewed her contributions by dynamically comparing her versions with changes performed by other members. It was clear that group effort was under-reported. While reviewing this student's contribution, the technology was applied to another student's contributions who also received poor peer evaluations. It became clear this other student's contribution within the project team was greater than initially evaluated based on peer evaluations and the instructor's perceived effort. It may be that this student's peer evaluation was not very good because he is exceptionally quiet. Based on this analysis within SenseMaker™, this other student, who did not question his grade, also had his grade changed.

5.2 Transition between Asynchronous and Synchronous Interactions within Class

For the most part, the common notion of class is that an instructor interacts synchronously with his or her students. It has become common practice to have the class breakout into project teams and work on samples of the problem in class. At this time they are now working synchronously within the team but asynchronously with respect to other project teams and the instructor. In one class, where students did not have direct access to computers, they added their solution to SenseMaker™ sequentially with the help of the instructor. In the graduate class, students were able to use SenseMaker™ directly during class to post their answers to the problem. Once posted, project teams presented solutions to the entire class synchronously. This reinforces the notion that classroom experience is a continual transition between synchronous interaction among all class participants, and asynchronous interactions among groups that work together until there is a need to share again synchronously with other groups in the class.

5.3 Peer Learning and Transition between Asynchronous and Synchronous Interactions between Class

This is similar to within a class, but more pronounced. A major problem in following a problem in-class throughout the semester is the problem of providing some way for the groups to continue to work on the problem between classes and then pick-up with some progression in the next class – one can't easily save what each group has done on the board or project what one's solution is to the problem.

> "Having the capability to use SenseMaker™ during class was very useful. Basically it saved some work for the students from writing down the notes and everybody had the capability to view the notes at any time and print them

out. It was a useful tool in the class, because everybody can participate in the class and (it) created an environment where everybody was helping out each other with understanding the concepts of the material being discussed in class [Anonymous]."

Several features of SenseMaker™ were invaluable to this process:

⇒ Subdividing. Artifacts could be subdivided and then assigned to teams to work on in parallel with other subdivisions by other team members. This permitted teams to work on their section and also see how other teams were progressing in their solutions. This also permitted progress on the solution as a whole.

⇒ Suggesting Alternatives. When class convened for the next section, some group's solution would be displayed to the class. As a class we could review the solution. However, instead of making changes directly to the solution, using SenseMaker™ an alternative can be suggested. This means a copy is made and linked to the original solution. Then, as a class, we could work on the alternative together and save it. Students have available the original result of their thought processes and the corrected version. In this manner, the differences of their understanding and the solution are always available for review.

This process meant almost the complete elimination of the use of the whiteboard in class and Blackboard™ in general. All work was created and available for use by the class. Since exams were practical exams to demonstrate learned skills; some students either downloaded the joint artifacts to their own notebooks for use during the exam, while others made hard copies. In the future, we intend to provide wireless access to SenseMaker™ artifacts during classes, including exams.

5.4 Co-development of Joint Artifacts

The enhanced features of SenseMaker™ provided "controlled" co-development of project submissions required of each team. Project teams could subdivide submission documents and work in parallel.

"Now, I believe SenseMaker™ is useful especially when working in groups. Because everybody can save their own work on SenseMaker™ and everybody can view each member's work without making any changes to it, unless the creator of the section wants to give permission for other users to change the context of the section. Also, it allows you to keep track of who is contributing to the project and who is not [Anonymous]."

Without resorting to technology that has problems with firewalls when sharing applications, such as Microsoft's Netmeeting, SenseMaker™ provided the functionality of secure application sharing without firewall problems while still co-developing in parallel:

"It was useful especially when we were completing the last submission. Since it was due at 6:00 in the morning, SenseMaker™ was helpful, because we all talked on the phone while doing the submission and one person was responsible for typing up what other members were saying and the best part was all the members could view the changes and tell the person typing for any changes, so it was like capability to have shared views and live changes when the changes were saved. It made the process organized and went smooth and without this feature we would have not completed the submission on time or be organized [Anonymous]."

5.5 Joint Evaluation

There were a larger number of project teams than usual and evaluation was more time consuming. Because SenseMaker™ permits parallel evaluation also, the teaching assistant was assigned to review submissions for certain aspects, such as correct format of the technique and grammar, while the instructor focused on more critical, time-consuming feedback. In one situation, the TA highlighted a portion of a submission and made a comment for the group. Although not expected because the evaluation and grading was not completed, a student in the group provided feedback to the TA. The instructor was then able to confirm the answer of the student. At first, what occurred was unexpected, then encouraged. In situations where the artifacts are created based on some interpretation, the feedback of the creator may be critical in understanding the thought processes. This began to be repeated and it was clear that in these situations evaluation should be done jointly. The added benefit of this process is that students can "see" the evaluation in progress. It may provide some psychological comfort similar to the "status bar" when downloading some large file. In this case, instead of a black hole until the graded submission is returned, the student can see the evaluation in progress and even provide feedback to assist in the evaluation.

5.6 Virtual Nods™ (Vnods™)

An assumption behind most collaboration technologies is that face-to-face is the best medium and one must use technology to overcome the limitation of not being able to collaborate in person [9]. However, there is growing evidence that face-to-face interaction may not always be best [10, 11, 12]. Asynchronous work may be superior to face-to-face in complex problems, while face-to-face may provide superior motivational cues for participants to pay attention [10, 12]. In a face-to-face interaction, non-verbal cues such as nodding provides this feedback on a continual basis as ideas are expressed. In an effort to incorporate motivational characteristics of face-to-face interactions within asynchronous interactions, SenseMaker™ records the date and time a participant visited some content. Since content can be subdivided into units as small as necessary to express unique ideas, SenseMaker™ can record the date and time a participant visited some sub-division of content related to an atomic, unique idea. This is important, because there can be many separate ideas expressed in a document, such as a syllabus, which is described in more detail in the following section. Initially, there was some resistance to this feature because it could be perceived as "big brother" watching; however, when it was reframed as a "virtual nod" and a way to improve interaction asynchronously it has gained acceptance.

In addition to the motivational benefit of Virtual Nods™(Vnods™) within SenseMaker™ helps to controls interaction feedback in a number of ways: First, it eliminates countless numbers of emails that would be needed to incorporate virtual nods on ideas or comments; Second, the instructor "pulls" the information when needed by easily reviewing who in the project/class has visited some content; Third, there is functionality within SenseMaker™ for the instructor to easily "push (send email)" to request a Vnod™ from the whole group or from the subset who has not yet vnodded on something. Vnods™ have been invaluable in providing motivation and focused feedback usually available within face-to-face interactions, but less available within asynchronous interactions.

5.7 Rethinking what is Static and Dynamic

With current web technology that provides the ability to post, there is an implicit assumption that the posted documents are static. For example, prior to using SenseMaker™, a syllabus seemed like a static document that was distributed or posted. However, the syllabus is far from static. The schedule can change. Students can have questions as to what is meant by some aspect of the syllabus. There could be errors in the original syllabus. Using SenseMaker™, the syllabus was subdivided into major subsections and these further subdivided as necessary. When a change was made to a section, only that section was updated. In the usual process, the complete syllabus would be deleted from the website, modified, and then reposted. In lengthy syllabi, it is unlikely that the student will take the effort to see the change; and without Vnods™, there would be no way to ensure whether the student is aware of the change. In another example, a student posted a question by attaching the question to a particular section. The response was made by the instructor and the section modified. Other students could see the question, the response, and the modification. Through the use of Vnods™, the instructor can see who saw the question, the response, and the modification. Finally, one can make questions that students have about the syllabus a positive experience. For example, students, who question the clarity of some wording in the syllabus, are encouraged to use SenseMaker™ to suggest alternative wording. This provides an opportunity to provide feedback to improve the syllabus and students gain practice in writing in a more clear style. Those students who provide such feedback can be awarded with extra credit.

6 Summary

Incorporating collaboration functionality in a piece-meal approach as add-ons within a portal-based architecture can limit the potential of collaboration technology to transform joint work processes. This paper discussed the limitations of a popular, existing collaboration technology which propelled the trial of more advanced collaboration technology. It reviewed the notion of Collaboration Envelopes™ that wrap around group processes to build more cohesive architectures to fully support collaborative processes. The co-development of joint artifacts was discussed and SenseMaker™ functionality was presented. A number of unexpected instructional transformations were discussed, such as the rethinking of static, joint evaluation, increased peer learning, and support for the transition of work between classes.

7 Acknowledgements

SenseMaker™, Collaboration Envelope™, Virtual Nods™, and Vnod™ are trademarks of SenseMaking Technologies Corp. Blackboard™ is a trademark of Blackboard Corp. Dr. Nosek is president of SenseMaking Technologies Corp.

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Characterizing E-learning Practices in Companies

an exploratory research in Australia

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Abstract. It becomes perceptible that each day more companies make use of e-learning for the capacity of its workers. During a congress in the e-learning area it has been noticed the increase in corporative e-learning cases. These cases show that there does not exist a single form of e-learning within the companies. Each program makes use of adequate practices for organizational characteristics, which may vary according to each company's knowledge, the technology, the available resources, and the vision administrators have concerning e-learning. Thus, this paper aims to characterize some of these different e-learning practices. Exploratory research was carried out where e-learning specialists were interviewed in nine different companies and a university in Australia. The results revealed successful accounts as well as challenges that must overcome. These results will form the basis for later research where an evaluation system that can be adaptable to each corporate e-learning practice will be developed.

1 Introduction

We live in the transition from current society to a knowledge society. In the latter the changes are extremely fast, providing a need for people and organizations to be constantly updated. In this context, organizations would rather choose workers that are able to go along with the changes and remain updated searching for innovation. In private companies, to maintain a highly capable staff may be a strategy to standout before competition. Public organizations also have this constant need of capability to better serve the citizen who is ever more demanding. People are trying to learn more in an attempt to go along with the transformations and to hold on to their jobs.

One alternative used in this process is Distance Learning (DL), a teaching-learning modality where teachers and students interact in different time and/or space. The idea of distance learning is not new. Seen some time ago as second-hand learning, today with the advance in information and communication technology, it is

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here to stay. Distance learning has been gaining ground in company and academic areas with a tendency for personal capacity.

In the corporation context, DL is normally in the form of e-learning and may be a strategic solution in improving organizational competency and democratizing knowledge. This is why there are so many companies using e-learning to improve the capabilities of their employees.

However, it is still considered new in the enterprise ambit. The non-existence of a form of e-learning is perceptible: each program uses different practices appropriate for organizational characteristics that vary according to the learning process of each company, the technology, available resources, and the vision administrators have concerning e-learning.

In order to know the different practices in e-learning, exploratory research took place in which several e-learning specialists were interviewed in different sectors of nine companies in Australia. The research query was: "What are the characteristics in e-learning practices in companies in Australia?"

Australia was chosen because it is a country where e-learning is relatively consolidated. E-learning there is a reality in teaching institutions as well as in companies. The financial support for the research was given by a Brazilian governmental agency – Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), to which we are grateful.

The results described in this paper reveal successful accounts and future challenges to overcome. These results will subsidize later research where an evaluation system, adaptable to each corporative e-learning practice, will be developed.

The next section presents the literature review and the following sections introduce methodology procedures, results, conclusions and references.

2 Literature Review

The study has its grounds on three subjects: e-learning, learning, and evaluation. Next, the main concepts are brought up.

2.1 E-learning

The e-learning concept that is being adopted in this research is the same Na Ubon and Kimble [1] use for online distance education:

> "Formally and systematically organized teaching and learning activities in which the instructor and the learner (or learners) are geographically separated, using information and communication technologies to facilitate their interaction and collaboration." [1, p. 468]

E-learning is capable of satisfying the needs that exist in lifelong education, integrated in working areas and to individual needs and expectations. Lifelong education is important when it concerns the need to reformulate the initial formation of people, develop integrated actions on continuous formation, and to transform working areas into learning organizations [2].

There are several benefits in e-learning for the organizations. Rosenberg [3] brings us: reduction of costs in training, an improvement in the company's lead time, consistent and personalized messages, content reliance, constant learning, better use of time, accessibility, community build-up, the exploitation of corporation investment on the Web, and the aggregation of the value of services to customers. Considering these benefits, we see that the e-learning market has been increasing significantly in the past years.

2.2 Learning

The aim of any e-learning program is to learn. It is regarded that learning is a change of conduct [4]. The people in the corporate ambit build and change an organization through learning.

Argyris and Schön [5] point out that the organizations learn something when their individual members or a fraction of them learn. Organizational learning, therefore, has to do with a process of collective learning. These concepts of organizations that learn are framed by a constructivist approach defended by theorists who encourage e-learning. In constructivism:

> "...there is the notion that nothing, strictly, is done or finished, and that, specifically, knowledge is not given at any moment as something complete." [6]

According to Becker [6], one builds up his knowledge on interaction physically and socially, that is, this build-up depends on one's conditions and the environment. Knowledge is seen as a construction, corroborating Piaget's theory. Hence, e-learning, by using constructivism, is concerned with collective learning.

Another approach that has been adopted in virtual training surroundings is Action Learning. According to Nicholson [7], this is a participative learning model where learning comes from experience. In this model the participants share their understandings and develop new ideas for their job knowledge through discussion actions, query, guidance, and personal reflection.

Ingram, Sandelands and Teare [8] also defend this approach. They believe that there is no competition in this sort of learning and only room for collaboration. It is not dictatorial, but a facilitator. That is, all may commit mistakes, but are directed to the correct route.

These approaches are compatible with organizations that operate in complex environments where requested knowledge is quite diffused. Nevertheless, due to its complexity the authors emphasize the importance of evaluating the efficiency of the learning process [5, 4]. Ingram, Sandelands and Teare [8] defend the evaluation of this type of program and point out the importance to evaluate the investment. The issue on evaluation appears to show more when it comes to e-learning programs.

2.3 Evaluation

Evaluation is the base of a process of a measurement of results, a crucial element in Human Resource (HR) and in company training. The evaluation model of Kirkpatrick [9] is a reference in corporative distance learning. According to him, the reason for the evaluation of a training program is to determine its effect. He then proposes four levels that represent a sequence to evaluate training programs. Each level is important and has impact on the next. The four Kirkpatrick levels are:

1. Reaction – did the trained like the training?
2. Leaning – did they learn?
3. Behavior at work – are they applying/using?
4. Impact on the organization – did it make a difference?

Nisenbaum [10] asserts that levels 1 and 2 are the most used in companies, while 3 and 4 are still less applied. Phillips and Stone [11] include a fifth level, the evaluation of the return on investment (ROI) in training. They present a review on the Kirkpatrick levels and add the fifth level as shown below:

Table 1. Levels of Objectives. Source: Phillips and Stone [11, p. 38].

Level of Objectives	*Focus of Objectives*
Level 1 Reaction/ Satisfaction	Defines a specific level of satisfaction and reaction to the training as it is delivered to participants.
Level 2 Learning	Defines specific knowledge and skill(s) to be developed/acquired by training participants.
Level 3 Application/ Implementation	Defines behavior that must change as the knowledge and skills are applied in the work setting following the delivery of the training.
Level 4 Business Impact	Defines the specific business measures that will change or improve as a result of the application of the training.
Level 5 ROI	Defines the specific return on investment from the implementation of the training, comparing costs with benefits.

This evaluation model is the most disseminated in companies that evaluate their training programs, be it present or by distance. However, it is perceived that many companies cannot make total use of this model without difficulties in the process. According to Levy [12], these conventional measurement metrics must evolve in order to supply significant information.

3 Methodological Procedures

3.1 Research Design

The research done in Australia was exploratory and qualitative.

3.2 Participants

For the pre-test, a professor responsible for e-learning in an Australian university was invited. The objective was to test the instruments before conducting the research in the companies. It has also served to test the interviewing procedures, such as to schedule the interview, to interview the person, to record the conversation, to transcribe the tape and to analyze the data. We have concluded that instruments and time for interviewing were appropriate for the research.

The research participants were all e-learning specialists in Australian companies. People who manage e-learning practices in business were observed. They were chosen by accessibility and convenience.

3.3 Analysis Technique

The technique to analyze the data was the content analysis based on Bardin [13]. Demographic data from the interviewed and the companies were used to characterize the sample.

The content analysis began with pre-determined categories referring to e-learning practices as follows: infrastructure and human resources (HR); design; participants; evaluation; benefits and limitations; future plans and desires. These categories were not regrouped because they can already provide a good level of analysis. The results, according to the categories, are presented in the next section.

3.4 The Interviewed and the Companies

After the pre-test interview, interviews with the companies' specialists took place. Nine people in total were interviewed, five women and four men. Five ranged from the ages of 30 to 39 predominantly. Three were in their forties, and only one over fifty. Six are post-graduate and most have a background in business (four) or education (three), while two are specialized in business and in other areas. All research participants are managers or leaders of a team, except one.

Table 2. Companies. Source: elaborated by the authors.

Companies	*Area*	*Number of employees*	*Number of e-learning completions in 2004*
A	Bank	28,000	24,500
B	E-learning provider	6	Approx. 800
C	Retailer	188,000	Over 47,000
D	Training provider	80	Over 100,000
E	Bank	8,500	9,000
F	Bank	27,000	Not informed
G	Bank	45,000	25,000
H	Entertainment company	6,000	Approx. 3,000
I	Food industry	3,300	200

4 Results: E-learning Practices of Australian Companies

4.1 Infrastructure and HR

The companies in our sample have used e-learning between 3 months and 5 years. It shows that e-learning is still new in the companies. The person who provides directions for the e-learning is usually Learning or Training Manager.

The number of courses offered by the companies varies drastically. We asked the number of courses they offered the past year because they have e-learning courses in different phases and we needed a standard of comparison. It ranges from two or three courses to 650. What we have noted is that the companies that have many courses adopt short modules and each module or small course counts as a course. The opposite also occurs. In company H, for example, there are just three courses and one of them is the Microsoft Package, which includes some other courses (Word, Excel, etc).

The staff number for e-learning also varies. It is from three part-time people to fifty part-time people. Part-time means there are companies that do not have a team just for e-learning. They also have the role to provide face-to-face training. The specialization of the staff lies in Education/Training, Management, IT and Administrative. The highest rates of specialization are in the educational area (some companies have more than 80% of the e-learning staff with this specialization).

The budget for e-learning also varies. It goes from less than AUSD 100,000 to probably around AUSD five million. One company (G) has a budget higher than AUSD ten million, but this value includes face-to-face training. In a certain way, the e-learning budgets are according to the size of the companies and the number of courses they offer.

Summarizing this category, we can say that e-learning has different infrastructures in the companies. The e-learning practices differ in terms of size, budget, staff and management style. The only common aspect is that e-learning is recent and it is being developed gradually. There are many things to develop and to improve and each step is a challenge. Hence, there is a growing market for e-learning developers.

4.2 Design

The design of e-learning is one of the categories that have surprised us. Starting with the teacher aspect, six of the nine companies do not have teachers in their e-learning courses. We think they probably have, but maybe they do not recognize these people as teachers. They might be internal or external professionals who create or develop the content of the course, like content specialists. The other three companies that have teachers listed as a teacher's role: learning design, content development and learning support.

The question about tutoring was also surprising. We could not find a standard. One company has a teacher and does not have tutors. Two companies have teachers and tutors. Five companies have neither teachers nor tutors. And one company does not have teachers, but has tutors. In the companies where there are tutors, they have the role to facilitate and support the learners. The most used technology for tutoring is the telephone. In company D, they do not have tutors, but there is a Help Desk service. Also some companies use e-mail and face-to-face.

In synthesis, the e-learning design seems to be a bit confused in the companies. The technology might be covering the teacher's role. In the companies where there are tutors, we believe this function could be highlighted. Some companies have brought up a help desk, a call center or an interesting e-coach model. Thus, we have not found standards in this category. Also the pedagogy is not clear for the companies. This is an area that could receive more attention. The companies could obtain a design with more collaborative e-learning practices where people can interact through technologies, share and build knowledge and experiences, have new ideas, work in teams or communities and solve problems.

4.3 Participants/students

The researched companies use e-learning to train their employees as do the e-learning providers (companies B and D). Casual workers also participate in e-learning courses in six companies. In some companies, e-learning goes outside to train suppliers (D and H), partners (A), and even the community and relatives (A). This means that e-learning is not only a program from the HR or training department, but also a business program.

4.4 Evaluation

We have found many different aspects about e-learning evaluation. We start by describing how the companies are using the evaluation levels of Kirkpatrick [9] and Phillips and Stone [11]: reaction, learning, behavioral changes, results and ROI.

As it was expected, almost all companies evaluate level 1 – reaction or students satisfaction. Most do a survey after each e-learning course, using a questionnaire. Only in company A is it carried out when the courses are being developed. Two companies have said that they do this online. In company C, the survey is used also to get information about the learner and demographics. It provides both qualitative and graphical information, like recommendation and satisfaction rates.

The next level is the learning evaluation. Seven companies do it and two do not. What is curious is that company H evaluates level 2 and does not evaluate level 1. It is one indication that the levels can be independent and, if they are independent, they are not real levels, but only different aspects that are evaluated. The learning evaluation is usually done through tests and assessments. Each e-learning course can preview this kind of evaluation when it is designed. Company B conducts pre-assessments to check the knowledge of the group and to customize the training. It tries to design courses where people perform activities that relate directly to them and to the work they do in the workplace.

Concerning behavioral changes (level 3), we have noted that only two companies (E and G) have reported that they evaluate this level. Only company E has explained how they do this. It is called application level and it is a responsibility of each manager to do the evaluation because it occurs in the workplace. For this mostly they are using case studies.

In our sample, four companies also evaluate the results of the e-learning (level 4). Some of them (C and H) have this kind of evaluation and do not have the evaluation of the previous level. To evaluate results, company C interviews the managers in order to receive feedback about the application in the workplace. It focuses on specific business outcomes. For company E, this level is harder to evaluate and what they do is show in the report the demonstration of some cases that have clear impacts. In company H, the results of e-learning are the outcomes of the compliance audit.

The return on investment, as expected, is the least-evaluated level. Just two companies – C and E – do that. We believe one reason for this fact is that most of e-learning courses are about compliance, and this is an obligation. Companies have to do that to maintain their operations and the best way to train in compliance is through e-learning.

Many companies make a comparison with face to face training, looking at the cost, as company F has reported. We think this comparison is really important, not only for cost comparison but also for time and accessibility comparison.

4.5 Benefits and Limitations

We have asked those who were interviewed what are the main benefits of e-learning for their companies. There is no doubt that finance is the most important aspect. But also the equity in accessing learning and the advantage of having quicker learning or time and travel savings (comparing to face to face) are often-mentioned benefits by the companies. In company H, for example, with e-learning they have reduced the time of a certain course from six weeks to approximately two weeks. Company D has a printed brochure where it clearly tells the benefits companies can get by using its e-learning product: accessibility, automatic record keeping, easily updated, engaging and intuitive.

On the other hand, those who were interviewed have issued a list of limitations that companies ascribe to e-learning. Technology stands out among the rest. In company C, for example, the challenge is to integrate the Learning Management System (LMS) with the new HR system. But there also are concerns about how to engage the e-learner and the manager, about how to evaluate, and also about the changes that are caused by e-learning in the management process. Another challenge for e-learning is the time people have to complete the courses. This aspect has appeared also in the pre-test interview. It is not only a problem of employees in companies. It is a society problem. A difficulty encountered by company E is the short time the staff has to evaluate e-learning.

4.6 Future Plans and Desires

Our last question was about the plans companies have for e-learning for the next five years. We had also asked about things they would like to improve. Analyzing these answers, we note they are dispersed, but there are many ideas to be concretized and work to be done. The aspects given by more then one person were in the following order: a more blended learning, a more interactive e-learning, and a more planned and/or strategic e-learning. They are tendencies for e-learning.

5 Conclusions

After this research, we finally arrived at some conclusions on the e-learning practices of Australian companies. We can encounter many positive aspects while others can be improved. The companies provided us with some ideas for the future development of an e-learning evaluation system. In this section we present the main findings and our insights.

We can see that e-learning is still new for companies in Australia, but there are many available courses where thousands of people have already taken advantage. It is an irreversible tendency in companies and in educational institutions that is growing admirably. We have found some companies that use e-learning not only for employee training, but also outside the company. In our research, we can point-out some differences between the e-learning practices, such as the infrastructure companies have. Even with these little differences, companies have one common focus for e-learning: compliance training. It is a reality that e-learning is helping the Australian companies to be compliant and this is very important for them.

On the other hand, we think that e-learning has a huge potential and could be far more strategic. All companies have their organizational strategies very clear, but when we talk about e-learning, it appears to be lacking in a strategic approach.

E-learning is much more a "mass training" than something more elaborated. The excess of concern about cost reduction influences a standardized design, with poor interactions between people and little innovation. But we think it will change in the next few years because we could see the desire of those interviewed to improve their practices.

When it comes to e-learning evaluation, at this moment we propose some directions based on the practices we have investigated. Our study reveals that the evaluation training model of Kirkpatrick is not entirely used by Australian companies. We think the idea of levels is not adequate for the companies today, but some aspects of his model are still useful.

Most companies use the smiley sheets to evaluate their students' satisfaction towards the program. We think they should continue to use them if they provide good information to improve their e-learning practices. We suggest they maintain this just for the new courses and do it online, because when the course is well-established it is not necessary to do any further survey. It results in too much work. Companies could open another tool of communication to collect free feedback from the students. Both the satisfaction survey and students' feedback may be done online. It saves time and money in this process.

Regarding learning evaluation, we like what company B does: it tests the student's knowledge before designing the course. We suggest this for the other companies when they have a new course and people have previous knowledge. It can also be done online. Learning evaluation is important and we believe that assessments are a quick way to do it. Yet, if possible, more elaborated evaluations should be done, like case studies and simulations. Most of them can be done online depending on what kind of course is being offered.

We did not find many evidence of behavioral change evaluation. We think the most important aspect to be evaluated is the result of the training and it can be done simultaneously with students' satisfaction and learning evaluations. Our research shows that even if some companies do not have a formal result evaluation, they have an informal way to do it. They know the benefits of their e-learning and limitations. The difference is that if they have an informal evaluation they do not have a way to assert that these results really come from e-learning.

We propose that the result evaluation may be planned at the moment the course is developed. It will vary according to each course and it is impossible to establish a standard model. But there is one important matter that should be highlighted: involving the line managers in this process is a fundamental task. The research also shows that to calculate ROI is not always useful. Sometimes, in compliance training for example, the best financial evaluation is to compare e-learning with face-to-face training, as compliance does not provide direct profits. It is an obligation.

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e-learning Activities in Educating e-business: a Pilot with a Process-Oriented e-learning Environment

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Abstract. Current e-learning tools offer a multitude of possibilities for the exchange of various types of documents and for communication between students as well as between students and teacher(s). But education is intrinsically process-oriented – and current technology in the field of e-learning offers no support for the activities which form the core of learning. In this paper the possibilities and limits of current technology as used in an extensive program (a minor) on e-business, are demonstrated. Furthermore, a first impression of a new, activity-based tool is given, which has been used in one of the courses of the program.

1 Introduction

The introduction of the Bachelor/Master structure in the field of higher education in the Netherlands has led to a rethinking of the various educational programmes. The focus in this paper is on e-learning in a minor program (a minor being a self-contained and coherent unit of study) with e-business as its theme. The main objective of this paper is to present the use of e-learning tools in an extensive program (half a year of study) and to show what can be done with current technology and (more important) what not. In our experience a different paradigm is needed for e-learning: activity-based instead of content-based.

From the start of the minor, the use of an e-learning tool was a central element in the program. In this paper we will present, after a short discussion of the most important transformations in higher education, an overview of the minor e-business and the various ways in which e-learning tools were used in the minor. Based on our experiences we will then discuss the need for tools which incorporate the concept of flow, supporting learning activities and in this way transcend the current tools which are data-driven, rather than process-driven.

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Quite recently we were able to experiment with a beta-release of Educator, a new e-learning tool developed on the Cordys[6] platform. Finally we will end this paper with our first impressions of this tool.

1.1 Transformations in higher education: towards more flexibility

Since September 2002 the Netherlands has implemented the Bachelor/Master structure in the field of higher education, in line with the intention made in Bologna [1], to create "an open and transparent European Higher Education Area".

The University of Applied Science in Utrecht (see www.hu.nl for more information on the university), has seized this opportunity to reform its curricula. One of the changes is the implementation of minors, a minor being defined as a coherent program of 30 ECTS (30 ECTS in the European Credit Transfer System being equivalent to 840 hours or half a year of study for a full-time student) which supplements the student's main course (which by contrast is called the major). Students with a major in Software Engineering can in this way broaden their scope with a minor in Human Computer Interaction, Business Informatics, e-learning or even Russian. The only restriction on their choice is the existence of a program, which conforms to the quality standards of the higher educational curricula.

By introducing minors, the University of Applied Science in Utrecht now has a very flexible system in which the students may to a great extent follow their own interests in their professional education. Other elements in which students may choose their own specialization are traineeships and the thesis. Contrary to the minor, these elements are restricted by the topic of the chosen major.

Another way in which the university reaches for more flexibility is in the use of e-learning. Contrary to countries such as Australia where distance learning is necessary for people living in the interior, in the Netherlands the distances to a university are small (typically less than 50 kilometres). The need for e-learning tools comes from the increasingly dominant role of ICT, especially the use of the Internet, in our society. Furthermore a paradigm shift has taken place in the field of education, from knowledge transfer to competence-based training, where the quest for information and knowledge is now the responsibility of the student with the professional in the role of tutor (see Figure 1).

For this paradigm to be effective, the student needs access to various knowledge sources for solving problems – e-learning tools provide a way in which all the different sources of knowledge can be structured.

During the last decade a lot of different projects have been undertaken by Dutch educational institutes in the field of e-learning. We have seen universities implementing e-learning in entire educational programmes, trying to outsource e-learning technology or even content development (with the help of publishers and/or companies). Only a couple of these first initiatives have been successful because of technological problems (e.g. bandwidth) or cultural problems: a lot of lecturers have

[6] The Cordys Company develops software that enables Service Oriented Architectures and can also be used to develop industry specific solutions (see www.cordys.com for more information).

had a hard time adapting to new ways of teaching. Today universities mostly use a blended learning concept in which e-learning has a supportive role, in this way securing the motivation and engagement of students via the 'live' contact with the professional – their role-model.

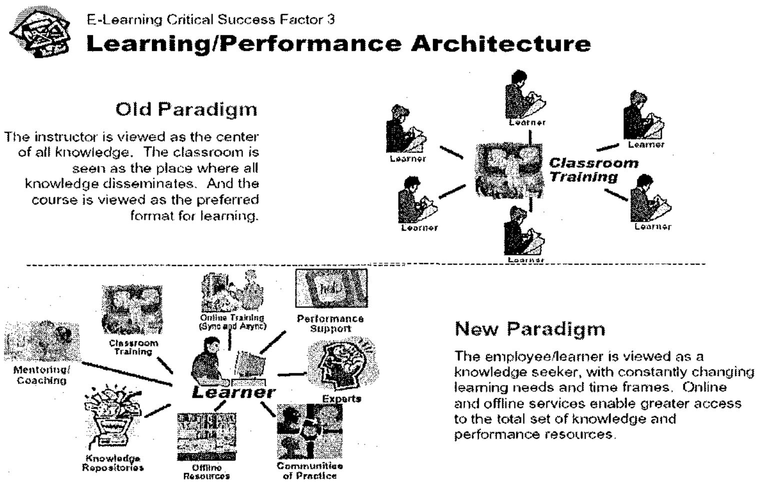

Figure 1. Learning/Performance Architecture (Gartner)

Under the influence of the developments mentioned before, the essence in managing educational institutes is shifting from managing curricula towards managing the process of learning. Electronic learning environments like Blackboard or LearnExact offer educational institutes the possibility to develop flexible and transparent learning paths.

2 Experiences with e-learning tools in educating e-business

As stated before, in this paper we will focus on e-learning in a minor e-business, a program developed for ICT-students from 3 different faculties by staff from these faculties.

When starting with the program (the first course was given in the fall of 2003) it was apparent that we had to deal with different educational cultures and different views on the subject. After ample discussions an agreement was reached on the following conditions:

- An e-business application for a real organization should be the end-result of the minor.
- To provide a common language and understanding, a mandatory framework of courses would be necessary.
- Students should be able to tune the minor to their personal interests by choosing additional courses.
- The organization should provide a professional working environment, to stimulate students in working together in multi-disciplinary teams on the subject.

Based on these conditions a program was developed which currently (after minor revisions for 2004 and 2005) consists of the following subjects:

1. Developing an e-business application for a real organization (12 ECTS).
   This process must result in an application that is tailored to the organization and is implemented at the organization, using the existing infrastructure and hardware.
2. Mandatory courses (12 ECTS):
   - Strategy, Change and Vision (3 ECTS).
     This course consists of weekly guest lectures by renowned speakers in the field. Students have to write individually a paper on a topic in e-business.
   - E-commerce (3 ECTS).
     During the course the students must apply the theory on the organization for which they are developing the application.
   - E-procurement & Supply Chain Management (3 ECTS).
     Traditional course with examination.
   - Organization and Business Processes (3 ECTS).
     Theory and practice on process modeling in order to adapt the back-end processes (using software from Cordys and Bizzdesign).
3. Optional courses (6 ECTS); examples are (students have to choose 2 courses):
   - Portfolio Management (3 ECTS)
   - Project Management (3 ECTS)
   - Knowledge Management (3 ECTS)
   - XML (3 ECTS)
   - Customer Relationship Management (3 ECTS)

From the start of the minor in 2003, we decided to support the resulting program, with its focus on multidisciplinary learning, with an electronic environment that should meet with various demands. On the one hand it should be possible to create a virtual office in which students could work on the e-business application, but also on cases and questions. Furthermore, the environment should help in the exchange of ideas and documents on various topics (student-student and lecturer-student(s)). Finally, the environment should provide a platform for discussion and assessments. For these goals we found the electronic environment of Teletop (www.teletop.nl) – an environment developed in the Netherlands – very easy to use. But other tools (e.g. Lotus Notes, Blackboard, It's learning, LearnExact etc.) offer more or less the same functionality.

As not everyone (lecturers and students alike) was familiar with electronic environments, we decided that it should be an extra tool and should not replace other forms of education. This decision was strongly supported by our belief that students and lecturers from different backgrounds should meet on a regular base to create the necessary community feeling. So we chose for a form of blended learning as our didactical approach. To make students and lecturers familiar with Teletop, we ask the students to deliver all their products (individual and team alike) via Teletop, thereby effectively using the e-learning environment. Lecturers are asked to use

Teletop as the only way to provide students with documents: syllabi, sheets, articles, cases, etc. and to give feedback on students via Teletop.

Apart from the exchange of documents, Teletop is used as the only tool for the communication between administration, students and lecturers. Examples are: schedules, announcements of guest lectures and results. As a rule the students know that news for the next day can be added until 18.00 hours.

Any other use of Teletop (e.g. the electronic office) is optional, not required.

Looking back, the chosen policy has proved sensible:

- Students were informed in time on changes in the schedule – even last-minute changes: a lot of students made it their habit to look on Teletop before going to the Institute.
- We accumulated a lot of useful material on the topic of e-business that can be re-used in the next courses.
- By monitoring the student discussions the staff was well informed on relevant student-themes. A good example is the discussion on the use of software tools for creating the e-business application in which the students proved very creative in finding free tools (e.g. shareware, open source software).
- The workspace provided by Teletop as virtual office was intensively used by all but one group. Most groups planned 2 to 3 physical meetings a week and did a lot of work at home while being in contact with other team members via Teletop.

Finally the use of Teletop as an instrument in assessments was unintentional but proved quite important. Students were asked to match their competences in the field of e-business before and after the program (a questionnaire on the various competences we aimed for was developed for this purpose). This provided us with a valuable insight in the added value of the various elements of the program, which proved in some ways quite different than we expected before starting. As an example we learned that students distributed tasks not on competences to be learned, but on the urgency of the task, thereby not always aiming on profit in educational terms but instead on rewards in the short term (which is probably a quite familiar pattern for anyone who works with students).

3 The next step: from e-learning to e-learning activities

Currently, the minor has run for a third time. We find that, except in the field of examination, we have reached the limit of the possibilities of Teletop (and similar environments). We discovered that most of the electronic environments can only be used as a repository for learning objects and are essentially static in nature. This is comparable with database tools in the seventies: static repositories that could be accessed via the process flow. But, not unlike business, learning is an activity and essentially dynamic in nature. According to [2], in developing education, not only resources (content) have to be chosen, but also the educational process (coordination of tasks or activities) has to be modeled. Finally support mechanisms are needed to enable students in their learning process. This didactical approach is quite natural to teachers, but is often not articulated to the outside world.

Here are some examples of processes we cannot (or not sufficiently) model in the current electronic environments. We refer back to our experiences with the minor:

- Students have to develop an e-business application. In accordance with good software engineering practice [3,4], students are asked to model the business process, model the application, build the software and test the application. But where every organization is different, and the nature of the business processes may vary quite a lot in different organizations, the steps which have to be taken and the timing thereof are different for the various student-groups. While for one group the best approach is a linear process, for another group a more iterative approach is demanded. Prototyping may be needed to get a feeling for the technology, but in other cases, it may not be necessary. So one of the first things students have to deliver is a phase model, explaining what is to be done and when. These phase models may differ and students should be able to implement their planning in the learning environment. And perhaps even more important, they should be able to change this plan if a better approach is feasible (after all: students are not professionals – yet). In this way the learning environment can act not only as a communicating device between students and between students and their tutors, but also as a dynamic planning tool. This is quite different from the current practice to make Word documents and post these. We want the tool to actively guard milestones etc.
- For the course Vision, Strategy and Change, students have to write a paper on a topic in e-business. Current learning environments offer no support at all for a process like this; they can only support students by providing content.
- The course Organization and Business Processes has a large practical assignment in the use of modeling software and methods. Dependent on learning style and former experience, it should be possible to take different, not pre-defined routes through this course. That is, the learning environment should provide a lot of flexibility, as is also described in [5,6,7]
- For the course e-Commerce students have to apply the marketing concepts to the organization they are building an application for. Support in the form of sample cases like in the 4C/ID- design method [8,9] and peer review would come in handy.

All in all, we want support from e-learning tools for learning activities and the coordination thereof, while with most of the current tools the only support is in "mere consumption of content by individual learners" [10,11]. This paradigm shift (in software engineering terms: from data-driven to event-driven) has its consequences for the construction of content. No longer is the start a break-down in learning objects, but instead, the first step to be taken is modeling different "use-cases", each describing a different way of how the content is used and which learning activities are expected. Learning objects in this way become nuggets of content, to be discovered by students while actively engaged in learning.

In the following section we describe some of our experiences with the 'Educator' electronic learning environment.

4 Experiences with Educator

As mentioned before the Cordys Company, with their business process management system, offers software for modeling and orchestrating (business) processes, integrating different information systems and business intelligence. Recently a spin-off company developed a special release for educational purposes: Educator. In the course of the last minor, we had a chance to work with a beta release of Educator.

Educator (see Figure 2) is a next generation e-learning environment, based on the activity-centered approach in order to design a student's learning experience. It uses both business standards in modeling [12] and the latest in educational standards [13].

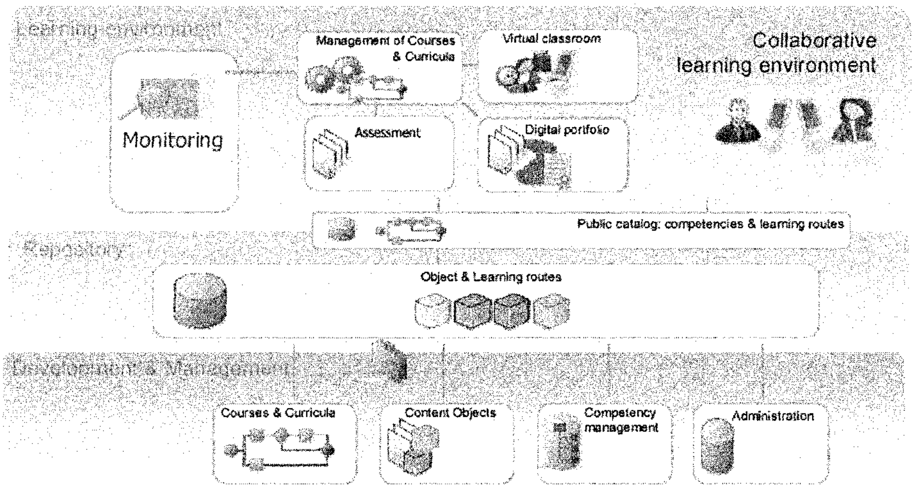

Figure 2. Components of Educator

In September and October of 2005 a project group of 4 students, two teachers and one representative from the Educator company reviewed a beta version of Educator and suggested improvements in order to be able to use it in a pilot setting during the period November 2005 – January 2006. The most important goal during this period was to try out the process-modeling environment. In the pilot itself a group of about nine students used the Educator environment to follow a course on Customer Relationship Management. The learning activities were modeled beforehand and all resources were connected to the different activities in the learning process (see Figure 3). During the pilot the modeling environment has been used only by teachers/course developers and not by the students.

After login students will typically see the 'regular' functionality of an e-learning environment (e.g., news, forum, courses, virtual classroom etc.). The main difference, however, is the way in which courses are represented. Instead of presenting all course content, a student starts a workflow by enrolling in a course. The workflow in turn starts activities that are sent to the student's task list. Depending on the type of task (e.g., preparing a lecture, (portfolio) assignment, writing a paper, etc.), different sorts of content and functionality become available.

To model learning processes Educator offers several elements. The most basic element is the "activity". This element can be used by the course modeler to describe tasks like "read an article" or "make exercise 12 on page 24" or "write a paper on …". It is possible to link resources that the students need to the activity and it is also possible to add a time limit (e.g., when this task is activated, completion should follow within five days). A second element that we have used frequently in the learning process that was modeled for the pilot is the "portfolio assignment". Whenever a student gets a portfolio assignment it means that the work that the student has done must be uploaded after which the teacher has to provide feedback, both of which are then automatically placed in the student's digital portfolio. It is also possible to give other students access to the digital portfolio to enable peer review exercises.

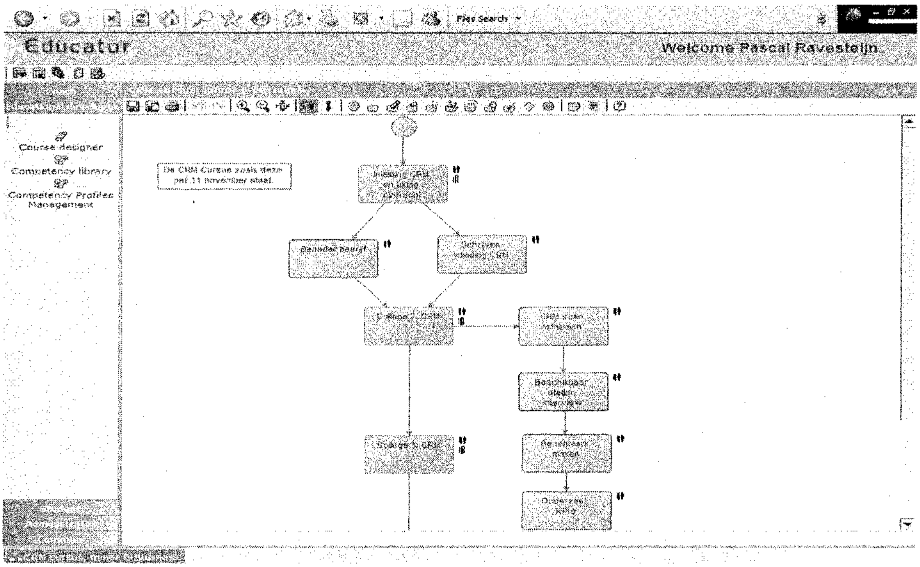

Figure 3. A part of the model of the CRM course

Elements that we have not used during the pilot but can be used to model learning processes are amongst others "360 degree feedback", "assessment", "(digital) classroom meeting", "forum", "chat", "approval" and "decision". One of the most important is the "decision" element which can be used to coordinate students along different learning processes based on the outcomes of earlier elements, for instance assessments. This is a very important difference when comparing Educator to most of the current e-learning environments.

Our current experience with this next generation e-learning environment is that it can simplify the work of the teacher by taking away a lot of the communication and coordination needed during the student's individual learning process. By making use of workflow technology it is possible to give each student just-in-time information and activities. However the task of modeling the learning process of a course is a daunting one. All the different activities, both standard and specific (for students needing more attention, extra assignments etc.), and the routes through the process should be thought out before developing the course model. Even if this is done it is still necessary to have the flexibility to change a student's learning process on the fly when that is needed. Currently Educator is not capable of doing this.

Another very important lesson that we learned is that students who start asking questions via means other than the e-learning environment should be guided back as quickly as possible. It is very tempting to quickly answer an e-mail of one student, but if the answer is already provided somewhere in the modeled learning process the student should get it from there. Even if the answer is not provided, it should still be encouraged to use the forum, chat or frequently asked questions functionality of the e-learning environment instead of phoning or mailing the teacher (of course this is important in a traditional e-learning environment as well).

Finally we would like to mention that some students during the pilot got the impression that there were only a few activities that had to be completed for this course due to the fact that a student could see the content of only one activity at each time. Although Educator does offer a high-level view of all activities that belong to one process, beforehand it is not possible to see the specific tasks and it is not clear which route the student will follow through the process.

During the pilot we didn't use time constraints on activities, causing several students to start too late with their tasks. Halfway during the pilot, functionality was added to the environment that enabled the teacher to track the progress of individual students and thus making it possible to intervene when students were not performing according to the course schedule and process.

After evaluation of the pilot it will be decided if we will use Educator in a larger setting and start using more of the elements available to model learning processes. Specifically the use of pre-assessments, to determine which activities and routes an individual student should take through a learning process, may be implemented.

5 Conclusions

In the last couple of years we have gathered quite a lot of practical experience with e-learning tools. While these tools are very handy as a repository for all kinds of documents and offer communication between students as well as between student and teacher, they are essentially static. In this paper we have expressed our need for more dynamic tools, supporting not only learning objects (content), but also learning activities and the coordinating processes. This shift is necessary to support the competence-based curricula most professional universities are trying to implement.

Our first experiences with the Educator program have shown us that a whole new "language" has to be learned by the course-developer, as the learning process is modeled based on activities rather than on the development of learning objects. This paradigm shift is in our eyes comparable to the shift software programmers had to make when object-oriented programming was introduced. But once used to the new concepts and possibilities, there is no way back to the old ways of programming.

For now Educator is promising but it currently is lacking in flexibility: making changes on the fly in the process is not possible once a student has started with the process.

Finally, for students this way of looking at learning activities makes e-learning much more social and also more effective in reaching the competences that students are working on. E-learning becomes natural when it is activity based and process oriented.

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Integrating Synchronous and Asynchronous Internet Distributed Education for Maximum Effectiveness

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Abstract. Distributed education delivered via the Internet is a growing practice, with most institutions offering at least course websites and many expanding to full course offerings and even degree offerings. There are two schools of thought with regard to delivery mode; the larger group has focused on asynchronous delivery, accessible at any time via web pages and interactive tutorials and quizzes, while a smaller group advocates synchronous delivery where students are online and interact during class time. This paper summarizes the advantages and disadvantages of the two delivery modes and describes our successful and growing experience of more than a decade using an open source synchronous delivery tool blended with a variety of asynchronous capabilities and classroom instruction. We conclude that a synergistic combination of the two modes with in-person instruction, designed to provide maximum flexibility to the student within the constraints of the subject, offers the best support for student learning.

1 Introduction

Distributed education via the Internet is a growing practice in many institutions today, making education more attainable by improving accessibility dramatically for students who experience barriers of schedule or distance to class attendance. Much of the education thus provided is based on asynchronous use of World Wide Web technology, where educational materials are accessed on the Internet via Web browser, primarily in text and graphic formats. This approach is simple to employ, although time consuming for the instructor, in that a collection of existing documents

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can form the core of an educational website. When the electronic documents are combined with an online learning management system supporting interactive tutorials, a qualitative improvement is achieved over the original form of asynchronous distance education, the paper-based correspondence course. Rapid growth in this area is described by Harris [1] and the Sloan Foundation [2].

While also using web sites and learning management systems heavily in our courses, the author and colleagues in the Volgenau School of Information Technology and Engineering at George Mason University (GMU) have pioneered use of synchronous Internet education as reported in [3] and [4]. For any given course session, roughly two-thirds of our students are in the classroom; the remainder are somewhere on the Internet, most often at home or office. We have described our teaching methodology, called *simulteaching*, and the supporting open-source technology, Network EducationWare, in [5] and [6]. Our approach extends a lecture or seminar over the Internet for improved accessibility by students. Goodwin and Bowman have shown that this approach results in the lowest costs for online teaching [7]. Moreover, we have found it results in the easiest transition from the traditional classroom, and is much more convenient to the student than distribution based on the other widely used synchronous approach, video teleconferencing.

Faculty involved in distributed education largely fall into two camps based on the dichotomy laid out above: synchronous or asynchronous. This paper addresses the fact that the two approaches are in fact highly complementary and should be used together in order to best support the learner. The paper begins with a description of our extensive work in synchronous Internet distributed education. This is followed by an assessment of the strengths and weaknesses of both synchronous and asynchronous modes, based on our practice in both areas. The assessment culminates in a discussion of the benefits of blending both approaches with traditional classroom instruction for maximum synergy.

2 A Low-Cost Synchronous Delivery System and Its Capabilities

While the author and colleagues have considerable experience in Web-based asynchronous distributed education, we are not unusual in that regard. Many educational programs provide such services, ranging in scope from simple course web pages to fully developed degree programs. Synchronous Internet delivery is less common and also offers great promise, as described by Wilson [8]. The perspective offered here for blending synchronous, asynchronous, and classroom delivery is based on our extensive experimentation using synchronous delivery, with which few educators have yet become familiar. Therefore this section begins with an overview of the supporting capability we have developed.

The author was privileged to conduct research using advanced networks for distributed military training in the early 1990s, at a time when the Internet was, in most cases, not capable of supporting synchronous interaction. These early experiments led to a conviction that nearly all the benefits of any social learning environment, from that of one-on-one-tutoring to that of large lecture halls, can be provided to remote participants using modern networking technology. As the capability of the Internet grew, this insight was applied to our courses at GMU.

Beginning in 1995 we offered students the option of participating remotely in our classrooms. Initially we used Internet multicasting tools as described by Macedonia and Brutzman [9]. Pullen and Benson [4] reported on an early attempt at commercialization of technology to facilitate this type of interaction and the students' positive reaction to the ability to connect over dial-up modems to participate. More recently, our Network EducationWare (NEW) project has built on this paradigm to become a source of free software that facilitates expansion of this model by lowering the cost of support.

The NEW system software is represented in Figure 1 and summarized in this section. Executable and source code for all system components is openly available for academic purposes.

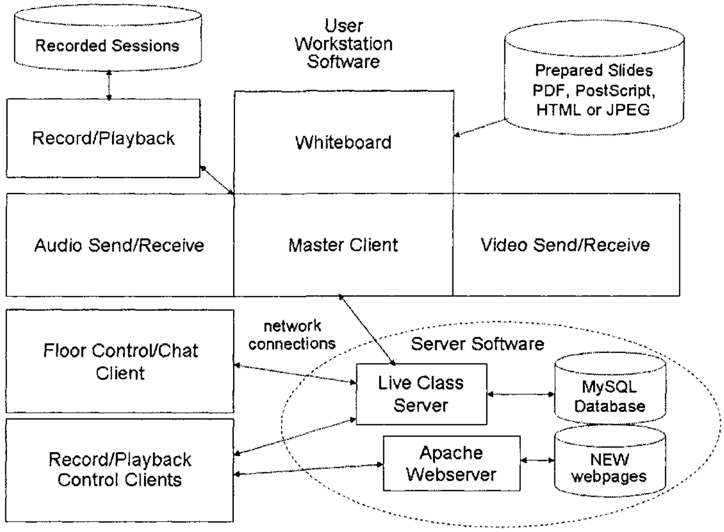


Figure 1. NEW system software architecture

2.1 Client Software

The multimedia interface software in NEW derives from a variety of sources and runs on Windows and Linux-x86 platforms, with a Macintosh capability planned for late 2006.

We consider the *Speak Freely Internet Audio* software to be the most important component in the NEW system, both because it is essential to the students' learning experience and also because conveying voice with good quality over the Internet at low data rates presents a big challenge. SF is capable of passing good voice quality over the Internet, using a standard sound interface, and requiring only 20 kilobits per second of network capacity. We have added a graphic interface that provides all needed user functions in one easy-to-use package.

The *Whiteboard* provides the other key element for teaching online: graphics. It will display a precomposed graphic prepared in any of several open formats, including most importantly the Adobe Portable Document Format (PDF). The precomposed graphics can be annotated during class with lines, rectangles, ellipses, handwriting, and text in any color, a very useful feature for maintaining the attention of the visual learner. We prefer to use the whiteboard with a Tablet PC interface so that it becomes a surrogate chalkboard.

The optional *Video* tool is capable of multiple network formats, including standard H.323 conferencing. A typical delivery rate for NEW is two frames of 320 by 240 pixels per second, although rates up to 30 frames per second are possible. While we have found that, for teaching Information Technology, video provides a marginal benefit at relatively high cost, as reported in [10], we offer it as an option to students who have high quality Internet service.

The *Master Client* encapsulates data from the multicast applications into TCP tunnels to the Live Class server, prioritized according to the importance of each multimedia tool (audio first, whiteboard second, video last). The server can support a viable class connection over a 56 kb/s modem, without video. The combination of clients and their network configuration established by the master client is controlled by a configuration file downloaded from the supporting webserver at the beginning of a NEW session. If software updates are indicated, the master client also downloads and installs them.

The NEW *Floor Control* shows the participants in the session, controls access to the virtual classroom "floor," provides for text questions to the instructor and text chat among the participants, and accepts URLs from the floor holder for browser launch on all participating client systems. It supports a "virtual hand raising" mode for lectures and an "anyone can have the floor" mode for seminars and meetings.

NEW *Record and Playback Clients* control their respective servers. They feature VCR-like button icons and an elapsed time readout. The playback control also is capable of jumping forward and backward to the next slide in the presentation. Recordings require about 5 Megabytes of disk per hour of class.

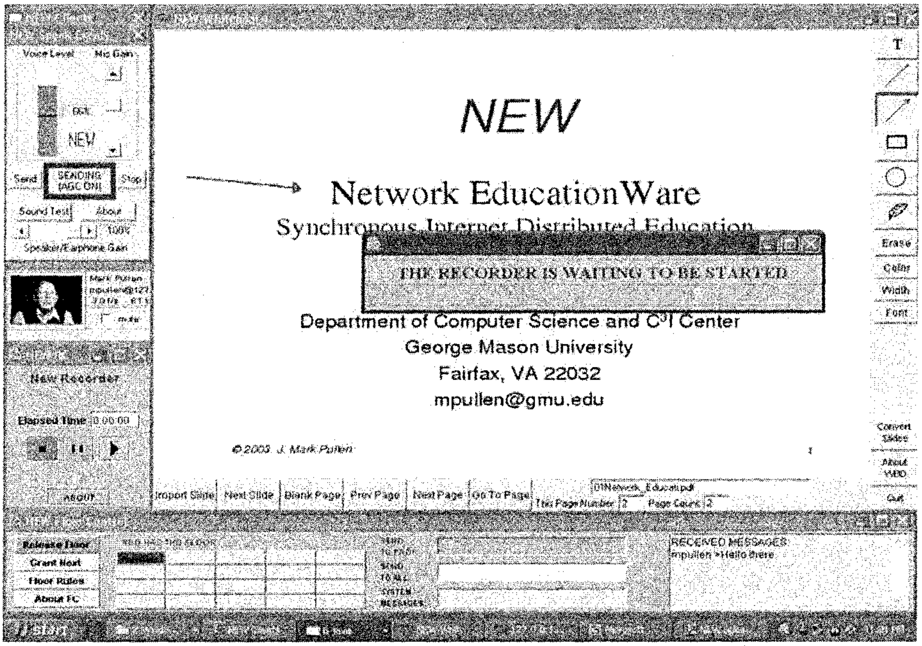
2.2 Server Software

The *Live Class Server* is the core of the NEW system. It implements group communication over the general Internet among a group of participating workstations by accepting a data stream combining transmissions from multicast conferencing tools on the floorholder's workstation and sending copies to all participants' workstations. It provides access control using either the system database or an external authentication service.

The *Record* and *Playback* servers are used to create and play streaming recordings that capture the information sent by NEW clients over the Internet from the instructor's workstation. Playback is accessed through the same software suite and also can be performed offline by downloading the recording files. Each segment of an online playback, starting with a new slide, can be Web-linked through a URL.

The NEW Course Management Web pages are the key to effective management of the mass of detail involved in supporting multiple courses. They provide teaching and learning functions, support and course management functions, authentication, and system administration functions. A single portal page provides access to all of these facilities, as described in [11]. Our webpages are hosted on an Apache Webserver that supports the PHP language needed for our webpages and a MySQL Database System supporting the standard Structured Query Language (SQL). Web-based support provides ubiquity and portability. It also makes possible data access over the network that we use to implement the chat room feature. The composite user interface for all tools is shown in Figure 2.

Figure 2. NEW user interface for open-source synchronous teaching



3 Characteristics of Synchronous Distributed Education

The common style of classroom teaching in higher education today, while often criticized, actually represents a solution that has been optimized over time to offer the best mentoring to learners at a cost that is acceptable to the parties involved. The NEW system as described above is simply a virtual extension to that sort of classroom. As such, it inherits the advantages of a system that has been proved to work well over many years: An instructor, serving as interactive mentor and interpreter of course materials, can enable more effective use of students' time for learning and can do so cost-effectively by simultaneous presentation to a group. Specific characteristics of the synchronous mode are:

- Most information flow is from instructor to student, although students experience significant learning from each other and astute instructors often also learn from the students. Synchronous delivery supports instructor presentation extremely well. Quality of voice and graphic delivery is good to excellent.

- A particularly important component of teaching is response to questions, because it clarifies points on which the students are confused and helps the instructor to refine the presentation. Synchronous delivery supports instructor-student interaction well, by either voice communication or typed questions with voice response.
- However, unless every student has a microphone, in classroom and online, interaction among students is limited. We provide for typed questions during class and also support an always-available Web chat facility to help remedy this. Some faculty members hold office hours online in this way. Faculty and students also often supplement synchronous sessions with electronic mail (email).
- Faculty report that the time to prepare for class is increased very little when online students participate synchronously during scheduled classes. Most instructors today have developed graphic slides to support their presentations; these are readily converted to use with the shared whiteboard, and the instructor's pointer is replaced by whiteboard annotation tools.
- Simulteaching students online and the classroom allows economy of scale in that one presentation supports both, using a smaller classroom than the combined numbers would require. This does not mean that unlimited online students can be added, because faculty time for mentoring increases with the aggregate number. However, simulteaching not only reduces classroom costs but also allows low cost introduction of online teaching, despite limited initial online enrollment. Whereas it is generally agreed that asynchronous online education costs more than classroom education to provide, the low cost to introduce and savings in classroom facilities for simulteaching may actually reduce the cost to present a course.
- The author's experience in several courses has been that many students fail to reach timely completion when they do not have the motivation provided by regular course meetings. Regular synchronous meetings, whether online or in a classroom, result in fewer delayed student completions and dropouts.
- Recordings made synchronously support asynchronous delivery in quite a different way from websites. The recording captures much of the ambiance of the classroom that is promoted by instructor-student interaction. Moreover, in highly dynamic topics (including most Information Technology subjects), the presentation will include the latest developments which, of course, also are captured in the recording.

4 Characteristics of Asynchronous Distributed Education

The recordings described at the end of the previous section actually support the asynchronous mode, and are used as such in our program for both online and classroom students. Many of our students prize the flexibility to time-shift class sessions to suit their schedules, which adds a new dimension to accessibility of education. However, the benefit does not come without some costs. Benefits and drawbacks specific to the asynchronous mode are:

- Restating the point made above: the defining characteristic of the asynchronous mode, its freedom from schedule, can be a significant benefit, particularly to working students who must travel for their job. The Internet offers "any time, anywhere" access to learning resources.

- For students possessing the self-discipline to sustain self-study, no instructor or peers are necessary. These students are the natural customers for asynchronous distributed education. For them, pure "distance learning" is possible without the mentorship of an instructor.
- Peer interaction is difficult to impossible in the asynchronous environment. Even though an online chat room may be available for discussions, the fact that every student is likely to be studying a different topic greatly reduces the potential for discussion.
- Many students are not capable of totally independent study; they want and need access to human information resources. In the asynchronous mode, this is most often provided by email. The higher level of interaction available through an online chat room often proves useful, but with the schedule impact of "going synchronous" for an online session.
- Interactive tutorial materials available through a learning management system (LMS) such as WebCT, Blackboard, or the non-commercial Moodle system can be very effective resources for students. However, preparing such materials takes time and generating interactive materials can be extremely time-consuming. Many faculty members, already carrying a full teaching load, have little interest in spending hundreds of hours to create interactive tutorials. As a result, institutions that want to offer the most effective asynchronous courses have found it necessary to offer release from teaching one or more courses for this purpose, entailing considerable expense.
- In a dynamic area such as Information Technology, once a course is posted online, it cannot be left without faculty attention. The subject area will continue to change so the course materials will need to be maintained.

5 Asynchronous and Synchronous Modes Blended with Classroom Teaching

At GMU we have steadily expanded the number of courses available synchronously; currently we offer twenty courses, taught by sixteen faculty members. Every faculty member approaches online delivery in an individual fashion. As the earliest of our faculty to begin teaching this way and the instructor for the largest number of different course offerings (six, to date), the author has had the opportunity to observe highly effective blended combinations. The following observations apply to the happy synergy of synchronous online, asynchronous online, and classroom education.

- The Web browser (*e.g.* Microsoft Internet Explorer; Mozilla Firefox) is far and away the most effective user interface for all Internet education. The ability of hypertext to link to the incredibly rich information resource of the World Wide Web also can be used to build links within an individual course or website. The browser can be used directly to offer text and graphics, or serve as a front end to other tools such as NEW or Adobe Acrobat.
- It is almost gratuitous to note that every course and every faculty member should have a webpage where course materials are posted and should interact

with students at least daily by email. In addition, use of a chat room can provide for more interactive response, and is particularly valuable for students whose distance or schedule makes attending scheduled instructor office hours difficult or impossible.

- Given the large time commitment to develop them, it is not at all gratuitous but may be impractical to recommend development of interactive tutorials and homework/quizzes. These provide a highly effective means of review and assessment. We have created them for a few of our courses, and plan to link these directly to NEW recordings for immediate review where the student is having trouble in understanding. Another good practice, where suited to the subject, is an online project where the student creates something in a way that requires consideration of the principles taught in the course. In the Computer Science discipline, we are blessed with an abundance of such opportunities.
- As reported in [6], there has been no significant difference between the examination scores of classroom students and online students using NEW. We do not yet have a large enough sample to examine the degree to which availability of interactive tutorials and homework/quizzes has a direct impact on learning. However, we suspect such a study would yield similar results, because in our experience the primary impact of these mechanisms is to facilitate learning by increasing accessibility.
- Most students in our synchronous courses make an informed decision to trade the classroom experience for the considerable saving in commuting time that is enabled by Internet delivery. However, a small fraction of students report that they prefer online courses because they find the classroom environment distracting. We anticipate that this syndrome will be recognized by educational psychologists as online learning matures. Whatever the source, in our experience the online environment definitely benefits these students. Conversely, a larger fraction of students find the online environment impersonal and prefer classroom attendance, although many of these use the recordings for review. Thus, the best arrangement is to allow students maximum flexibility consistent with the course of study, so they may take advantage of the mode that best suits their needs.
- Simulteaching of classroom and synchronous online students is a highly effective approach with low costs and low barriers to adoption, using the arrangement shown in Figure 3. It is most effective when integrated with asynchronous supporting materials, but even if adopted without them it will result in increased accessibility to education over the Internet.
- When expanding a course to online delivery, consideration needs to be given to administrative support. Carswell has presented a compelling case to the effect that a true distance education program will allow students to do anything remotely [12]. However, we have found that a regional approach works well for us; our students come to campus for examinations unless special arrangements are made for proctoring. It would be possible, with some extra effort, to arrange for proctored online examinations via an LMS, conducted remotely at the testing centers offered by many community colleges today. In addition to testing, issues such as registration and textbook purchase must be considered. However, today the advent of Web-based administration and online bookstores removes most of the difficulty in these areas.

- Above all else, any computer software the student is expected to use should be adaptable to as wide a range of platforms and operating systems as possible so it can be run on personal computers, taking the place of laboratory facilities.

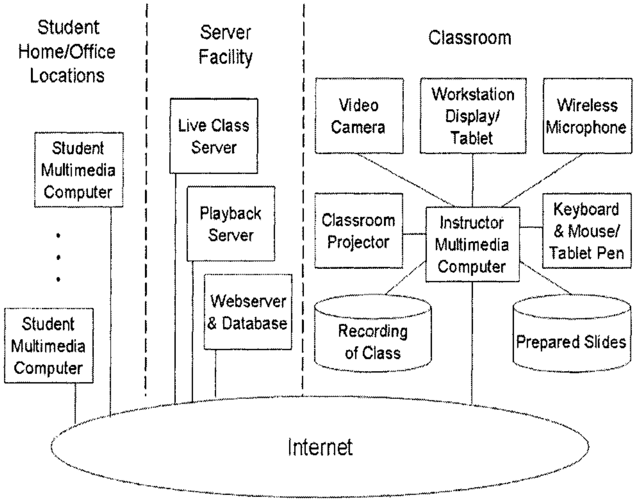


Figure 3. Simulteaching combining classroom and the Internet

- The most important goal is accessibility for the student. Ideally each course that is suited to Internet delivery will be offered both in the classroom and synchronously online. It will include a variety of supporting asynchronous materials, with recordings of all class sessions readily available for online playback and download. Recordings will be integrated with tutorials and homework/quizzes in an LMS, and with supporting projects that can be accessed and submitted online. Any cost savings from facility reduction enabled by simulteaching ideally should be applied to support the effort required to integrate asynchronous materials. That process requires increased faculty time, but the payoff in support for the student is great.

6 Conclusion

Today's information technology offers support for teaching and learning that allows access to excellent education in many subjects from anywhere on the Internet. Synchronous Internet delivery offers improved accessibility to the student and is the simplest and least expensive to offer. Asynchronous Internet delivery provides high flexibility but its interactivity with the instructor and other students is poor and should be supplemented. The best way to employ these technologies is blending classroom instruction with synchronous online delivery by simulteaching, supporting the synchronous course with asynchronous Web-based resources, interactive tutorials, quizzes and homework, plus projects that can be completed or submitted online. Creating such a blended course with an effective set of asynchronous supporting materials that provides strong support and good flexibility for the student is challenging, but it is the best way to perform the academic mission given access to the Internet and its technologies.

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Structural Awareness for Collaborative Learning Environments

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Abstract. In this paper we propose a peer-to-peer support approach that we call structural awareness support. The structural awareness aims to support the communication that takes place in virtual learning communities. Its emphasis is on revealing the group structure to its participants in order to promote collaborative interactions. This support has been implemented on a forum type tool called Mailgroup. It has been tested twice in different contexts, obtaining initial feedback of its pertinence according to our objectives.

1 Introduction

Network technologies led to the establishment of new web-based learning activities and the emergence of new types of communities called virtual learning communities (VLCs). The VLC expression is used in this paper to designate online social systems, where their actors are generally geographically distributed, collaborate usually via ICTs, and maintain a shared purpose [10].

Particularly, we focus our research on providing mechanisms to support VLCs. In VLCs, collaborative learning activities are mainly carried out through a conversational, written and asynchronous environment, which we call forum-type tools. The term "forum-type tools" (FTTs) is used for text-based and asynchronous electronic conferencing systems that make use of a tree hierarchical data structure of chained messages called threads. In their origin, FTTs were designed for the distribution of news, not as an environment for interactive communication [5]. Although research has shown some difficulties associated with FTTs for educational use [6, 7, 18], these tools are currently widely used in this domain (computer conferencing packages, web-based newsgroups and e-learning platforms). In this

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context, we address issues related to the structure of learning conversations taking place in VLCs. Particularly, our research issue is to analyze learning conversations taking place in VLCs in order to provide mechanisms to support and facilitate the emergence of these interactions among the users of FTTs.

In order to create this support mechanism, we work with a methodology we call "technological innovation". The tenet of this inductive methodology is that the design of new technologies deals with "revealing anomalies in practices". An anomaly is an invisible tension that exists when users carry out a particular activity, which for phenomenological reasons people are sometimes unaware of. Nevertheless, they are found at the origin of work practice dissatisfactions. Thus, we create new technologies that aim to overcome the found anomalies.

This paper is organized as follows. First, we present the anomalies found from a relational perspective and their associated incongruencies. Next, we describe the structural awareness perspective that aims to overcome the anomalies found. Finally, we present our prototype, which is built over these propositions and we present some results from an empirical study.

2 Anomalies in VLCs

We can analyze the conversations and interactions that take place in VLCs that use FTTs from different points of view (semantically, sociologically, pragmatically, etc). In this work, we understand and analyze interactions from a relational perspective. In this sense, we no longer interpret the conversations as semantic chains of participants' contributions, but take an approach where we interpret interactions in a purely relational way. That is, we think about interactions just as links between messages in conversations. In the case of an FTT, the link is produced by an explicit action of a participant that relates the messages by answering a preceding message or by creating a new one. From the study of these interactions (in a relational perspective) and the network of relations that generate them, we wish to reveal certain anomalies in the communication that takes place in FTTs.

We conjecture that if we can identify what we call structural incongruencies, anomalies become visible. Structural incongruence is a difference between the expression of the users' actions and the perception of the structure of interactions that turns out to be a salient product of these actions in the current FTT. Therefore, in this work we look for structural incongruencies as a way to make anomalies salient. We have used different methods for analyzing data to reveal anomalies (observation analysis and quantitative analysis).

Observation analysis took place principally in a selection of USENET newsgroups (comp.ai.philosophy, humanities.lit.authors.shakespeare, humanities. philosophy.objectivism, sci.anthropology.paleo, soc.culture.french, talk.origins, talk.philosophy. humanism, talk.politics.guns.). This option is not in opposition to our aim of studying VLCs. Research has shown that some newsgroups can be considered as a community [14]. The quantitative studies are based on the analysis of FTT interactions of a set of eight selected newsgroups (the most active and having longer threads length) in order to unveil evidence of anomalies based on solid data from real usage.

In our study of FTTs we found four different incongruencies: (1) the *interactional incongruence* derived from the difference between the message unit that users can handle and the one they can make reference to, causing information loss and reference confusion; (2) the *convergent incongruence* triggered by the lack of a mechanism to manage the convergent interactions taking place in FTTs, such as consensus, connecting ideas or making a synthesis; (3) the *turn-taking incongruence* caused by the disruption between (a) the temporal and thread order of messages, and (b) the management of parallel threads; and (4) the *group perception incongruence* caused by the deficient perception of the interaction structural regularities taking place in a group.

Interactional Incongruence: It has been detected that within a message we can find several topics that appear and develop as threads [1, 18]. Users usually answer by choosing a fragment of the message that they want to answer. This segmentation is done by (a) selecting a part of the message, or (b) selecting several parts of it when answering several paragraphs. However, the segmentation is not visible in the current implementation of systems based on message threads (that we call interactional incongruence), since this only denotes the link relation between messages and does not take into account the specific parts selected by users. Consequently, when examining a discussion through the current tools, topics are not easily localized because they are buried in the rest of the message content. This incongruence is detailed in [12].

Convergent Incongruence: Collaborative learning activities include "divergent interactions" such as brainstorming, which is a highly generative and dispersed interaction that does not tend to build collective results and "convergent interactions" such as the process of synthesizing, summarizing, reaching a consensus, and connecting or integrating different ideas. Moreover, different authors have observed the lack of mechanisms for convergence of FTTs [7, 12]. In an empirical study, Rocco [15] finds that consensus convergence and social enforcement were weaker in a FTT than in a face-to-face context.

The lack of convergence can be partially related to the intrinsically divergent representations used in FTTs [7]. The data structure of threaded conversations is a tree structure that diverges naturally on multiple branches from the top-level message (initial message). Even if the messages convey synthesis, consensus, or other convergent interactions among different branches of a thread, these cannot be visualized on the data structure, and consequently, they are "buried" among all the messages. This situation is named convergent incongruence.

Turn-taking Incongruence: By turn-taking incongruence, we refer to related issues in the management of turn-taking in FTTs. This incongruence has serious consequences for the emergence of learning conversations. The turn-taking in spoken conversations is a process that takes place in an orderly fashion. In each turn the participant speaks and then the other responds, and so on. Thus conversations are oriented as a series of successive and negotiated steps or turns, so turn-taking becomes the basic mechanism of conversation organization. The turn-taking system in CMC tools is substantially different from face-to-face communication (e.g., [8, 9]). The communication carried out using these tools follows a multidimensional sequential pattern (through parallel threaded conversations), rather than a linear sequential pattern, with "complex interactions that result in layered topics, multiple speech acts, and interleaved turns".

We conjecture that the lack of linearity and the dislocation of turn-taking are related through two dissociations. First, the dissociation in threaded conversations between the temporal and the thread order of messages (Figure 1). Second, the dissociation between a particular work pattern [8] (users do not send messages in a regular frequency, they answer generally in a buffer-like way to different threads) and its representation on FTTs. The importance of orderly turn-taking can be found in [16], which observes that through iterative turn-taking structures, "students are able to build on each other's ideas and intentions, draw new ideas into a common conceptual frame, and repair divergences" [16].

Regarding the first dissociation, in threaded conversations, several authors have observed a dissociation between two possible views in current FTTs: the temporal and the thread order of messages [2,6]. This dissociation is caused by the dislocation of the factors of space and time in most of the threaded conversation visualizations. In FTTs, users are able to look at the same conversation from two different viewpoints: messages ordered by time or by threads (Figure 1). This dislocation makes conversations not as seamless as they should be: sorting by threads makes the tracking of timely exchanges difficult. Along these lines, Davis and Rouzie [2] note "as messages can be added to any node in a thread at any later date, students often failed to follow the development of a particular debate" [2, p.12]. But sorting messages by time does not allow users to regard the actual placement of a message in the threads.

Regarding the second dissociation, some authors have observed that users have a particular work pattern [8]: users do not send messages in a regular frequency, but tend to answer in a buffer-like way. They successively concentrate their replying activity on sending several messages in a short period of time in order to bring their interventions in a conversation up to date (consecutive messages). In these responses they sometimes answer two or more consecutive messages in different threads. In [13] is found the quantitative study that confirms this temporal work practice in some newsgroups.

Group Perception Incongruence: We notice that users in face-to-face interactions are able to perceive structural regularities such as the level of

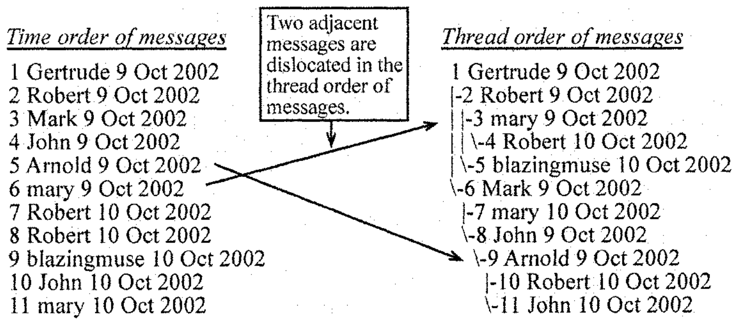

Fig. 1. Dissociation in threaded conversations between the temporal and the thread order of messages.

interactivity in the group (i.e., if it is talkative or not), its clusterability (whether it has different subgroups), role of participants (e.g., identification of the group leader), as well as others. Nevertheless, for those who communicate through FTTs, it is difficult to perceive these structural properties.

The lack of perception of these structural regularities can be an element that diminishes the social presence of a group. The social presence is a measure of the feeling of community that a participant experiences in a virtual environment [17] and this corresponds to the degree of awareness of a participant in his or her interactions with others and their consequent appreciation of the interpersonal relationships that are constructed from these interactions. Gunawardena [3] indicates that the social presence is needed to improve learning.

3 Structural Awareness

We propose a peer-to-peer support approach called *structural awareness* as a way of overcoming the detailed incongruencies. In this section, we explain the notion of peer-to-peer support and describe the structural awareness support perspective.

3.1 Peer-to-peer Support

The kind and extent of support mechanisms provided to the users by the CSCL platforms are a critical element in the design and conceptualization of these educational tools. These support mechanisms are a very active field of research in educational technologies. Multiple strategies and developments exist in this field. However, in this multiplicity of support initiatives in collaborative learning, we can distinguish three possible approaches: "teacher-supports-students", "automated-system-supports-students" and "students-support-students". The main difference between these approaches lies on the locus of processing who provides the support.

The students-support-students approach, what we call peer-to-peer support, has as a characteristic element the reciprocal assistance and organization between participants. Peer-to-peer support is a bottom-up approach: *One does not seek to make a system that intervenes on the actors, but a system that gives them the means of intervening by themselves*. Consequently, the strategy of support is based on the need to inform the actors, enabling them to be conscious about their activity.

3.2 The Structural Awareness Design

Structural awareness deals with knowledge about structural features or activities of a group. It puts emphasis on revealing the structural properties of a group to its members in static and dynamic viewpoints in order to promote better collaborative interactions. Structural awareness is a strategy to overcome the anomalies detailed in the previous section.

This option is mainly based on two ideas. First, we are interested in studying and supporting the peer-to-peer learning perspective. Moreover, we think that there is insufficient research on this peer-to-peer approach in the domain of supporting interactions. Secondly, looking at the structural perspective of interactions, we see that it is motivated by the relational perspective of conversations taken in this work. Moreover, we think that there is a lack of research on structural perspectives as applied to the domain of supporting interactions.

The foundational idea of structural awareness support is making salient to users some structural aspects, features and anomalies of the group. With the structural awareness support we do not seek to build a system that intervenes on the actors, but a system that gives them the means for intervening by themselves. The basis for this idea is that a proper knowledge of the interactions structure helps users to be conscious about their activity, and by being conscious they obtain benefits to the self-management of interactions.

Structural awareness employs different strategies that aim to make more coherent the VLC users' actions and perceptions of these actions that take place in FTTs, overcoming the identified incongruencies. These strategies try to facilitate the emergence of learning conversations. In particular, the structural awareness will be reified through different strategies that aim to enable participants to perceive their interactions in what we suggest is a more congruent and concise way than in current FTTs, by being able to see the structure of their exchanges in an ordered visual manner, thus overcoming the interactional, convergence, and turn-taking incongruence already mentioned. Thus, we show the participants the group's structure of interactions, enabling them to perceive their interactions through a graph-like visualization, providing particular mechanisms for maintaining a higher coherence between their interactions and the visualization. Additional reification occurs through a set of persistent indicators of certain characteristics of the group, which allows users to get summarized information related to some group structural properties, and even some structural attributes of individuals, that are not salient in VLCs based on some quantitative indicators, namely the complexity of a group, cohesion of a group, and individual status indicators.

All of these strategies aim, according to our structural perspective, to show different aspects of the group structure of interactions, in order to help users to perceive their interactions from this perspective. We conjecture that this perspective can give users new elements for their peer-to-peer support of learning conversations that take place in VLCs. All these strategies have been implemented in an experimental FTT tool we call Mailgroup.

3.3 Proposed strategies

We propose several strategies that make up the structural awareness support. Each of these strategies, which are implemented on the Mailgroup FTT, aims to overcome an identified anomaly.

Regarding interactional incongruence, we propose changing the current minimal unit of exchange (the message) for a new minimal unit, the topic. The topic is a subset of a message, generally a smaller portion of it, which has been selected by a user. This change will allow us to make reference to any segment of the message and thus easily track every participant's intervention throughout his interactions. The localization is carried out through the *What You Answer is What You Link* (WYAIWYL) principle [12]. Therefore the participants, in order to respond to a specific topic, must explicitly select it. We note that the topic is not an "object" previously defined (a topic is only a part of a message), but becomes a visible object once it is selected through the WYAIWYL principle.

We propose a tool that allows users to create a link between the selected topic and the answer. Therefore, threaded conversations can be defined by the users from the selected topics. It is important to note that we do not use any semantic text analysis method for locating the topics: They are defined by the participants. Thus, the WYAIWYL principle allows users to define their threads freely, thereby overcoming the interactional incongruence. This strategy is detailed in [12].

Regarding turn-taking incongruence, we propose a visualization of threads, so one can quickly and graphically visualize the flow and patterns of online discourses at the same time. We will merge both types of existing views (the time order and the thread order of messages) in a single view that graphically depicts both concepts, as presented in the next section. Moreover, we propose the creation of a structure called session that aims to overcome temporal incongruence. This structure intends to model the turn-taking behavior and make the particular rhythm of answers visible. A session corresponds to a group of messages sent by the same participant consecutively in a short period of time. In other words, it is a new structure that holds together the messages sent almost at the same time.

This structure corresponds to columns (Figure 2) that package the messages in a parallel and linear way. These arrangements seek to reduce the dispersion and the dislocation of threaded conversations by augmenting the linearity of conversations and allowing one to start or to maintain parallel discussions in a unified visualization. This strategy is detailed in [13].

These two strategies (merging time order with the thread order of messages, and the integration of session construct on a FTT) seek to reduce the dispersion and dislocation of threaded conversations, by augmenting their linearity and making it possible to start or maintain parallel discussions in a unified visualization.

Regarding convergence incongruence, we propose a new functionality that

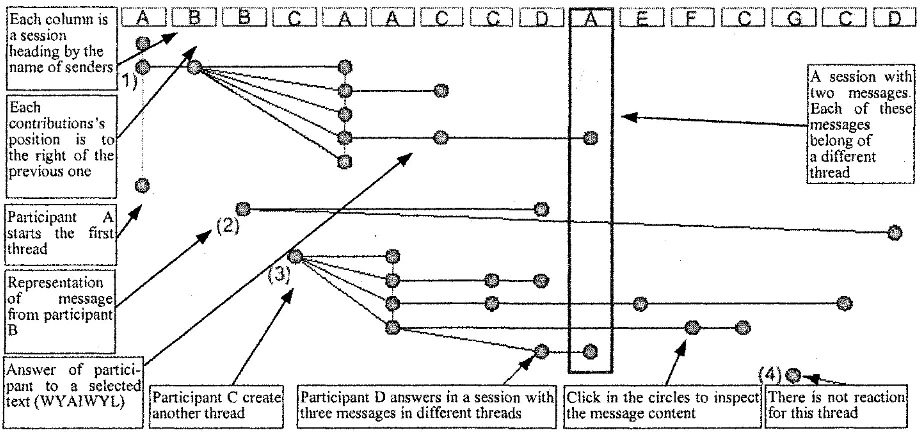

Figure 2. "TIC and disciplines" conversation in Mailgroup

allows multiple threads to merge into a single one. The result of this operation is properly visualized through the visual space in the proposed tool. Consequently, all users will be aware of the existence of convergent interactions and also they can inspect the convergent interactions and react to them.

Regarding the group perception incongruence, we propose the creation of an observation level which allows users to get summarized information related to some structural properties that are not salient in VLCs. Here, we have implemented an observation level of the communicational activity based on quantitative indicators (complexity, cohesion, and status indicators). This level offers some synthesized group behavior information about users, which is neither easy nor transparent to obtain from the level where the message interactions actually take place in an asynchronous and text based communication.

4 Tests

Empirical studies were designed in order to collect feedback on the actual characteristics of our prototype from the user's perspective. During this study, the tool was used just as the medium of communication, not as a point of concern in itself. We did not want the students to discuss the tool, nor think about it. We were interested in evaluating just how they could "work it out". We tested Mailgroup in order to: (1) test the system usability and (2) obtain the first corpus that allows us to analyze how Mailgroup is used and what is going on when people use this system.

4.1 Empirical Context

Mailgroup has been tested twice. First, a test that aimed to get the feeling of users towards the proposed tool. In this study, nine groups of 3 or 4 students (32 participants in total) were recruited. They were second year undergraduate students, who voluntarily carried out, for one month, a distance collaborative activity. Second, a test with a deeper and more complete usability study and corpus analysis. In the second test, 15 participants were recruited. All of them were teachers, who for a month and a half carried out a distance collaborative activity as part of a training course on information and communication technologies.

4.2 Results

First, we detail one conversation that took place in Mailgroup. Next, we present some results of the survey. Finally, we present the principal findings found through the realized tests.

Figure 2 shows the "disciplines" conversation. Here seven people took part and four threads were created by four different members. The initial number of threads of this discussion (4) can be considered initially as low. But the exchanges are very rich. They include recommendations, advice, and examples proposed to others. There are also interrogations and incentives to offer an opinion. Moreover the thread depth (i.e., the number of responses within a particular thread) goes up to five levels.

Consequently, the group does not stay in a situation of question and answer. In total, when regrouping the messages, this conversation constituted a document of almost 3 pages.

In order to obtain the students' impressions of the use of Mailgroup as a communication tool, we conducted a survey of the participants on the last day of the training course. In general, a high percentage of participants (75%) considered that the proposed visualization and organization of messages allow for a better following up of the ongoing development of conversations. Moreover, a high percentage of participants (75%) considered that Mailgroup permits an effective visualization of the participant's exchanges. Only a small percentage (13%) had difficulties following up threads in the proposed visualization.

Participants used the WYAIWYL principle. Since students could choose more granular and "findable" topics in the easily navigable thread view, they could organize and collaborate better. Also, the most significant benefits of using this criterion identified by users were: (a) an easier identification of the active threads and (b) it better allowed for the organization of answering, relative to current FTTs.

Consequently, the survey, though limited, seems to strongly show the benefits of using this visualization for threaded conversations. The results of this study are preliminary, mainly due to the relatively small size of the sample. Nevertheless, the results have allowed us to obtain good feedback about the usability of the proposed system. These results indicate that the proposed system and the concepts underlying the construction of Mailgroup are significant.

5 Conclusions

We propose structural awareness support. This support aims at users being aware of their activity through their communication structure. The tool presented in this paper focuses on the notion of enhancing coherence in threaded conversation systems. It is aimed at facilitating the emergence and development of learning conversations. This was done overcoming some incongruencies we have identified as undermining the emergence and development of better communication.

Our principal findings are as follows. (1) The experience carried out with Mailgroup confirms that WYAIWYL principle is a useful mechanism for structuring FTT threaded conversations. (2) The use of this tool enables a change of practice: students organize the structure of messages into paragraphs. Indeed, they affirm that creating messages in this way will make it easier for other participants to locate and respond to parts of a message (topic), facilitating topic salience and definition. (3) Another observation is the salience of no-answer topics. The proposed visualization facilitates the tracking of no-answer topics that take place during the conversation. These topics are visualized and highlighted in the interface as circles without links to or from other messages. (4) Indicators can be an element used to analyze the group in order to obtain a structural awareness of their interactions, although more studies concerning this must be made.

We consider that in future developments the graph visualization must be improved by (1) using algorithms that allow fewer lines to be crossed between messages, because these lines make the visualization of references between messages difficult; and (2) optimizing the space that is now poorly exploited (in the current visualization there are many zones without messages).

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Meaning Making Through e-Learning

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Abstract: Different approaches have been proposed to add more educational value to e-Learning. One of these views proposes modern pedagogical models that better fit the nature of the unique features of technology. A related approach is to embed modern learning and instructional design theory into new communication and interaction channels provided by information and communication technologies such as the Internet. This study presents a model for e-Learning illustrated with a specific case study of in-service teacher training in learning with digital media. After presenting the model we describe the design, implementation, and evaluation of an e-Learning program for school teachers that uses our model. We highlight the way teachers construct meaning by reflecting on teaching and learning. Intact e-communities were developed through interaction and communication by using Internet services to share meaning, views, and understanding. Thus meaning was constructed from teachers to be used during everyday school pedagogical practices.

1 Introduction

Diverse approaches have been offered to add more educational value to distance learning programs. Many e-Learning programs emphasize the "e" side, centering on the learning management system used and searching for new tools to "improve" distance learning [3].

Even though these views are necessary we believe that the central focus is somehow missed. Very few studies concerning pedagogical models for distance learning to fit the particular and unique features of the Internet are proposed. Most programs follow a chalk and talk way of teaching without paying much attention to innovation by designing new pedagogical models to fit the unique features of new

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media [5] [7] [20]. We can summarize this vision as the "old wine in new bottle" view.

Other studies identify learning management systems as key tools that define the learning methodology and strategies. The software framework forces a way of teaching that reduces the flexibility required by active learning methodologies [3] [17] [15]. Many of them end with a model tailored to the technological framework used instead of a software framework built upon the needs and features given by the pedagogical model assumed.

Some authors have proposed innovative methods and learning strategies for e-Learning [3] [2] [4] [10] [13] [14] [9] [11]. The emphasis of these innovations is on learning and centered on learners by including ways of fostering different modes of knowledge representation. They design a virtual space to construct knowledge and collaborative learning strategies supported by learning management systems.

As a result, we can end up with some e-Learning principles that support any course implementation, such as: to promote an active role of learners in the construction of knowledge, to promote meaningful learning, to promote broad and deep learning, to develop skills, attitudes and values, to allow real experiences through real world activities, to promote collaborative learning, to promote a changing role of teachers/tutors as learning facilitators, to involve learners as co-evaluators, to make learners to reflect on what is doing, to use technology to enrich learning, to enhance action on knowledge objects, and to solve cognitive conflicts.

These principles emerge from underlying theories and models of learning such as constructivism, understanding as thinking, understanding as a network, social interaction, social distribution, situated learning, generalized learning, and self-regulated learning [1] [8] [17].

This study introduces a model for e-Learning that is built upon these principles, models, and theories. We describe the design, implementation, and evaluation of an e-Learning program. Our pedagogical model is illustrated with a pilot implementation with teachers. We highlight the way teachers construct meaning by reflecting on teaching and learning.

2 Design

We designed a whole e-Learning training program for teachers. We wanted to preserve academic quality and innovate the way we deliver education, both the technology and the model of learning. To do this we followed these steps:

Technology evaluation: We selected a learning management system and evaluated the technical requirements.
Team organization: We created a multidisciplinary team to implement the e-Learning program with engineers, educators, and educational computing specialists.
Model of learning: Once we knew the characteristics of the LMS and content we designed a pedagogical model for e-Learning.
Pilot testing: We designed a pilot testing course on methodologies for using information technologies with a reduced number of teachers. We tested the functioning of the LMS and the pedagogical model. We also evaluated diverse

materials, working interfaces, learning strategies, type of interactions, and time spent in different sections of the course.

Modeling: We designed and implemented the structure of the LMS by considering the learning model and the structure of the course program. The content of eight courses was modeled. Most of this content was already in digital format, facilitating the process content modeling.

Online classes: The students were selected and registered. Then the first week they inspected the platform by following an entrance module. Students also started to virtually communicate and know each other.

Online modules: To enhance the interaction between learners in each course we designed modules with individual and team activities to design products weekly. They used different interaction tools such as chat and forums to do collective designs and constructions.

Face-to-face modules: We designed three out of eight course modules to be delivered face-to-face. They included content that requires more student-facilitator interaction. Each course was delivered in an intensive week with a day topic and collective works.

Evaluation: We finally evaluated the courses through questionnaires and opinion polls to get ideas, comments, and suggestions concerning online and face-to-face classes. We also implemented a focus group with professors and tutors of the course to analyze and discuss the attainment of goals and objectives.

2.1 A model for e-Learning

Our model [18] is based on constructivist principles of learning [9] [16]. We view learning as the process of construction and modification of cognitive structures through learning by experience and collaboration. Each module of the learning cycle is oriented to obtain contextualized meaningful learning. Learners are required to reflect, apply, criticize, argument, and solve problems, thus allowing them to construct their own representations. We identify five major processes in e-Learning: realizing, approaching, conceptualizing, structuring, and applying.

Realizing consists of identifying the educational challenge. This process consists of orienting learners in their studies by identifying the problem and making their point of view. They also understand the objectives of the course work proposed and the starting points. They know what they will learn and the reason why the activities are proposed. The learner has to make representations of the expected products and results, and the rationale for doing this. Realizing involves the process of motivating, problem identification, and pre-concept/concept contrasting.

Approaching consists of constructing a new learning plan and point of view by learners, guided by a group of professionals, by designing diverse methodological proposals to fit their cognitive styles. The idea is to produce a cognitive conflict to question the learner's intuitive models and to identify the strengths of the proposed models. It involves the process of reflecting, retention, adapting, exploring, and researching.

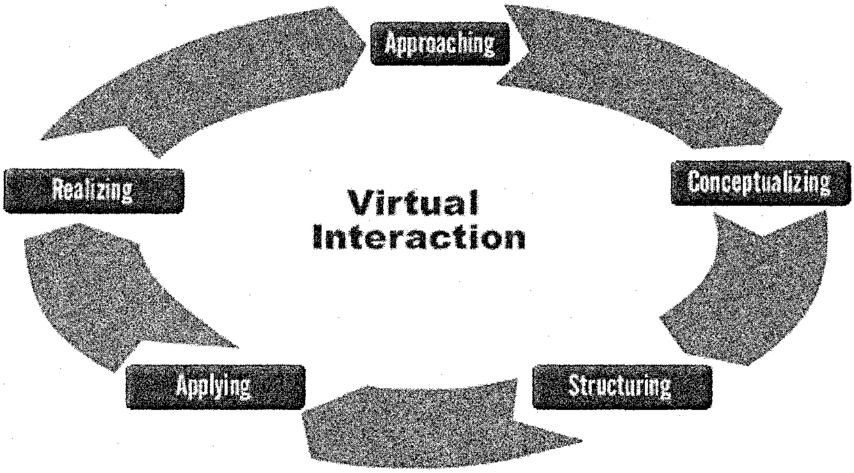

Figure 1. A model for e-Learning

Conceptualizing involves identifying the concepts and possible conceptual changes when exploring and approaching the content. It involves the processes of metacognition, representation, and adaptation.

Structuring refers to constructing meaning through didactic strategies such as synthesis, monitoring, and metacognition. This involves processes such as analysis, synthesis, retention, metacognition, and abstraction.

Applying consists of giving the opportunity to students to apply their conceptions to new and different scenarios. It involves evaluation, imaging, adaptation, abstraction, problem solving, contextualizing, and metacognition.

Virtual interaction triggers a synergetic effect on the model by carrying these five processes of knowledge efficiently and thus allowing feedback, confronting ideas, discovering, and collaboration. All these processes are critical in the construction of meaning.

2.2 Training teachers through e-Learning

Our center implemented an e-Learning experience in order to design and evaluate the proposed methodological learning model. We also wanted to evaluate the learning management system used and to identify main components and strategies to implement an e-Learning course. Another experience applying a former version of this model with Chilean teachers has been described in the literature [19].

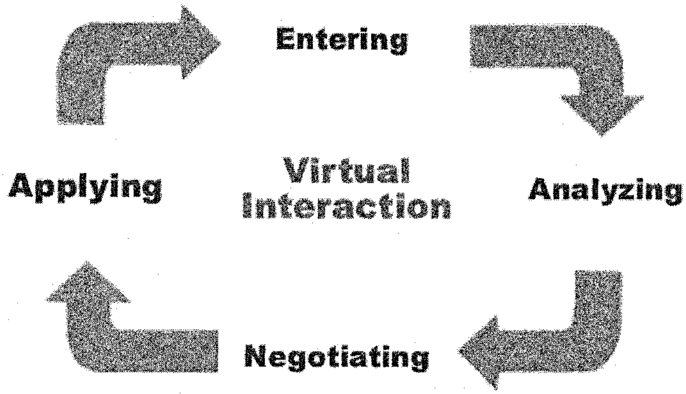

Figure 2. e-Learning cycle

In order to do this we followed five phases: Design, implementation, evaluation, feedback, and redesign. The design of the e-Learning cycle involved processes such as entering a content unit, analyzing documents, negotiating meaning, and applying what learners have learned through collaborative constructing to end with a group synthesis (see Figure 2).

To illustrate the feasibility of the model we describe the implementation of a course on methodologies for using technology for teachers (see Figure 3). Thirty-five experienced teachers took the online course. We divided the course into eight working units with the corresponding learning activity and questions to enrich interaction among learners participating within the virtual dialog classroom. Each unit was covered in one week and ended with a synthesis of conversations, analysis, discussions, and exchanges.

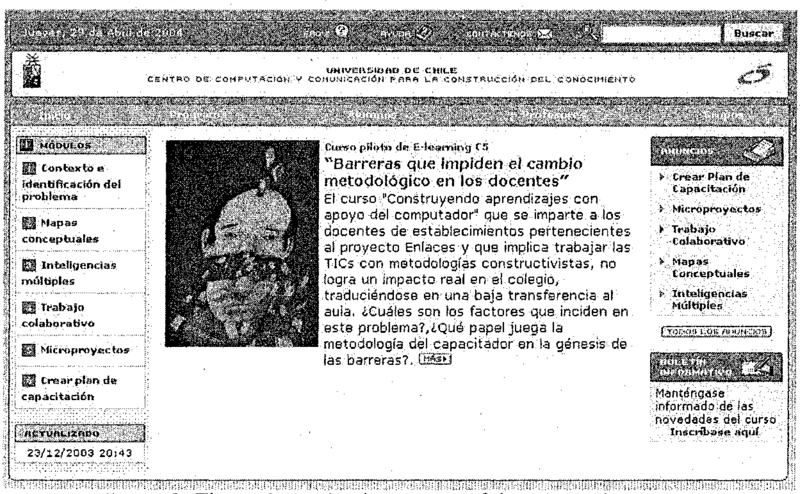

Figure 3. The main navigation screen of the e-Learning course

Each unit was based on seven sections: 1. Unit description, 2. Mandatory documents, 3. Complementary documents, 4. Related links, 5. Activities, 6. Virtual dialog classroom, and 7. The learner's synthesis (see Figure 4).

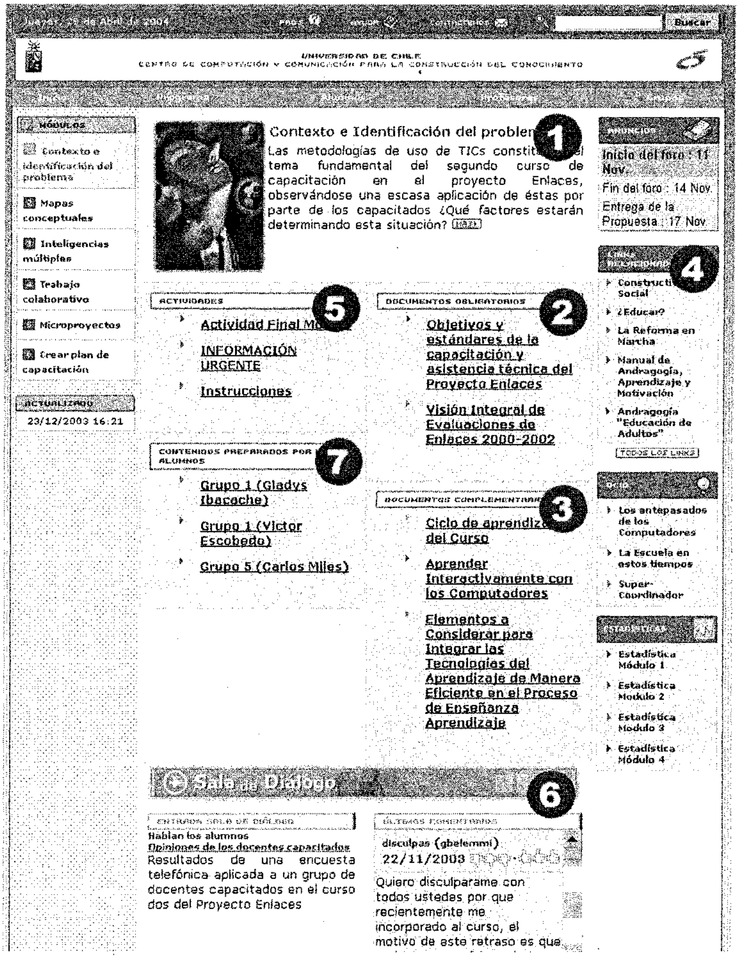

Figure 4. Unit sections of the e-Learning course

We have created an interactive virtual space for each content unit to integrate the construction of knowledge around a topic. Due to the fact that the quality of the interaction among learners was not tacit we implemented an initial strategy to break the initial barriers to communicate and interact. Learners had to introduce themselves to the class by highlighting personal strengths in a playful way and listing their expectations for the course.

As a result, we evaluated the learning management system used (www.newtenberg.cl). It was a Chilean commercial system that was modified, extended, and adapted to our pedagogical goals. The level of interaction and communication among learners was very high, more than what we have observed in a similar content course delivered face-to-face. Due to our emphasis on group interaction we observed that learners wanted to have individual experiences that were not provided by our learning management system. This led us to suggest a balance between individual and group experiences for e-Learning courses.

We identified some key aspects to implementing e-Learning courses for teachers. The time of the experience is very important. Courses such as the one we are presenting should concentrate on time issues when the teacher's work load is high. The time spent by students is a key to retaining them in the class. The role played by facilitators is very important to foster participation and knowledge construction. The learning management system used can determine the type of activities to be implemented but not necessarily the learning model involved. The follow-up strategy is also relevant to the e-Learning experience. Facilitators and administrators should have tools to visualize learners' actions within the virtual environment. We also think that the time period dedicated to tutoring and coordination can determine the quality of the learning experience in online courses. This means time for solving problems, follow up, and to create a working climate to motivate students to actively participate in the learning process.

3 Methodological strategies

Each online course was divided into five working units during six weeks with a final evaluation. Units were developed on a one-week basis and ended with an individual or collective product. The last week was dedicated to preparing and taking the final evaluation. Each unit consisted of unit description, objectives, general directions, activities, support materials, web links, and online discussions around each activity and working document.

During each module students were involved in activities such as document synthesis, term glossary, abstracts, graphic representations (schemes, concept maps), collective constructions of documents, comparative charts, and case studies.

Each course consisted of a virtual class section, synchronic communication with the professor responsible for the course and diverse discussion forums to implement activities and documents. A professor was in charge of the course, assisted by a coordinator and a teaching assistant facilitator.

4 Meaning making through virtual interaction

We based our observation on meaning construction when learners were interacting within the virtual dialog classroom. Two processes can occur: presenting and comparing. Presenting involves posing an opinion, comment, information or knowledge. Comparing includes contrasting beliefs and personal knowledge with other learners by verifying agreements and disagreements.

This implies three other processes: falsifying, complementing, and discovering. Falsifying means to assign falsity and error to comments and judgments as a result of disappointment with a belief, comment or knowledge idea. Complementing means that we agree with the comment and accept it as a truth but we believe that it is incomplete. Discovering is new knowledge for learning in terms of new ways of viewing known knowledge. These processes are grouped within the most general process of comparing and can be externalized or just mentally processed without explicating it.

The idea with our study was to go further than just presenting information. We foster discussions where personal knowledge is proof tested because of the collective interaction ending with collaborative social knowledge construction. If we wish to evaluate these processes as triggers for meaningful learning, we observe a direct relationship between previous knowledge and the quality of the construction of knowledge. Thus the more knowledge a teacher may have on a specific topic, the more probability of falsifying. This is very relevant when assigning a role to content and support materials for the virtual dialog classroom.

5 Discussion

The main goal of this study was to develop a model for e-Learning and test it with a group of teachers by using modern learning theories and principles that better fit e-Learning.

Some of the premises of our design were the enormous potential of collaborative work and virtual interaction in e-Learning as it is mentioned in the literature. However, these learning strategies are not tacit. Even though they can facilitate learning they can also impede it. To ameliorate this there are some strategies such as teachers sharing their interests in teams and maintaining informal communication during the course work. This promotes confidence among students and group interaction around academic tasks.

One of the key aspects of facilitating collaboration was solving educational problems. Teachers could discuss themes based on their everyday experience by connecting theory and practice, and by taking into consideration the teacher's knowledge. A balanced mixture between individual and collaborative strategies is also recommended. E-Learning programs should exploit the unique capabilities of the Internet as a communication medium by going further than just student-teacher communication and emphasizing group work among students.

We believe that distance learning programs should exploit the unique features and added value of a powerful medium such as the Internet. Thus some constructivist theories and principles can be embedded into virtual environments to promote active learning and the construction of meaning.

We have presented an e-Learning model and described the design, implementation, and evaluation of a training program for school teachers. We analyzed the teacher's construction of knowledge by reflecting on teaching and learning. Through interacting and communicating we have developed electronic communities around pedagogical content. We believe that this experience reflects a way of knowledge construction from teachers that is not exclusive to e-Learning; rather, it can be used in a meaningful way during everyday pedagogical practices in the school.

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A Model to Design Multimedia Software for Learners with Visual Disabilities

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Abstract. Current interactive multimedia learning software can not be accessed by learners with disabilities. This is the case for students with vision disabilities. Modeling techniques are necessary to map real world experiences to virtual worlds by using 3D auditory representations of objects for blind people. In this paper we present a model to design multimedia software for blind learners. The model was validated with existing educational software systems. We describe the modeling of the real world including cognitive usability testing tasks by considering not only the representation of the real world but also modeling the learner's knowledge of the virtual world. Finally, we analyze critical issues in designing software for learners with visual disabilities and propose some recommendations and guidelines.

1 Introduction

A great amount of educational software has been developed for supporting learners with disabilities. Software for blind people aims to increase their access to current computing materials based on Graphic User Interfaces, GUIs, such as games, educational software, and Web navigation systems.

Clearly the task of developing software for people with visual disabilities has some complexities. For blind learners we face the problem of constructing interfaces that do not rely on graphics. However, we can find some similarities in the process of designing and constructing computer software for people with different types of disabilities. This is the case when developing cognitive systems aiming at modeling and implementing the real world by a computer system.

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Problems in constructing learning software for people with disabilities arise when the model is presented to the user to interact with. Multimedia software for sighted learners transmit this model to the learners by using graphics (with or without animation), sounds and text, taking advantage of a wide spectrum of the computer's multimedia capabilities. People with visual disabilities have shrunk this spectrum. This forces the software designer to project the information kept in the model provided by the student through the available auditory channel. Additionally, non-traditional interaction modes such as haptic devices can be used. The same considerations are valid for the construction of the learner's model.

Several virtual reality systems and virtual environments combined with appropriate human-computer interfaces have been used to enhance sensual capabilities of people with sensory disabilities. This is the case of presenting graphic information by text-to-speech and 3D auditory navigation environments to construct spatial mental representations and to assist users in acquiring and developing cognitive skills [20].

A sonic concentration game described in Roth, Petrucci, Assimacopoulos & Pun [15] consists of matching different pair levels of basic and derived geometric shapes. To represent geometric shapes it is necessary to build a two-dimensional sound space. The concept allows the shape to be rendered by the perception of moving sound in a specific plane. Each dimension corresponds to a musical instrument, and raster points correspond to pairs of frequencies on a scale.

VirtualAurea by Sánchez [16] was developed after interactive sound-based virtual environments proved to trigger the development of cognitive spatial structures in blind children. VirtualAurea is a set of spatial sound editors that can be used by parents and teachers to design an ample variety of spatial maps such as the inner structure of the school and rooms, corridors, and other structures of a house.

This paper proposes a model for developing multimedia learning systems for learners with visual disabilities. The model includes various steps and recommendations by considering key issues for conceptualization and implementation. Special attention is paid to the feedback issue considered to be a critical point in existing software.

2 Model

2.1 Development of educational software

We propose a model for creating educational software for people with visual disabilities. The modeling process starts with the definition of desired cognitive skills. Then we create a virtual environment that includes a navigable world by using adequate modeling languages, dynamic scene objects, and acting characters. Scenic objects are characterized by graphic and acoustic attributes; character's actions are based on deterministic and non-deterministic plans in the same way as in interactive hyperstories described by Lumbreras and Sánchez [11]. The learner explores the virtual world by interacting with appropriate interfaces and obtains interactive feedback. The learner's actions, such as sound reproductions, are collected, evaluated, and classified based on student's modeling and diagnostic subsystems. The modeling process follows the steps illustrated in Figure 1 [19].

We define cognitive skills in a real world situation, for example self-motivating activities, drill and practice applications, problem solving, and leisure time occupations. Objects in fictitious world scenarios are constructed of geometric primitives. They are characterized by acoustic attributes and grouped into components with input and output slots. Control elements of the virtual world are represented by acoustic elements, known as icons and earcons.

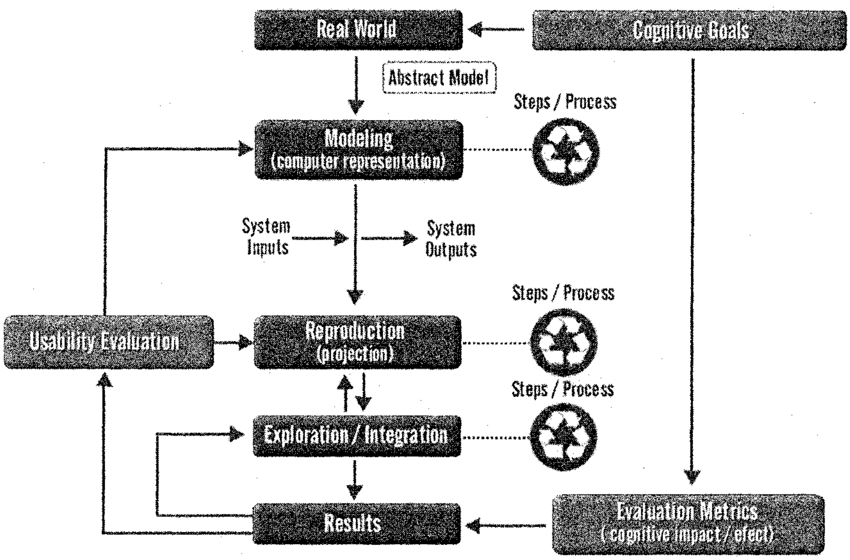

Figure 1. A model for designing educational software for children with visual disabilities.

We develop an internal computer representation and define a geometric environment containing a 2D or 3D visual and acoustic model without considering the limitations of potential users. Modern object-oriented modeling languages are powerful tools for building virtual worlds using scene graphs, interaction, and animation facilities. We insist on the necessity of special editors for teachers and learners to create synthetic models independently. According to the problem and target users, problem-specific correspondences between graphic and acoustic attributes or properties can be used to reduce the model to its acoustic projection. The resulting model meets the requirements in terms of certain information channels that should not be used in such a way that cannot be explored by people with visual disabilities. Another way is to generate the model directly by using a special editor for visually-impaired learners.

The acoustic representation of the model for learners with visual disabilities uses spatial sound. Interaction and navigation are based on acoustic control elements.

The learner explores the object space by navigating, interacting with suitable interfaces, interpreting, and reproducing the structures. This can be done through navigating without changing viewpoints or by using internal representations of users by giving them the illusion of being part of the virtual scene. A blind person explores neighboring models by grasping them, tracking objects or listening to typical sounds. Sound-emitting objects help them to build a mental model of real or fictitious worlds. Additionally, the learner may build an external reconstruction of the mental model or try to rebuild the acoustic model as it was perceived and imagined after exploring the model space. We must be sure that conditions during the reconstruction process are always the same. Therefore, the interfaces involved are calibrated accordingly.

Depending on the particular parameters and entities of the model, error measures between internal representations and the model reproduced by the learner are defined. Learner's actions are collected, evaluated, and classified. The outcome is transformed to a user-adapted aural output.

2.2 Workflow

AudioDoom was used as an exemplary application for blind children. Thus, we validated our model by describing in more detail the modeling workflow. The whole testing is described in Baloian, Luther, and Sánchez [3]. AudioDoom allows blind children to explore and interact with virtual worlds created with spatial sound [10] [17]. AudioDoom has been usability tested with more than forty Chilean children aged 7-12 in school settings for blind children [16].

We followed the modeling steps introduced above. First, a computer-based representation is derived from the real world scenario by means of abstraction and reduction without considering the limitations of potential users. Then, the computer-based model is reproduced (projected) to an appropriate acoustical internal model explored by people with sensory disabilities through the use of available communication channels. Appropriate editors support the modeling process. Important model entities and parameters must be identified at this stage. By interacting with the model, the learner makes an internal or external reconstruction, which is later evaluated (see Figures 2a and 2b). This can be done by using appropriate error measures depending on the learner, the computer-based (internal) representation, and the reconstructed model. Finally, the degree of similitude is derived from the error measure and the result is displayed on a learner-adapted output and used for modeling the learner's knowledge.

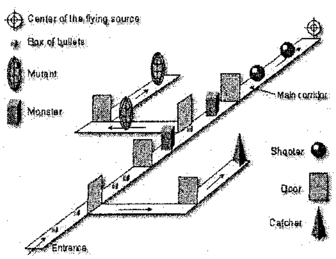

Figure 2a. Virtual game world in AudioDoom

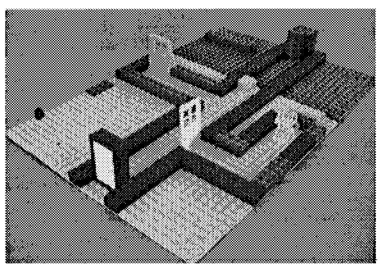

Figure 2b. Reconstructed external model

The modeling workflow in AudioDoom starts with the computer representation of the virtual game world (a simple labyrinth with one main corridor and two secondary corridors including entities and objects) which is projected to an internal model consisting only of sounds. At this stage, the role of volume, frequency, melody, and rhythm in representing different forms, volumes, and distances is analyzed. Learners interact with this model by 'virtually walking' through the labyrinth with a keyboard, mouse, and ultrasonic joystick. Sound-emitting objects help them to build a mental model of the labyrinth. Finally, they make concrete mental modeling with Lego blocks and try to rebuild the internal model as it was perceived and imagined after exploring the spatial structure. Different types of blocks represent objects of the virtual world in the computer representation.

The concrete reconstruction is checked by a human tutor against the game world or by a camera and image processing algorithms to look for any spatial correspondence with the computer representation of the original world model by evaluating the error measure.

As we can see, despite object representation, interfaces, perception modes, and error measures, there are important tasks which should be undertaken when developing systems for blind people. A critical task in this modeling process is the reduction of the original model to only acoustic output.

2.3 Testing

We can describe in more detail two steps of the modeling process. To process an external model and to evaluate error measures, we assume that a blind child reconstructs AudioDoom's maze structure by using Lego blocks. Each block is individually marked by black bars and dots. A blind user perceives different blocks, selects the appropriate ones, and rebuilds the mental image by using the blocks one by one.

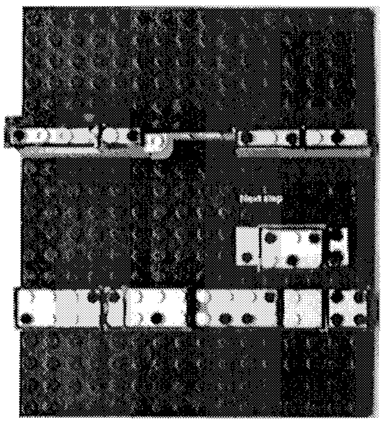

Figure 3. Reconstructed LEGO-model

After each step a picture is taken by a digital camera placed on a fixed position over the scene. We highlight a typical state of the reconstruction process and indicate the next step by adding a new Lego block on the lower wall. Figure 3 shows the situation before and after the next step. Reducing the colors to black and white makes it possible to apply low level image processing routines to detect the new Lego block. After a calibration of the two pictures, we can localize the new block through an XOR-operation on both images resulting in one or two dashes, otherwise in new dots. Starting from these new picture elements we calculate the position and type of the new Lego block. Finally, the learner's model representation is updated.

Thus it is proved that by certain low-level operations on succeeding pictures the external model can be transformed into an internal representation which is used to feed an error measure function. A degree of fidelity is derived and displayed by text-to-speech. For a more sophisticated approach using Lego RCX robots see Ressler & Antonishek [14].

In AudioDoom the differences concerning the parameters volume, articulation, stress, and intonation must be visualized. From these visual patterns important parameters are detected by means of picture processing and in connection to the stored reference patterns. An intelligent component of the system interprets these results, displays a visualization of the error function and transforms them into instructions for the learner. Whereas the wave amplitude image provides in the xy-plane any feedback concerning volume and rate, omitted syllables are characterized by a lack of colored areas, intonation and articulation by the parameters hue and saturation as well as the shape of the curves. Details are described in Hobohm [8] and Gräfe [7].

For designing and developing information-equivalent interfaces for people with visual disabilities we followed a similar model work flow as described above in two new systems. AudioBattleShip [18] is an interactive version of the board game Battleship, providing different interfaces for both sighted and blind people to enhance collaboration and cognition (see Figure 4). Ebbinghaus's forgetting function experiments were implemented in a project concerning the historical replication of key experiments in psychology [5].

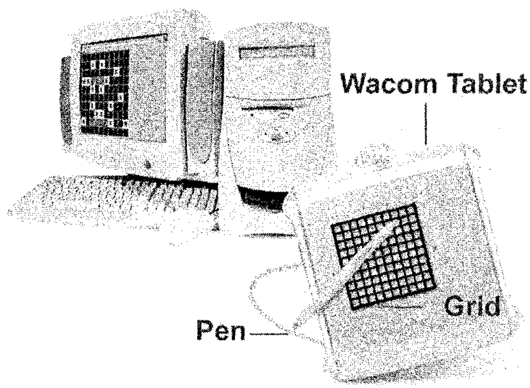

Figure 4. AudioBattleShip input device for blind players [18]

3 Guidelines and recommendations

Virtual environments (VE) can be used to simulate aspects of the real world not physically available to users due to a wide variety of reasons. They become more realistic through multimedia displays which include haptic and auditory information. According to Colwell et al. [6] and Paciello [12], there are several domains in which VEs can be used to build educational software for people with visual disabilities:

A. In education a virtual laboratory assists students with physical disabilities in learning scenarios. Possible applications concern problem solving, strategic games, exploring spaces or structures, and working with concrete materials. Special VE interfaces such as head-mounted devices, the space mouse, and gloves are often included.

B. Training in virtual environments deals with mobility and cognitive skills in spatial or mental structures.

C. Rehabilitation is possible in the context of physical therapy - a recovery of manual skills or learning how to speak and listen to sound can be targeted.

D. Access to educational systems is facilitated via dual navigation elements such as earcons, icons, and haptic devices.

Our idea is to support learners with visual disabilities in building conceptual models of real world situations as sighted users do. Our approach is comparable to the one introduced by Zajicek et al. [26].

We can identify four important common elements and aspects in modeling for software for people with visual disabilities:

1. The conceptual model is a consequence of mapping the real or fictitious world situation into a computer model using digital media by applying adequate modeling languages.

2. The perceptual model is created by developing a perceptual model and a script for the dynamic changes of the model. It can be perceived by the learner using only available information channels and considering the type of disabilities of end-users. It is important to provide surprising elements to call attention in order to enhance the perception process. The computer model description should be based on text. Explanation of graphic objects should be given in caption form. This text can be presented to the blind by using a text-to-speech plug-in and a Braille display. Intuitive correspondences between graphic and aural objects must be defined. Attention must be paid to the fact that only a small number of sounds can be memorized. Also, melodies that help to identify objects should be used.

3. The implementation design provides icons and earcons in parallel. If there are animated image sequences or videos with sound, subtitles and moving text-banners should be used. Sound provides a rich set of resources which complement visual access to a virtual world. The four types of audio examined by Ressler and Wang

[13] are ambient background music, jingles, spoken descriptions, and speech synthesis. Ambient music can play and vary as the user moves from one room to another, providing an intuitive location cue. Jingles or small melodies should characterize special objects and control elements. Spoken descriptions of objects can play as the viewer moves closer to an object. Speech synthesizers can read embedded text from the nodes in a scene graph representation. Recent Web-languages provide anchor node descriptions, EnvironmentNodes or WorldInfo nodes. Internet accessible speech synthesizers supply easy access to text-to-speech technology.

4. The implementation tools concerning special editors or languages such as Java, Java3D, VRML, OpenGL, and DirectX should be used. VRML defines a standard language for representing a directed acyclic graph containing geometric information nodes that may be communicated over the Internet, animated, and viewed interactively in real-time. VRML also provides behavior, user interaction, sensors, events, routes and interpolators for interactive animation. User interaction, time dependent events or scripts can trigger dynamic changes in some properties of an object. VRML viewers are available not only as plug-ins to Internet browsers, but also as interactive objects that may be embedded into standard Office documents. However, the actual version does not yet support collaborative scenarios. As shown in Sánchez, Baloian, Hassler & Hoppe [18], a special platform for replicated collaborative applications such as MatchMaker (TNG) together with Java was successfully applied. This is a summarizing description of some tools that are currently available. We have focused on those that are platform independent and based on international standards.

4 Conclusion

This paper presents an integrated model to design multimedia for learners with disabilities. We provide an overview of the state of the art in the field of existing educational software for people with visual disabilities. We focus on transferring the real world into appropriate computer representations by introducing an integrated methodology for modeling the real world for these people. The model starts with the definition of targeting cognitive skills. Then a virtual environment is created including a navigable world through the use of a modeling language, dynamic scene objects, and acting characters. The learner explores the virtual world through appropriate interfaces and obtains immediate feedback. Actions such as sound reproductions are collected, evaluated, and classified based on student's modeling and diagnostic subsystems. The usability of the model is illustrated with software for blind people. We believe that by using models such as the one presented here the process of software design can be facilitated and improved.

Some educational software has already been developed for people with visual disabilities. Then by following our model we can make generalizations and recommendations for designing and improving educational software. The development of computer systems for people with visual disabilities should no longer appear as isolated handcrafted efforts. Rather, efforts should be made to systematize the construction of these systems. Recent advances in hardware and software design support our idea and provide hope that the technological and educational foundation for such systems has already been laid.

5 Acknowledgement

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Adult Learners in an Online College Class: Combining Efficiency and Convenience of E-learning

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Abstract. In view of the growing adult learner population in the USA, the traditional campus-based paradigm of higher education has been shifting towards more efficient innovative models that meet the needs of working adults. These particular needs include practical goals, increased motivation, high demands for quality, structure and organization of the learning process, limited time for study, flexibility and convenience, which imposes certain conditions on the instructional process. Among the many innovative approaches to adult higher education online learning seems to be attracting the most attention among both adult students and educational researchers. This calls for the discussion of instructional approaches and special pedagogy focused on adult learner.

1 Introduction

According to NCES (2002), adults comprise 39% of all undergraduate students in the United States. The percent of adults in graduate and post-graduate programs is, by definition, much higher.

There is a significant difference between educational systems oriented at adult (25 years and older) and young (18-24 years old) college students [1[2]. Adult pedagogy is built on an andragogical assumption that adults are self-directed learners who are shaped by the accumulation of authentic personal experience. Their desire to learn grows out of a need to confront an ever-changing reality. Adults are not captive learners in the same way as kindergarten through high school students. "Adults vote with their feet," may be cliché, but it indicates that if a learning model does not suit the particular needs of the adult learner, he or she may well exit the school.

Recall Knowles' six assumptions about the adult learner [3]:

- Adults learners are likely to be self-directed
- Adult's life experiences can serve as a unique learning resource.
- Adults are usually goal-oriented learners, not curriculum oriented learners.
- Adults are more likely to initiate and sustain learning due to genuine motivation rather that external incentive.

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- Adults demand an explicit initial framework of study, and then the freedom to pursue knowledge within those borders.
- Adults hate to waste time.

Hence, adult learning is commonly affected by the following factors:

1. Time-efficiency of the learning programs
2. Independence in learning based on life and professional experience and background
3. High intrinsic motivation and responsibility
4. Need for rational structure and organization of the learning process
5. Pragmatism in the choice of the content, methodology and applications, i.e., what and how to study, and what for.

In short, adult learning should be learner-centered, practical and efficient. This calls for the discussion of the pedagogy of online adult learning.

2 Convenience of learning

Moreover, our research [4] demonstrates that one of the most important factors in adult learning is convenience. A more recent study of adult learning [5] helped to identify five groups of convenience factors: external, personal, programmatic, procedural and technical ones:

External factors:

- Easy, unobstructed access to learning
- Reduction or elimination (wherever possible) of the commuting, classroom presence, inefficient enrollment, advising and supporting activities
- Cost-efficiency

Personal factors

- Appreciation of the student's opinion and work in the class
- Low anxiety class environment and respectful relationships in the group
- Personal, informal engagement, communication and collaboration with the instructor and the peers

Programmatic factors

- Wide choice of learning programs and formats
- Simplicity of the course structure and its navigation
- Clarity of the goals, outcomes, requirements, content, assignments and evaluation instruments and criteria
- Attainability of the goals, requirements and outcomes
- Short-term, accelerated pace of learning
- Sequential structure of the program (one course at a time – Greiner et al. 2005)

Procedural factors

- Flexibility of the class schedule
- Efficient course delivery
- Smoothness (seamlessness) of the learning process
- Efficiency of the structure, organization and implementation of the instruction

- Rich, well-organized, multimodal content presentation and learning environments
- Satisfying learning experiences
- Opportunity for using one's background and professional experiences
- Unlimited opportunities for communicating with the peers and the instructor
- Reasonable, measured independent work
- Constructive and expeditious instructor's feedback
- Objective and unambiguous assessment and evaluation
- Customization (individualization) of the learning and of the instructor's interaction with the student

Technical factors

- User-friendly interface
- Technical proficiency of the learner as well as the instructor

When surveyed on the reason for choosing a non-traditional, accelerated model of adult higher education provided by National University, students gave the following responses:

- Short (one-month long), accelerated courses – 71.8%
- Flexible time of study – 57.1%
- One-course-at-a-time format of the instructional process – 56.0%

Convenience of learning comes as a result of rational planning and organization, effective teaching methodology and educational technology applications, instructor's enthusiasm and professionalism, program delivery adaptation and adequate instructional support. Convenience is essential for student's comfort zone that is a necessary condition for optimal productivity in learning. It becomes one of the major criteria for the adult learner's selecting a college program and remaining in it to the end.

3 The roots of teaching and learning online

Although online education is a technological innovation that is a relatively new idea, collaborative learning or more particularly an andragogical approach to learning is built on solid pedagogical notions that extend back at least three centuries. The philosophical roots of a shared approach, which embraces what Malcolm Knowles has defined as self-directed lifelong learning, stem back to the 18th Century, to Jean Jacques Rousseau (1712-78), shaped 19th Century Romanticism by influencing among others Immanuel Kant, Johann Wolfgang von Goethe, and Leo Tolstoy. The 20th Century introduced John Dewey's democratic pragmatism, Jean Piaget's developmental theory and Lev Vygotsky's social constructivism leading toward a path to collaborative interaction in learning.

Online education is a transactional model (as opposed to transmission or banking) that can be with the proper curricular model transformative in nature. This model stems from establishing a learning environment where students choose both interactive (e.g. discussion boards) and autonomous (e.g. essays based on their explicit connections to the readings and authentic personal experience) activities to produce interactions both scholarly and relevant. Among these interactions are learning experiences gained through: the texts and images presented in an online course, the instructor to learner and learner with learner collaborations, and a growing sense of empowerment by the learner based on his or her genuine motivation nurtured through a collaborative power sharing format [6]. Students' life experiences and field-based studies in the course also contribute to the collaboration and knowledge construction. This interactive environment is further enhanced in cyberspace. In asynchronous online environment students have the benefit of time and the resources of the World Wide Web in order to have the opportunity to make their responses to a professor's question or assignment on point, scholarly, and based on reflective thought [7].

Online learning can provide learning outcomes that are comparable or even superior to those of conventional educational formats [8]. However, assuring proper skill development in some online courses may be more difficult due to the textual rather than verbal, and distance instead of face-to-face interactions with instructors and peers, as well as the mostly individual nature of such learning.

4 Andragogy integrated into online education

Given their goal-oriented approach to learning and an ever more crowded personal calendar (adults hate to waste time!), a self-paced asynchronous online course design has proven to be a most effective instructional approach.

Online learning is conducted via the Internet, usually by educational institutions whose students who are separated from them by distance and time. In some aspects, this approach resembles traditional education, particularly as regards the course goals, objectives, syllabus, content, and learning outcomes, for these must be congruent for both on site and online formats. Also, instructors play a key role, though the instruction in an online environment is mediated through technology. Much more so than onsite versions, online learning is essentially organized and structured self-education. The institution provides the course; the instructor facilitates learning by offering guidance and feedback; but students themselves choose the schedule of study, allocate time, and use their own learning procedures and resources. So, formal online education can be described as an instructor-facilitated learning environment, but for a learner it is, in reality, essentially self-sufficient learning. Hence, the challenges of independent planning, management and self-control arise [9].

Nevertheless, online courses can be effectively self-managed by the student if he or she is supported by the proper instructional tools [10]. It has been noted, however, that online students often do not have efficient learning and self-management skills, which calls for their special development in an online program. Moreover, due to job and family obligations, many working adult students have very busy schedules. Thus, overcoming the challenges of distance learning and helping students learn how to learn in a virtual environment have become two major issues of online education.

The goals and curriculum of an online course should be the same as in the traditional onsite course. The difference between the course given online as opposed to one taking place in a classroom, is in a distinct methodological approach. Accordingly, there is a need to articulate a particular educational philosophy (i.e.

andragogy – learner-centered adult education) when preparing an online professor or in orienting an online student. It is critical to point out that the training of a professor to teach an online course should be done by a qualified faculty rather than a computer savvy technician. Online pedagogy should be taught by a pedagogue.

An appropriate philosophy informs a coherent methodological approach so that a professor will be prepared for distinctive techniques and the online student will be assured that he or she will receive the most enriched learning experience in an online format. Similarly, an important relationship exists between adult development and online education based on the andragogical notion that adults are self-directed learners. Specifically, adults possess authentic life-long experiences, and have the desire to gain increased knowledge to face the tasks they encounter in their studies and in life. An online course, which asks students to use their critical thinking skills (analysis, synthesis and evaluation) by means of reflective written work, is on solid pedagogical ground. For example, essays which request explicit connections to required readings (new knowledge) as well as the revelation of authentic personal experience (stored knowledge) can lead to enhanced learning. Rigorous academic writing demands higher order critical thinking skills that demand adults confront their ambiguities about issues in educational theory or best practice.

Online classes at the collegiate level can be developed and put into practice as tutorial, group, or independent instructional modes. Given a background of understanding the stages and transitions of adult life, as well as paying special attention to the interrelationship of adult and career development, certain kinds of instructional techniques are indicated. For instance, online approaches that include contract learning, discussion boards, experimental learning, portfolios, choice of assignments and self-pacing in an asynchronous environment seem most fitting. For a growing number of adult learners a powerful new model exists in cyberspace where andragogy affects online course design.

Thus, the logical extension of these assumptions for an online class is a collaborative asynchronous learning format. Such a learner-centered format calls for both direction and support. The key factors in providing a foundation for a partnership among facilitators and learners is to provide both direction and support for all. It is usually up to the facilitator to determine direction (i.e. how to carry out the learning process) and support (the learner's competence to take part in that process) although students familiar with this paradigm can also partake in a shared decision making process. Support for the online adult learner is provided through a learning environment that meets both the adults' affective and cognitive needs. An academic atmosphere in which all have a sense of well-being is an essential element in a collaborative partnership among facilitators and students. Facilitators need to balance between being friendly and challenging the adult learner [11].

5 Online collaborative learning

Research indicates that one of the most commonly mentioned characteristics of adult education is its collaborative aspect [12]. Clearly, the foundations of modern adult education have emerged out of the progressive education movement [13]. Yet given this well-known conceptual framework of participation through collaboration, there has been a dearth of empirical evidence to support adult collaborative learning especially as it relates to an andragogical model. The data from the online education research presented in this paper indicate that the process of collaborative learning can be a positive methodological approach with adult learners.

Collaborative learning works through the online experience in five distinct ways - especially by means of asynchronous discussion boards:

- Both facilitators and learners become participants in an educational process that is both active and reflective.
- The hierarchy among the facilitators and learners is modified (common inquiry is stressed among all adult learners)
- A cyberspace community is created based on scholastic interactions with immediate feedback (e.g. within a 24-hour period).
- A synergy made up of responses, with explicit connections back to readings and lectures along with authentic personal experiences produces a learning model where knowledge is both created and transferred.
- The locus of control shifts from the individual to the participating online community.

The philosophical foundations for this kind of student-centered learning go back to Dewey, Piaget, and Vygotsky. Though all wrote and lived before the invention on online education, their notion that collaborative learning assumes that knowledge is socially, as opposed to individually, constructed by a community of learners is key. When learners shape and test ideas, and authority is distributed and experienced among all in the learning community, that particular process is inherently participatory and therefore collaborative. Collaborative learning differs from autonomous learning in that the course designer fashions a curriculum with appropriate rigor and with a power sharing emphasis so that learning is collegial. The learner is presented with options and alternatives, real choices on how to respond to various developmental tasks within a specific curricular conceptual framework. The role of the facilitator determines the extent of a collaborative learning environment by shifting authority and commensurate responsibility for learning to the student. Thus the facilitator does not perform the traditional role of the sole authority and transmitter of knowledge. Instead, a process of mutual inquiry, where students are viewed as co-learners, is implemented. For the online class a redefinition of control, power, expertise, and authority may well be indicated. It has been stated that "Learning is part of a circuit that is one of life's fundamental pleasures: the [professor's] role is to keep the current flowing" [11]. Online instructors who interact with adults as partners can create, especially in an asynchronous environment, a unique synergy based on reflective thought converted into insightful writing.

Modeling scholarly dialog on the part of the professor in a timely way was a key element. Therefore, what is called for is a judicious mix of the facilitator's sense of responsibility to cover the required course concepts while at the same time being unconditionally committed to enable students to learn on their own and share their new knowledge via discussion boards with the online community. In order to attain that goal a facilitator prepares learners for collaborative work by clear explanations of the particular shared process involved. An example of this can be found in an online *course information* section. Such a section explains the *what* (i.e. the curriculum) and the *how* (i.e. the methodological approach) of a course in cyberspace and thus permits students to succeed in a collaborative learning situation. An explicit rationale (e.g. course description, goals, and learning outcomes) and a coherent framework (e.g. assignments, scoring scales, evaluation factors) are essential components of a *course information* section. Such care in designing an intuitive website has very real implications in terms of student success. After the facilitator has decided the appropriate learning activities, established clear objectives, used suitable participatory techniques, developed meaningful questions, provided a clear sense of expected outcomes, and by means of generic online technology creates an interactive site in cyberspace, an online collaborative learning situation has been formulated.

This formulated environment provides an atmosphere where participants feel at liberty to exchange ideas and share notions in order to create community-based knowledge. The result is a democratic setting where student have a sense of well-being and acceptance where the seemingly dichotomous needs of affiliation and autonomy are mutually fulfilled through the commitment to both individual growth and group development inherent to online collaborative education. When a culture of online collaborative learning is constructed with the learner in mind, well-defined shifts in learning take place. Cognitive psychologists have noted that how we learn affects what we learn. Put simply, curricular technology does affect instructional methodology. In this environment, the focus of the education paradigm will shift from teaching to learning.

Traditional Model	Online Collaborative Model
- Listener, observer, note taker	- Problem-solver, constant contributor
- Competition with others	- Collaboration with others
- Attendance at a certain time and place	- Choice of a convenient place and time
- Learning independently	- Learning interdependently
- Authority through instructors and texts	- Authority shared among facilitators, peers, online "worldwide" and library resources
- Control and pacing set by instructor and explained to students	- Control and flexibility of pacing set by students

One benefit of the online collaborative format is that it provides for an increase of democratic decision making. Correspondingly, the participants can acquire insights to their own academic and social development as well as the potential of group generated knowledge. By making explicit connections back to the texts and using authentic personal experiences, learners are able to expose and resolve previously unshared biases and well as share their collective knowledge and wisdom. This appears to parallel the findings at the primary and secondary level [14], which strongly indicate that learning is enhanced when students experience collaborative group work in a noncompetitive environment.

If we view the adult learner in cyberspace as a mutual partner in the learning process, what is called for is a coherent strategy to serve this particular student population.

6 Threaded Discussion as a Primary Tool for Knowledge Construction

Threaded Discussion (TD) is a tool that has a primary importance for online education: it makes students interact with their peers and with the instructor on relevant topics, and also with the course materials. As opposed to chats, the asynchronous TD format has been shown to provide more consistent opportunities for participation, for revisiting previous postings, deeper levels of student reflection, access to a broader spectrum of ideas, more concrete connections to lecture and readings, and more ways for instructors to model higher order responses, monitor learning, and offer clarification [8].

Asynchronicity of TD allows students time to prepare, reflect, and express themselves in the relatively stress-free environment of their own individual workplace and at their convenience. Using an extended timeframe of TD, students are better able to use and apply the recommended literature and other course resources, search for additional support materials, include quotations, and write their text using appropriate format and style. Thus, TD, in addition to its main role of knowledge construction and collaboration, allows for further development of writing, composition, structuring and formatting skills. Moreover, asynchronous environments tend to reduce anxiety. Synchronous discussions, on the contrary, encourage reaction and spontaneity, but may sacrifice depth of cognition and use of the professional literature. Nevertheless, chat can serve as a complementary tool to the asynchronous TD when used for such purposes as exchange of opinions or ideas on some topic, or for brainstorming, problem solving, or additional clarification by the instructor. Together, they can embrace all of the major characteristics of learning and interaction.

TD has a definite advantage over the other online communication tools (email, chat and videoconferencing) with regard to collaboration and knowledge construction for the following characteristics: academic depth, length of posting (There is evidence of a direct relationship between quantitative and qualitative characteristics of students' learning products (in this case, a TD posting) based on the universal law of transformation of quantity into quality. Therefore, the length of a student's posting can be one of the characteristics of the quality of his or her preparation, in addition to other qualitative characteristics.), expressiveness, collaboration, self-management, retention, and use of resources.

Remarkably, students in online classes participating in TD tend to interact among themselves and with the instructor 12.5% times more often than required, on average, (2,25 postings per discussion vs. 2.0), and post three times more words than required (360 vs. 120) per discussion [9]. Online learning activities, according to National University online faculty survey (2004), provide an adequate means for students to achieve the desired learning outcomes and to demonstrate their level of achievement. Faculty, however, note the need for more guidance on teaching strategies, especially in effective use of TD, which highlights the importance of continuous instructors' professional development

7 Providing equal opportunity in cyberspace

Perhaps one of the most socially dynamic notions about online teacher education is the creation of an equitable learning environment. Many adults (e.g. women, minorities, the less affluent, persons with disabilities, those who live great distances from a campus) do not fully experience or have been totally shut out of traditional teacher education programs. Theoretically, this group may now have the opportunity, by means of online education, to truly connect with educational offerings and become engaged in the scholastic endeavors of a community of learners. Serving all online learners requires the following:

- Facilitators must model acceptance of every adult learner regardless of gender, perceived ability, race, or ethnic background. It has been said that 80% of all teaching is modeling. Reaching out in cyberspace is an inclusive enterprise that can bypass much of the traditional bias, which continues to exist in the traditional classroom.
- The curriculum (subjects or topics) should reflect the needs of the group being taught. Recall adults come with an array of experiences and lifelong constructed knowledge from a variety of cultural domains. Images and examples should reflect, acknowledge and validate the diversity among adult learners. This is critical in developing partnerships.
- A facilitator is a leader. A great leader doesn't produce followers, but other leaders. Facilitators must be change agents, believing that change and development is possible for all, and that the roles of facilitators and learners are to assist in that process for the collective academic and social development of the online participants.
- Facilitators, who engage adults as partners through the aforementioned direction and support, may well enjoy a fruitful collaborative learning process. To carry out this mission, the facilitator must lead the adult learner to new levels of understanding and action.

Learning has to be convenient, as mentioned above, which can be described as a composite factor providing encouraging and supportive conditions for student's productive and low-stress learning activity

8 Conclusions

Just as online education provides an out-of-class option to the traditional education program, which historically has proven exclusionary, a true power sharing collaborative methodological format challenges traditional assumptions about learning which have also proven exclusionary and limiting. Online models, which change the concepts of time (from synchronous to asynchronous) and space (from the traditional classroom to literally anywhere where a computer can hook up to the Internet or using mobile technology) open new outreach opportunities for an ever more diverse student population by offering higher education courses online and further through mobile equipment. With well-designed online curricula based on an andragogical (for the learner-centered adult) and an asynchronous basis (given the idiosyncratic life style of adults), a wider diversity of the adult population will have the ability to enter education programs. The reality of online education is rooted in a new technology; the promise of online education is premised on inclusion. Among many factors contributing to the effectiveness of online adult learning are learner-centeredness, self-sufficiency, pragmatic approach to teaching and learning, effective organization of the learning process, time-efficiency, collaboration in an asynchronous format, and convenience.

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E-learning Tools and Web-resources for Teaching Reconfigurable Systems

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Abstract. The paper shows that the teaching of reconfigurable systems is a complex and difficult process requiring many novel methods and tools to be considered within the same course. This process can be greatly simplified with the aid of the information resources and e-learning tools that have been developed and incorporated into an integrated methodology that includes original evaluation and motivation methods. This methodology has been successfully applied to the teaching of reconfigurable systems for approximately 10 years. The paper discusses the impact of this methodology on such important components of higher education as research activity, postgraduate learning, and training for engineering work in industry.

1 Introduction

The functionality of a reconfigurable system can be customized on the fly and altered, if required, after the design steps have been completed. This feature opens up a vast range of possibilities for such very useful techniques as the reuse and customization of physical components just through reconfiguration, the adaptation to external conditions that are not known in advance, the fulfillment of particular user requirements post-design, etc. It is also very important that the design of high-speed reconfigurable systems can be done through the use of methods and tools that are very similar to software development taking into account the many specific features inherent in hardware circuits.

When field programmable gate arrays (FPGA) were first introduced, they were predominantly used for implementing simple random and glue logic [1]. Nowadays, even undergraduate students are capable of constructing quite complex FPGA-based

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systems. Today, advanced research is being intensively performed in the areas of System on Chip (SoC) and Networks on Chip (NoC) [2]. Let us consider some examples. Recent cheap FPGAs from the Xilinx Spartan-3 family [3] contain up to 5,000,000 system gates, which is sufficient for the construction of quite a complicated special purpose computer. A single FPGA chip can be customized for executing a virtually unlimited number of computationally intensive algorithms, and the same chip can be reused for different algorithms. Most advanced FPGAs contain embedded microprocessors, large-volume memories, circuits for multi-purpose synchronization, multipliers, etc. New sophisticated FPGA architectures appear on the market each year and they are used intensively in industry.

The rapid evolution of reconfigurable systems has created a demand for an increasingly large number of engineers who are well-prepared in the relevant areas. An ongoing review of the corresponding curricula is essential in order to incorporate recent advances and ensure that classes are up to date. The curriculum must be sensitive to changes in technology and new developments in pedagogy and should emphasize the importance of lifelong learning [4-6]. Because the domain of reconfigurable systems is very dynamic and many-sided, many topics from different areas must be considered in detail. For example, the majority of design steps are based on methods inherited from software development. This includes the specification of the required behavior, coping with complexity using different strategies (based on the divide and conquer principle, for example), modeling and debugging, etc. On the other hand it is necessary to provide hardware-specific features, such as concurrency, proper timing characteristics, the synchronization techniques needed for satisfying numerous hardware constraints, etc. There is a wide range of tools used throughout the design process, including the synthesis of finite state machines, the use of libraries and intellectual property cores, and so on. In other words, the design methodology can be seen as a very complicated integrated process that requires a wide spectrum of knowledge from different fields. This paper demonstrates how different information resources and E-learning tools can be applied to increase the efficiency and productiveness of teaching, and ultimately to enable the difficulty and complexity discussed above to be managed effectively.

In general, this paper describes a methodology that has been used for teaching reconfigurable systems at the Department of Electronics and Telecommunications of Aveiro University (Portugal). Some results in this area have already been shown in [7]. In 1997 the first optional discipline in this area entitled *Advanced Digital Systems* was introduced. Today three disciplines are included in the pedagogical plans: *Reconfigurable Computing*, *Reconfigurable Digital Systems*, and *Advanced Reconfigurable Systems*. They are also planned to be taught within the new curriculum according to the Bologna proposal [8].

2 Programs, Theoretical Classes and Labs

The primary objective for the group of courses on reconfigurable systems is to provide experience in the design flow shown in Fig. 1, which is based on either system-level or hardware description languages. Basically the design flow splits into two courses. The first course is dedicated to hardware-oriented tools (Very High Speed Integrated Circuits Hardware Description Language – VHDL [9], in particular) and the subsequent course considers the design flow based on system-level tools (the Handel-C language [10], in particular). The reasons for choosing these languages are explained in [7].

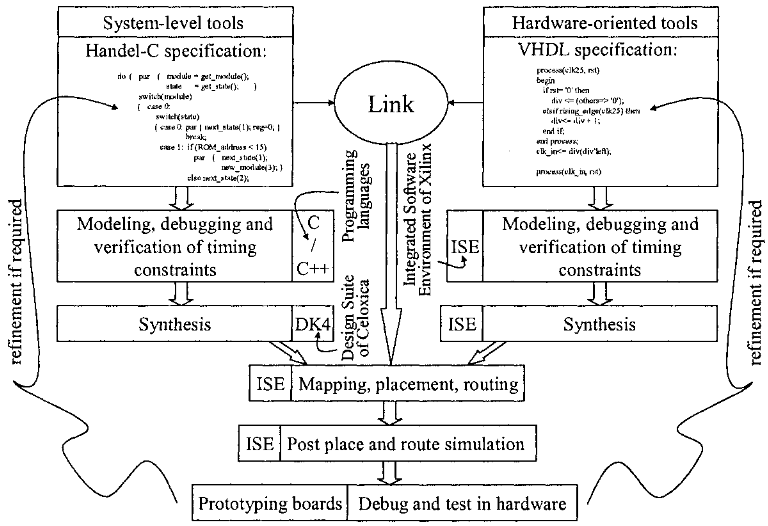

Fig. 1. The design flow for reconfigurable systems

Fig. 2 shows the material that is required as a base for the disciplines on reconfigurable systems (see the left-hand part of Fig. 2) and the knowledge that has to be acquired after completing the two courses (see the right-hand part of Fig. 2). Consequently, the material that is given in the theoretical classes covers the set of topics listed on the right-hand part of Fig. 2. The first course (see the right-hand part of Fig. 1) is given over a 14 week period with 3 hours of theoretical and 2 hours of practical classes per week. The second course (see the left-hand part of Fig. 1) is also given over 14 weeks with 2 hours of theoretical and 2 hours of practical classes per week. Laboratory work is based on a variety of prototyping boards (namely, RC10, RC100, RC200 [10], TE-XC2Se [11], DETIUA-S3 [12]) and one of these (DETIUA-S3) [12] has been developed at the department. After finishing the courses, the students acquire experience in the design of small and medium size reconfigurable systems based on recent commercial FPGAs that are currently recommended for future applications. The majority of the students present a quite complicated mini-project that is used for final evaluation; this will be discussed in more detail in section 4. During laboratory work, the following types of FPGA-based circuits have to be designed (see also [7] for additional details):

- For communications with peripheral devices, such as pushbuttons, dip-switches, LEDs, segment displays, LCD, mouse, keyboard, VGA-monitor, etc.;
- For interfaces with standard microchips, such as static RAM, flash RAM, etc.;
- For communications through standard ports, such as RS232 and parallel;
- For executing arithmetical and logical computations, implementing various algorithms (for example, solving combinatorial problems), etc.

As can be seen from the previous discussion, the material of the group of disciplines considered presumes very intensive study of new methods and tools on the part of the students and hard practical work with digital systems that must be tested and demonstrated in real hardware. In fact, a very large and diverse amount of material needs to be assembled within the courses and this gives rise to a serious problem. Indeed, it is necessary to provide a great deal of new material that is mostly unfamiliar to the students within a limited time period. The subsequent sections of this paper discuss how the information resources and e-learning tools that have been developed make this problem manageable.

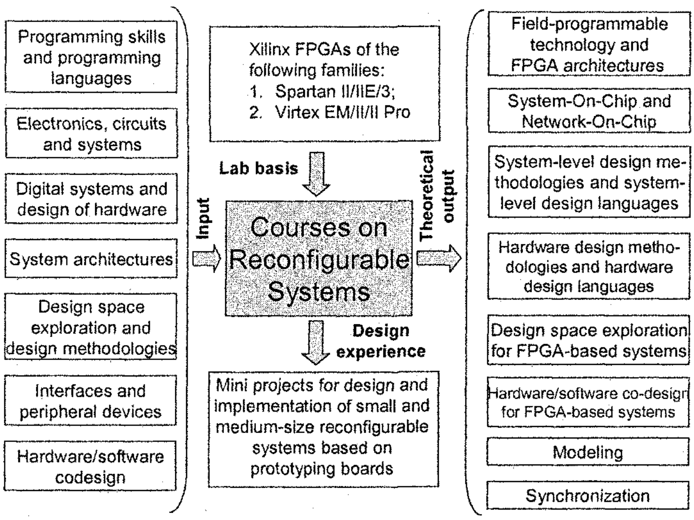

Fig. 2. The input (basis) and output (acquired experience) for the group of courses

3 Information Resources and E-learning Tools

Fig. 3 classifies the basic information resources that have been created and intensively used for the group of disciplines under consideration. They are divided into the following key segments [7]:

1. Technical papers and Web resources, which include exhaustive materials for labs and mini-projects. If possible, the source is given in Portuguese, otherwise in English. Most of the materials are provided in both English and Portuguese, which essentially simplifies dissemination of the information internationally. Note that many other universities have already used the information resources developed in this context at Aveiro. Besides, there are a number of international students attending the courses who don't speak Portuguese.
2. Documentation and supplementary materials that present all the details necessary for communication between FPGA-based circuits and external devices. They include the specification of interfaces, timing diagrams, instruction sets and programming modes for peripheral and other controllers,

information about device drivers, etc. This segment also contains detailed information about architectures and the utilization of FPGAs and CPLDs (complex programmable logic devices). The materials that are required mostly can be downloaded directly from the course site, and less important materials can be referenced through the relevant Internet addresses.

3. Examples and design templates that enable students to reduce the design time significantly. This has been achieved because of the following reasons:
   a. Examples have been selected in such a way that it is possible for new circuits to be developed by analogy with a given prototype.
   b. The generalized design templates enable students to select and customize a template for a particular circuit. For example, the design template for a hierarchical finite state machine (FSM) [13] specifies the basic functionality of fundamental blocks such as stacks and combinational circuits with control facilities at two levels, for state transitions within the active FSM and between different concurrent or sequential FSMs.
   c. Certain parts of examples can be reused in student projects. As a rule, such parts describe auxiliary circuits that are used for debugging, visualizing results, etc.
4. Tutorials and design diagrams explain the various design scenarios. They make it easier to understand the algorithm to be implemented or the primary functionality of the designed system, and can be classified as follows:
   a. Tutorials that demonstrate various scenarios within the respective computer-aided design (CAD) environment and explain the use of the prototyping boards.
   b. Tutorials that explain language constructions that can be synthesized and their distinctive features.
   c. Tutorials that illustrate different modes of interaction with typical peripheral devices through widely-used standard interfaces.
   d. Tutorials that permit different design methods to be understood. For example, they explain how to describe reprogrammable FSMs, how to construct a hierarchical FSM, how to execute recursive algorithms, etc.
   e. Tutorials that explain advanced synchronization techniques.
5. Student mini-projects, which have made it possible to realize an evolutionary approach for the group of disciplines related to reconfigurable systems. Current student projects are based on previously-developed student projects as well as other resources indicated above that are well-documented and available for the future. Thus, specific requirements have to be established for the projects to make their repeated reuse straightforward. This permits the complexity of the projects suggested in each new pedagogical year to be increased. As a result, small size projects that were proposed to students starting in 1997 have been evolved into medium size projects that are presently close to real-world problems in engineering design. Finally, it enables the department to reduce significantly the lead time for training practical engineers for industrial enterprises. Note that mini-projects provided the basis for many final year projects developed in different application areas involving FPGA-targeted design flows.

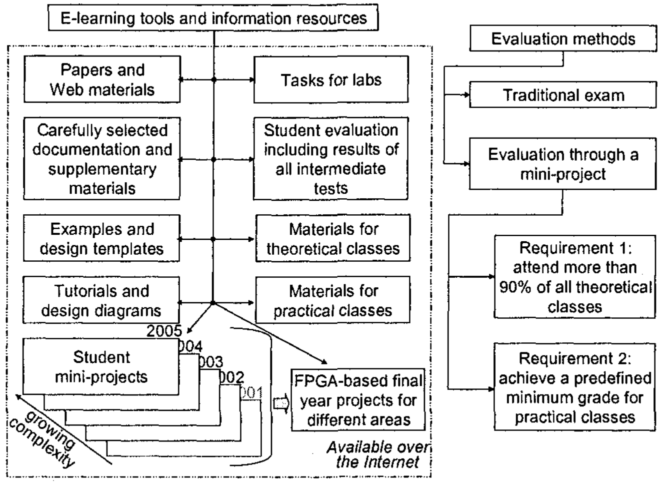

Fig. 3. Information resources and evaluation methods for the group of disciplines on the design of reconfigurable systems

In addition to the key elements considered above, the available resources include traditional supporting materials for classes and the results of different types of evaluation (see Fig. 3).

Special attention should be paid to tutorials because they cover practically all the directions in FPGA-based design considered above to produce the required output knowledge and experience (see Fig. 2). Each tutorial is organized as a set of graphical animated slides developed as a Microsoft PowerPoint presentation. Fig. 4 gives an example that demonstrates how teaching materials are presented. One theoretical class is dedicated to comparing iterative and recursive algorithms that might be used for hardware design as well as for software development. The class is organized as a set of topics that explain:

1. The structure and execution of recursive and iterative algorithms;
2. The specification of recursive and iterative algorithms for implementing such algorithms in hardware;
3. Models of control units that enable recursive and iterative algorithms to be executed;
4. Synthesis and implementation issues for practical CAD systems (such as Xilinx ISE [3] or Celoxica tools [10]).

Each topic is supported by the relevant part of the tutorial. For example, the left-hand part of Fig. 4 illustrates how a binary tree for recursive sorting can be constructed that implements the algorithm [14]. Animated graphics show how the tree is constructed incrementally and how each input value either creates or modifies a node. Being able to step forwards and backwards through the tree creation process significantly eases understanding of the algorithm. The middle part of Fig. 4 demonstrates how hardware-oriented flow-charts for recursive and iterative algorithms are built. Once again, all the required steps are shown sequentially with the opportunity to return to any intermediate step. Finally, control unit models for recursive and iterative implementations are explained (see the right-hand part of Fig. 4) with all the necessary language constructions.

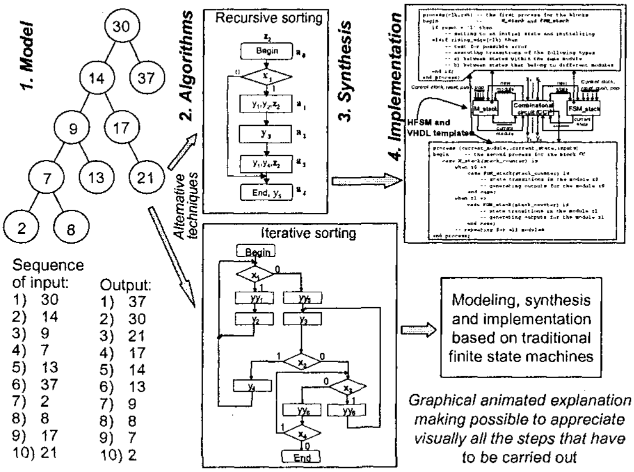

Fig. 4. Explanation of the fundamental features needed for implementing recursive and iterative algorithms in hardware

To maximize the effectiveness of the classes, students have access to all the available materials through a central point, the University e-learning Website [15]. Access to the Website is password protected, but the password can be supplied on request. In part, the materials described above are available at [16]. The data are organized so that students can rapidly find and download any required item (such as a tutorial, an example, a design template, etc.). The "Theoretical classes" and "Practical classes" sections (see also Fig. 3) are updated during a semester, and they include lectures and references to the relevant tutorials, examples, projects, and other material. For example, the tutorials alone contain more than 1000 animated slides that cover practically all of the material that is required for the classes.

4 Evaluation Methods and Criteria

The right-hand part of Fig. 3 shows the evaluation methods used (see also [7]). These are:

1. Traditional examination at the end of the course;
2. Evaluation through individual mini-projects that are allowed if and only if the following mandatory requirements have been satisfied:
   a. Students must attend practical and theoretical classes. Every absence is taken into account except where an acceptable justification document has been presented. Students must not miss more than 10% of the theoretical classes. Every task in the practical classes must be completed before the deadline established for the task (usually the end of the proper practical class with some exceptions for complex design problems).
   b. Students must achieve at least predefined minimum grade for practical classes (which is 14 within a grade range of 1 to 20).

Our experience has shown that 80% of the students were able to be evaluated through projects. It should be noted that this has been achieved in spite of the fact that the criteria for evaluation through mini-projects have been toughened compared with [7]. The best student projects are submitted for publication in a Portuguese magazine on electronics and telecommunications. At present there are more than 30 student publications devoted to different areas of FPGA-based design.

A mini-project option for the final evaluation can be chosen at the beginning of a semester. The requirements that are agreed upon for each mini-project have the following basic characteristics: 1) the project is individual, 2) the project involves using the majority of methods and tools considered within the relevant discipline, and 3) the project is complete and relatively complicated. The time available for each mini-project is 13-15 weeks. At the end of this period the students have to be able to explain all the methods, language constructions, and automation tools used in the design. The development process for mini-projects has been organized as a sequence of the following steps.

- Formulation and discussion with the student of the design problem, which usually requires a few iterations;
- After the student understands the problem, he/she will begin the design with an opportunity to reuse blocks that have been developed previously;
- Periodical discussion of intermediate stages and results;
- Delivery of the final report;
- Public presentation and evaluation of the project.

It should be noted that mini-projects cover a wide range of potential applications [7]. Many of them may be needed for other projects that have to be completed outside of the courses. This approach provides an additional motivation for the students because reconfigurable systems can be linked with a similar work within other disciplines in which a particular student may be very interested.

Note that evaluation through mini-projects becomes very difficult or even impossible when the number of students exceeds a certain value. Our experience shows that this value is 40-45 students for 2 teachers responsible for the discipline. In this case the impact of laboratory classes on final evaluation is considered to be very important. A variety of methods have been put into practice. For example, good results have been obtained using the following approach in 2005/2006. At the beginning of each practical class a small project is proposed to the students, which has to be finished and presented for evaluation at the end of the same class. As a rule, not all the students can cope with this problem, and such students are allowed to finish the work within a given additional time period (one week maximum). If the student succeeds, a positive grade (10 or more in the range of 1 to 20) is guaranteed, but it will be significantly lower than the grades for students who completed the work during the class. Before the practical classes, relevant (but not the same) examples are considered and explained in theoretical classes. This approach achieves two important results: the students seek to attend theoretical classes (that are not obligatory in the University) because by doing so their subsequent work in the practical classes is significantly simplified; and the students work very hard in the practical classes.

5 Relationship with Research

During 2003-2006, three Ph.D. theses have been successfully completed in the scope of reconfigurable system design. Currently, there are two Ph.D. students working in this area. In 2003-2005 the student papers were accepted and presented in the major conference on reconfigurable systems – FPL – *Field Programmable Logic and*

Applications. Student papers have also been presented in a number of other conferences, such as *Euromicro Symposium on Digital Systems Design*, *Engineering of Reconfigurable Systems and Algorithms*, etc.

In 2002, the Advanced Microelectronics Engineering (AME) course was opened to provide additional training for graduate students for the Portuguese microelectronic industry. The majority of the AME attendees in Aveiro University were found to be former students of the disciplines considered in this paper. The former students of AME are currently working in industrial enterprises dealing with FPGA and ASIC-based design.

The following summary lists the basic scientific results produced by the students (including also former students) in 2003-2006 (i.e. during the last three years):

- Hardware and software for the prototyping board [12] targeted to the educational process and research activity. Information about the core hardware and software is available in [12]. One of the innovations is the implementation of a Bluetooth-based hardware block for the remote downloading of projects and communication with the board, supported by the relevant software tools. This simplifies laboratory work for the students significantly because any student can develop the projects in PC and as soon as it is necessary to debug/test the project in FPGA, he/she can interact with the board remotely.
- Design space exploration and implementation of computationally intensive algorithms, such as those for combinatorial search (for example, for solving the Boolean satisfiability problem [18] and for discovering the minimal cover of binary matrices, for graph coloring).
- Experimental analysis and comparison of different competitive and alternative implementations of computational algorithms, for example, recursive and iterative implementations [17], how embedded memory (or memory with application-targeted access facilities, such as parallel matrix addressing for rows and columns) affects the final complexity and performance of the system.

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6 Conclusion

An analysis of trends and tendencies in the scope of reconfigurable systems shows that this area is very dynamic and demanded by industry. As a result, a large number of well-prepared engineers are required and this number is expected to increase each year. The paper shows that training of engineers in reconfigurable systems is a complex problem. In order to simplify and increase the effectiveness of the training process, a wide spectrum of information resources and e-learning tools have been developed and successfully used in pedagogical practice. This paper shares the experience in this area acquired during about 10 years of teaching reconfigurable systems at the department of Electronics and Telecommunications in the University of Aveiro (Portugal).

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Teaching for Blended Learning

How is ICT impacting on distance and on campus education?

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Abstract. The concept of blended learning, defined in a range of ways, has begun to change the nature of all teaching and learning in higher education. Information and communication technologies have impacted by providing a means of access to digital resources and interactive communication for all courses and the blending of pedagogy and technology has produced a range of approaches to teaching and learning. This paper will investigate reported studies from both research literature and from the writers' research, defining what they have concluded are teaching practices that use the concept of blended learning effectively.

1 Introduction

The online environment has become accepted as a medium for learning in higher education, initially by those teaching and learning at a distance, but now more pervasively by those teaching and learning in more traditional on campus environments. Information and communication technologies (ICT) have impacted on all sectors of education by providing the means for ease of one to one and group communication while providing access to digital resource sharing but particularly in higher education, this use could be changing the nature of learning and teaching. ICT use in the field of distance education, as a means of communicating with learners who previously relied on more traditional and individual technologies such as telephone, fax and mail services has changed the nature of the field in providing the medium for ongoing interactive social learning, However, even in distance education, blending modes of learning and teaching has been a common practice

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where this is practicable. ICT use in on campus education, where face to face communication and resource access are more available, dominant and unproblematic, has meant that it is used in a variety of ways and its impact is more variable.

The term blended learning is being used to describe the combination of modes of learning and teaching made possible through the mediation of ICT. Such a term needs careful definition and study as there are many different combinations of media, learning designs and teaching strategies encompassed in the concept. The blending of pedagogy and technology has produced a number of approaches to teaching and learning not always consistent in their effectiveness and quality of learning. However in both distance education and on campus education, learners are seeking blended learning as a mode of choice and this paper will describe the learners' perspectives and reasons for this. We will analyse studies reported in the research literature and draw from our own research studies in both distance and on campus learning environments, defining what we have concluded are teaching practices that use the concept of blended learning effectively. With a focus on blended learning from the learners' perspectives, we examine what is effective teaching for successful blended learning.

2 Literature Review

Blended learning is a term now used in the literature to describe a wide variety of teaching and learning that generally involves ICT. Its use has been described in many contexts, for example, the corporate sector [10], distance education [4], and also for different kinds of learners, for example, in professional development [1] and foundation degrees [3]. Most of the reports in the literature have related to conventional university settings where traditional campus based activities have been mixed with online learning, which might include CMC. Molesworth [6], for example, has recently reported on the introduction of online learning with CMC in a traditional undergraduate marketing course and Cottrell and Robison [2] report an introduction of online learning to an undergraduate accounting course.

A major theme in the literature is the varied way in which blended learning is described conceptually. This diversity is acknowledged by Whitlock and Jelfs [11] in their editorial of a special journal issue on the subject and illustrated by wide ranging definitions and frameworks in the journal papers that follow. Osguthorpe & Graham [8] also introduce a special journal issue defining the term and its direction in practice and describe "the aim of those blended learning approaches is to find a harmonious balance between online access to knowledge and face to face human interaction" (p228). This blend may involve the mixing of online and face-to-face learning activities, students or instructors with a number of goals including pedagogical richness, access to knowledge, social interaction and ease of course revision (p 231).

Most commonly, however, writers interpret blended learning as a combination of face to face learning with technology based, and particularly internet based, learning [5] but in a review of the literature on blended learning, Oliver and Trigwell [7] have extended the notion of what is blended in identifying seven different blends, which were mixing:

- e-learning with traditional learning
- online learning with face-to-face
- different media,
- different contexts, for example, work and study
- different theories of learning
- learning objectives, for example, those concerning skills as opposed to knowledge
- pedagogic approaches, for example, distance and campus based learning.

They regarded the field as 'ill defined' (p.17) and in their view, 'almost anything can be seen as blended learning and consequently, use of the term does not help us understand what is being discussed' (p.18). Often, the term was very general and reflected an aggregation of different circumstances, so there were no underlying principles from which to determine what might or might not be blended learning. They describe the diversity of definitions as lacking in an analysis of the learners' perspectives and they offer 'variation' theory as a framework for research that shifts the perspective of the blend from the teacher to the variation in learning experiences of the learner and reconstructs the term blended learning. This was "based on the idea that for learning to occur, variation must be experienced by the learner. Without variation, there is no discernment, and without discernment, there is no learning…learning occurs when *critical* aspects of variation in the object of learning are discerned. Discernment is about the experience of difference" (p.22). What is important is not variation per se but the impact of the contrast and comparison that occurs because of the variation. They argued that different teaching media could be used to help students experience variation and that there was a role for blended approaches in creating this learning situation. Advantages can be gained by drawing on all possible ways of learning with variation theory providing a new conceptual framework to further investigate blended learning environments, particularly from a student perspective.

3 Methodology

This paper acknowledges the confusion in definition of blended learning and the inconsistency that is described in the literature. In this paper we will investigate the impact of ICT in providing variation for student learning, from the perspective of the dominant mode of pedagogy, learning environment and technology that is used in each blended situation to provide the variation that learners need in order to learn. In our application of the term blended learning, ICT may be used to either enhance the dominant mode of face-to-face on-campus interaction and or may provide a blend of synchronous and asynchronous media (that can also include face-to-face classes) to complement a dominant mode of distance education. In the studies we report, we will describe the difference in the way ICT complements the dominant mode for learning and we will seek to analyse the way teachers can use the learners' perspectives most effectively.

We will draw on two main studies:

1) a study that investigates blended learning in the dominant mode of on-campus education and
2) a study that investigates blended learning in the dominant mode of distance education.

We will examine research that has been carried out in these modes to show the way learners have perceived and used blended learning. Both studies focused on the way students learned online and were driven by research questions that focused on different ways of learning from individual approaches to learning to collaborative group learning. They were both mainly qualitative studies that used interviews and content analysis of online discussions as central sources of data. In the course of the interviews, students spoke freely about their responses to the dominant mode of learning and the choices they made from the possibilities for variation for effective learning and these aspects will be discussed here.

1) The study with a dominant mode of *on campus teaching* was a case study that researched 25 New Zealand undergraduate business students with on campus classes complemented by an online discussion. The course was about ethical behaviour and was compulsory for all business students, irrespective of their field of study and each class contained students from different business fields, for example, accounting, marketing, information technology and international business. They were interviewed individually after the completion of the semester with their recall stimulated by the archived discussion provided digitally on a laptop computer.
2) The research study with a dominant mode of *distance education* was an ethnographic study of three sample groups of students (31 students) studying for their Master of Business Administration degree by distance education. These students met initially at a weekend residential with face to face sessions and their communication for the rest of the semester was in small groups online. The group interaction of these students was a compulsory process in their course and was implemented through the use of the university's computer mediated communication (CMC) system. The data gathering methods of the study were predominantly qualitative with data gathered from a range of sources mainly through individual interviews at the beginning and end of the year of group study, as well as through a constant monitoring, saving and analysis of the text of the electronic group conferences and electronic participation logs over the length of the one year course, with the researcher a participant observer in the electronic community.

4 On campus education and blended learning

The case described was situated in an undergraduate course in the business faculty of a New Zealand university. The main online discussion activity was styled as a debate and was assessed. The debate was based on a moral dilemma and related reading was provided and preparatory tasks were required. This activity produced high levels of student engagement, and, at times, passionate and heated discussion. The participants included both New Zealand based students (locally termed Kiwi) and international students from China and the case has therefore been able to provide descriptions of learning from both points of view. Each class had a weekly two hour face-to-face class, where new topics and concepts would be introduced and this was followed by independent work which was based on online activities, for example, readings, quizzes, and case studies. The task of the online debate was a focus of the blended learning environment and 25 students were interviewed.

The results of the study showed that:

- online discussions helped all the students to learn,
- reading the online postings prompted engagement,
- writing the postings aided deeper understanding,
- the need to communicate to peers clearly and persuasively also aided their understanding,
- Chinese students could participate more due to the online features that gave them time to read postings, think and prepare answers in English and
- students were never off task.

The learning design was effective as the online discussions were linked to the face to face class and course by (a) weekly class discussions of such things as theoretical concepts, e.g. of the theories, the debate issue and reading, and case studies/application of the theories, (b) the teacher, who clarified the task and expectations, - encouraging everyone to go online and talked about the debate and postings in class and (c) their assessment. The online discussions were regarded as complementary to the face-to-face classes.

The main enhancements that the online component added to the face to face class were the record of the discussion, reading and writing instead of listening and talking, time to think, all of which improved the quality of the discussion. There was also the possibility for everyone to have their say and for some Kiwi students the virtual environment meant that it was easier to take part in the discussion, to disagree with other students and the opinions expressed were often more honest. For Chinese students, these features enabled them to talk far more with their peers online than they did in the classroom. The differences were that their conceptions of learning were much more teacher focused and they found it hard to participate in class discussions. While they did not like the debate as a learning activity, there was better interaction with peers in the online discussions their asynchronous and text based nature gave them time to read, think and express their ideas in English.

Peer interaction for all of the students occurred in two ways. Students were reading and thinking about others' postings, but the real potential value of the online debate lay in the students' responses to others' ideas and the way that that activity was deepening their understanding. Here, responding occurred because of the debate requirements, and if the debate had been voluntary, then a lower level of interaction would have been likely. This illustrates that interaction is not inherent in the CMC environment and confirm the important role of curriculum design in prompting students to go beyond their own internal conversations and start testing their ideas with their peers.

Other people's points of view would send me down tangents, of opening my mind and get me thinking about different angles on a subject.

For these students, place flexibility meant that they mostly participated in the online discussions at home and rarely at the university or at work. This may result in less demand for computer laboratory access at universities and indicated that students are ready to use laptops and other mobile technologies for interactive learning away from universities. Time flexibility for the students meant that they were able to access the debate at any time of the day or night, thus fitting their learning into already busy lives. The content analysis showed that students were always on task in the debate and the interviews indicated that, despite the reduced class contact hours, students regarded their participation as occurring in their own time and did not wish to waste it. This was different from class, where students were there for a defined time, which they did not regard as their time and hence the temptation was to chat and go off task. There was also a strong sense of the online discussions as a learning space where it would be inappropriate to socialise. The other dimension of time flexibility that students recognised was having time to think as they read the postings and composed their own contribution.

The case illustrated the ways in which on campus students go about learning in an online discussion when it is included within their course as a significant activity. Key features of the learning context for students were identified as assessment of the activity, the discussion was structured as a debate on a controversial topic, and students were required to respond to their peers. The online medium, meant that students had to work in a communication environment that was text based, and virtual, with no visual or aural cues, but with time and place flexibility. The teacher's expectations, and the activity were well documented and the debate was well connected to the class activities in terms of both content and skills, and the teacher regularly commented on the debate proceedings in class. Overall, the students described benefits of the online environment for their learning. The main one was the text based nature of the debate which engaged students with the activity, and required them to clearly establish their position and communicate it to their peers.

It [writing] makes you kind of get all your thoughts and condense them and actually realise what you think...cause I think very much, up in your brain it all a big mess of thoughts and things...so actually condensing it and going "this is what I really think" ...helps you to learn.

What also emerges from this case is the ways in which students view the blend as an effective part of their learning with a clear recognition of the benefits of both ways of learning with online discussions as complementary to face-to-face discussions. The importance of integration of the online component with the class and course as a whole was evident in establishing its coherence and legitimacy.

5 Distance Education and blended learning

The second study involved a group of postgraduate MBA students that consisted of 31 part-time students (21 male, 10 female) based in a diverse range of workplaces and geographical locations in three states of Australia. Their course in Business Economics within the MBA course at an Australian university was designed for students who were geographically distant from the university so distance education was the dominant mode of learning. However the course blended a range of learning activities beginning the semester with a weekend residential of compressed classes supported by print readings and study guides with a central learning activity of online class discussion, complemented by required small group discussion. The online system also provided email communication and access to digital resources and small group interaction was required for assessment to complete group tasks throughout the semester. The assessment tasks devised for the course established a purpose for collaborative group processes through the use of electronic group space. Students were assessed as a group by 5 fortnightly tutorial assignments submitted electronically and a group case study.

The learning design was effective as the small group online discussions, though run as student facilitated interaction were linked to the distance education print materials and readings and were structured and assessed. The teacher used the face to face residential component to define the course expectations, and encouraged the small group interaction through media of choice as the central course design. The face to face residential component and the traditional distance education materials complemented the online group interaction.

The teaching and learning that took place in the Business Economics unit within the MBA course satisfied criteria for an effective model of collaborative group learning devised for the online environment.

1) It involved heterogeneous groups of peers mutually negotiating roles rather than acting in teacher directed roles as in the cooperative learning model. The original group structure was devised as part of the MBA course but the role structure was decided autonomously within the group and adapted to changing group activities and individual capabilities.

2) The assessment tasks devised for the course established a purpose for collaborative group processes through the use of electronic group space. Students were assessed as a group by 5 fortnightly tutorial assignments submitted electronically and a group case study.

3) Students were also individually assessed by an individual case study proposal, a multiple choice test and a final exam. If evaluated both individually and as a group, the students understand that they have a responsibility to the group to contribute and meet assessment requirements but this also provides the assessor with a means of assuring that all students have learned from this process.

4) Students could gradually learn the language of the new knowledge area of Business Economics through the online discussions. Through the small group conferences, students coming from many workplaces and previous learning environments were acculturated to the learning community of Economics.

In interviewing the students, it became obvious that they chose a blend of varied learning environments and media where possible. They were grouped into three groups in as close a geographical proximity as possible, although this proximity varied widely. One group, Group A, were able to meet periodically as a face-to-face group as well as being regular users of their group conferences. A subgroup of this group consisted of 3 students working in the same workplace who decided to work together and not via the electronic group conference, although they used the system for reading the whole group conference. Another group, Group C consisted of students who were so widely scattered geographically that the electronic conference was their central communication, but they supplemented this with the use of phone or fax. The third group, Group B, chose to meet face-to-face as all group members worked in the central business district of a capital city. Though two thirds of this group used the electronic system to read the whole group conferences, they did not share text and ideas through their small group conference.

There was a layer of communication outside the online discussion space that was very important to the group communication. Often the small-group conferences were used as a means of flagging other group communication, either faxing, phoning or establishing group meetings. One student described their group's layered communication process:

What generally happens is that reading a message on the board is a precursor to a telephone call or a series of telephone calls.

The whole data group, represented the type of postgraduate student often studying in this distance mode, with an average age of 33 and jobs ranging from accountancy-related occupations to engineering positions, public servants etc who shared similar management responsibility or potential for such responsibility in their workplaces. This factor also meant that all students were based in workplaces that demanded full time commitment and one of the reasons many of them had chosen to study part-time and by distance mode, was to attempt to balance these demands. Most students had easy access at work to fax machines and telephones for either local or distance calls. One student raised the aspect of distance influencing the choice of technology. Students who were further away and faced with more costly telephoning may be more likely to try using the online system. Sometimes, though, it was the purpose of the activity that dictated the communication used, as with one student's need to 'caucus' opinion in his group which he thought needed the one-to-one communication of the telephone.

You know we got on the phone and talked about some of the issues quite a bit. And the electronic medium no doubt helped to keep the information flowing, but I think that the telephone is a more useful means of caucusing and chatting and getting support.

However the students were aware of the limitations of these other technologies as well as the specific advantages of online communication of asynchronous shared text. The flexibility for managing the time of communication at their convenience, as well as the ability to share digitised text without having to retype it were both advantages that busy collaborating students appreciated.

If Frank's got something he knows I want and to save me having to retype it or whatever he will post it on the board and I can get access eventually so it's, yeah it is very useful from that point of view.

The use of layers of communication with a central message base on the online conference and through a mixture of technologies for different purposes enabled effective and efficient communication in the groups and showed the students' need for blending media even when the dominant mode of learning is at a distance. A further small scale study of this course [9] showed a similar pattern of choice of interaction with students choosing a blend of media and communication modes for learning where this choice was possible.

6 Conclusion

As predicted by Oliver and Trigwell [7], when learners' perspectives were researched, they expressed an understanding of the benefits of both online and face to face interaction and chose, where possible, to blend these modes. Teaching effectively for blended learning, whether the dominant mode was distance or on campus learning, required careful design and preparation with expectations of student interaction online explained and designed to complement the dominant mode and required as part of assessed tasks.

A concern that is raised from these studies is that increasingly traditional distance education courses are offered only through the mediation of internet based technologies with fewer structured face to face opportunities built into programs. Though the students learning on campus will gain by the blended mode that provides them with variation in the experience of learning, students learning at a distance may have fewer opportunities for blended learning, especially as programs are taught globally. Developments in ICT with internet based telephony and accessible forms of audiovisual synchronous communication are addressing these needs to some extent but the role of teachers in designing for effective learning within these models are becoming even more important. As with the careful complementary blending of on campus and online learning, they will need teaching strategies that acknowledge the importance of explicitly establishing social presence and a sense of community among distance education students as the impact of development in ICT affects learners at a distance.

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Biographies

Elizabeth Stacey is an Associate Professor in the Faculty of Education at Deakin University. She teaches, postgraduate distance education coursework and supervises students researching flexible learning and computer and communication technologies. Her research and publications include learning with computers, and the use of interactive technologies, particularly for collaborative group learning online.

Philippa Gerbic has been the Program Leader of the Bachelor of Business Program at the Auckland University of Technology. Her research focuses on computer mediated conferencing, and she is currently researching how undergraduate students learn in online discussions in blended environments.

Blending Projects Serving Public Education into Teacher Training

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Abstract. About 10 years ago informatics teacher training did not seem to be too productive. Even though many students graduated, most of them chose well paid jobs as IT specialists rather than underpaid teacher positions in Hungary. What is then the reason for striving to provide the most up-to-date technology and methodology for future teachers who will never be able to transfer their gained knowledge into public education? The only possible solution seemed to be to convert to e-learning. The significance of TeaM e-learning activities at ELTE University is mainly that they are interconnected and add up from course project works, undergraduate diploma works, Ph.D. dissertations of students, as well as all local and international projects that TeaM Lab participates in. Thus a dynamic development is under continuous progress which is a win-win relationship between all participants, teacher training and projects.

1 Introduction

It is believed that this century shall be the century of the information society. The Hungarian government set up its goals – development of information infrastructure, generalization of electronic information supply, educating citizens of the information society, stabilization of a competitive economy, efficient services, public administration and a human-centred society – several years ago. All of these goals themselves require the development and modernization of all levels in the education of the future informatics experts.

The Faculty of Informatics (http://www.inf.elte.hu/en) – one of the newest faculties in the Eötvös Loránd University (ELTE – http://www.elte.hu) – considers its main task the training of informatics experts and teachers as well cartographers

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and geoinformatical specialists. The aim of the *informatics teacher* major is to train teachers who can educate the disciplines of informatics within all levels of schooling. They should also be able to give advice on their use for teachers of other subjects, to be active in professional and social life and to advance in their studies throughout life [1].

The high level of the training of informatics experts and teachers is strongly expected from the society because the teachers play a significant role in forming the society's information culture. That is why students have to possess the most up to date pedagogical knowledge, to be confident in the use of IT tools, to be aware of digital learning tools and innovative teaching methods.

TeaM Lab has been established in the beginning of 1997 under the leadership of the author of this paper with founding membership of students, some of which are now assistant professors and have their own specialty in e-learning activities. TeaM Lab (Teaching with Multimedia) operates within the Informatics Methodology Group at the Faculty of Informatics and serves mainly informatics teacher training undergraduate and graduate programs. Its aim is the application, teaching, experimentation, evaluation, research and development of innovative multimedia tools and methodologies for the benefit of effective learning and developing skills. Research includes the ergonomics and content of developing educational applications, authoring tools, Internet and telematic environments, their cross-curricular and cultural integration, creative implementation and evaluation of their effects on the learning process. Our methods give emphasis to creative open ended explorations within constructive environments.

TeaM Lab takes an active part in local and international scientific life, which is realised within the spectrum of activities and publications, as well as our active participation in European Union projects. Our activities are not the sole work of our members, but we co-ordinate and integrate the work of our students (doing Ph.D. research and courses, dissertations, and undergraduate course assignments) as well as the work of our experimental schools' children and teachers. This TeaM-work is reflected in our web pages: http://teamlabor.inf.elte.hu/.

3 TeaM e-Learning

If one is working 25 years in teacher training, there must be times when doubts surface and remedies are sought for. About 10 years ago informatics teacher training did not seem to be too productive. Even though many students graduated, most of them chose well paid jobs as IT specialists rather than underpaid teacher positions. What is then the reason for striving to provide the most up-to-date technology and methodology for future teachers who will never be able to transfer their gained knowledge into public education? The only possible solution seemed to be to convert to e-learning:

- to provide infrastructure and environment for learning and teaching with technology; to be able to actively contribute even if students cannot be physically present, which could prolong their contribution after graduation;

- to convert as many courses as possible to productive project work serving public education; to get value out of innovative knowledge gained by students while at university and give meaning and context to their contributions by directly placing them into learning situations;
- to involve students in all our local, EU and other international e-learning activities, projects, and research; to develop competencies in working in team on international level and quality;
- to provide free access to projects and products for public education; to gain a short-cut for directly transferring innovation into public education;
- to maintain tele-mentoring services (apart from learning about tele-mentoring) as course work; to provide direct help for public education and alternative learning institutions in implementing innovation.

Thus we can say that public education already gains from students' active participation while at university and a lot of the students become highly motivated in further involvement with e-learning activities after experiencing the success of their own contributions.

4 TeaM courses

Most of our courses are undergraduate non-compulsory electives, mainly within the informatics teacher training program and secondly for programmer and program designer mathematicians. With relation to developing e-learning materials and running projects in public education, we here restrict our description to subjects closely related within special M.S. and Ph.D. studies that contribute to the production of materials and services for newly launched projects.

Table 1. Course blocks offered on M.S. and Ph.D. level building spirally on each other

MSc	Autumn semester	Spring semester
C.		Evaluation of educational software
	ICT in basic education	Designing educational microworlds
	Authoring tools in basic education	
H.		Desktop publishing
	Web design	Web animation
		Designing multimedia materials
B.	Tele-mentoring I.	Tele-mentoring II.
Ph.D. 1	Research methodology	Foundations of ICT and types of interactions
Ph.D. 2	Innovative, capacity building digital pedagogy	Inquiries on e-Learning

Each course has a specific content and output requiring collaborative project work as contribution to an emerging project:

- ***Evaluation of educational software***: Formative evaluation of educational software in accordance with the evaluation rubrics developed throughout the years. Analysis of National Curriculum and teaching strategies in order to define a hypothesis for pinpointing the scope of development, designing activity to produce the process, and composing pre- and post-test to prove hypothesis. We often use educational microworlds and portals for evaluation that have been developed by our students in previous semesters or are parts of running projects.
- ***ICT in basic education***: Analysis and methodological evaluation of ICT use in the full scope of kindergarten, elementary and lower secondary education. Designing collaborative e-learning projects for launch in the coming semester.
- ***Authoring tools in basic education***: For many years we used *Comenius Logo*, but since 2001 we use the *Imagine* authoring tool. Students develop modelling assignments for different disciplines practicing constructivist pedagogy. The e-learning material of the course itself has been improved, updated and refined from the feedback of this process. The course runs blended, using the e-learning course material individually plus consultation periods in class.
- ***Designing educational microworlds***: For many years we used *Comenius Logo*, but since 2001 we use *Imagine* as the authoring tool. Students develop complex educational microworlds to be used in different disciplines practicing experiential and constructivist pedagogy. Our microworlds within e-learning materials have been improved, increased and refined as products of this course.
- ***Desktop Publishing***: Mastering all aspects of design criteria for development of printed learning materials and analysis of different prints on the process of perception and understanding. Designing printed materials for different educational purposes.
- ***Web design***: Mastering all aspects of web design and analysis of different web sites on navigation, and usability. Designing web sites for different educational purposes. Course can be registered only as distance education plus consultation periods.
- ***Web animation***: Mastering all aspects of web animation for use in web sites and simulation programs and analysis of different previous products on process of perception and understanding. Designing web animations for different educational purposes. Course can be registered only as distance education plus consultation periods.
- ***Designing multimedia materials***: Mastering all aspects of design criteria for development of e-learning materials and analysis of learning environments and learning styles of students. Students participate in experiments on the effects of different learning materials to the learning process. Designing e-learning materials to be integrated into one of the portals under development.

- ***Tele-mentoring*** (2 semester course): Study of different aspects of distance and e-learning, different frame systems used and the role of mentors in virtual learning. Analysis of previous e-learning projects. In parallel, students register with an ongoing e-learning project, and take part live in the mentoring process. The course can be registered only as distance education plus consultation periods – using different e-learning environments.

There are also some postgraduate PhD courses in connection to undergraduate courses:

- ***Research methodology***: Study of research methods and the different situations that suit their application. Studies in writing up a research paper – students have to produce research plans for future projects.
- ***Foundations of ICT and types of interactions:*** Research on foundations of technology in education, the types of interactions that are involved and the methodologies used – students have to produce monographs of their research field.
- ***Innovative, capacity building digital pedagogy***: Research on innovative technology, tools and methods as well as reports on their research results concerning effective use within the learning process. Students take part in upgrading evaluation rubrics for *Evaluation of educational software* course and design criteria for *Designing educational microworlds* course. Students develop evaluation instruments for use within e-learning projects.
- ***Inquiries on e-learning:*** Study of action research "theory research– data collection & analysis – evaluation" cycle and its implementation into practice through a live e-learning project. Students have to produce evaluation reports of projects.

5 TeaM activities

All courses require project work that outlines a definitive part of an actual project to be launched and the sequence of courses contribute to the building, launching, running and evaluating processes within project activities.

Table 2. Blending course deliverables into project work

<table>
<tr><th>Sept.</th><th>Oct.</th><th>Nov.</th><th>Dec.</th><th>Jan.</th><th>Feb.</th><th>Mar.</th><th>Apr.</th><th>May</th></tr>
<tr><td colspan="4">ICT in basic education
Brainstorming</td><td></td><td colspan="4">Designing multimedia e-learning materials
Development of materials</td></tr>
<tr><td colspan="4">Foundations of ICT and types of interactions
Planning research</td><td></td><td colspan="4">Innovative, capacity building digital pedagogy
Research</td></tr>
<tr><td colspan="9">Tele-mentoring I., II.
Projects are launched in February and end at end of May</td></tr>
<tr><td colspan="4">Inquiries on e-learning</td><td></td><td colspan="4">Evaluation of educational materials</td></tr>
</table>

Evaluation methodology *Evaluation of projects*

Publication →

Projects are launched directly into public education, often in association with the John von Neumann Computer Society Public Education SIG, and results are reported twice a year at conferences of the Association of Informatics Teachers, where discussions with practicing teachers can produce important conclusions for the future. Some of these projects were run within local or European funded activities. Thus in the past 10 years or so, TeaM managed to run lots of projects within public education and has contributed to public education considerably by injecting innovation in a direct way, through projects blended into the TT program. Some specific projects of the past years:

ELTE kindergarten project: For more than 20 years we have constantly supervised the university kindergarten and developing educational software for early education. The project is continuously mentored on spot by our students [2,3] (project web page: http://matchsz.inf.elte.hu/colabs/nursery/index.html).

„MATCh" Multimedia Authoring Tool for Children EU project: Developing a multimedia authoring system for children, story applications and its implementation within Fogócska elementary school 3rd grade between 01.01.1997 and 01.01.1999 [4] (project web page: http://comlogo.web.elte.hu/team/match/).

Tele-house projects: Developing a model for mentoring youth (aged mainly between 10 and 14) living in underdeveloped regions and giving them a perspective for their further development. The first project involving the least developed areas of Hungary was 01.12.2000-30.07.2001, sponsored by US AID, and the second project involving various other regions was 01.09.2001-15.01.2002, coordinated by Demnet and sponsored by the Informatics Committee of the Prime Minister's Office [5,6,7,8,9]. These tele-house projects were the first such in Hungary that provided a model for capacity building activities in underdeveloped regions and had a great impact for further tele-house activities. Such activities are now well implemented within the Tele-house association (http://www.telefalu.hu/g), where lots of e-learning activities emerge by now as well as IT mentoring (project web page - only in Hungarian – http://matchsz.inf.elte.hu/Telehaz/).

"Co-didactics" Austrian-Hungarian project: Joined teacher-training activities in research and development of creative didactic tools that could be implemented, in both cultural settings, sponsored by Hungarian Science and Technology Foundation between 01.01.2001 and 31.12.2002 [10] (project web page: http://matchsz.inf.elte.hu/tet/).

TeaM perspective project: Building a model for practical teacher training, producing basis of the needs of teachers/mentors, providing competencies in developing effective tools for progress within their dynamically evolving role, transferring innovation into public education by meeting the notion and the requirements of present age in public education – sponsored by Pubic Funds for Modernisation of Public Education (project web page - only in Hungarian – http://matchsz.inf.elte.hu/koma/).

TeaM Challenge game series: Providing examples for context based "e-problem solving", developing key competencies through search for solutions of complex problems, data analysis and synthesis using the Internet and various application systems within interdisciplinary topics through team project work among students aged 10-14. In 2001 it was developed under course project work that was redeveloped by students and played in 2002. In 2003 it was a huge national game that was developed for the 100th anniversary of John von Neumann and sponsored by several institutions, among others the Ministry of Education, and was a tremendous success. In 2004 we switched environment and the game was sponsored by IBM and Pubic Funds for Modernisation of Public Education. In 2005 we opened up for more contributions coming from schools and are sponsored by the John von Neumann Computer Society, Public Education SIG [11] (project web page - only in Hungarian – http://matchsz.inf.elte.hu/Kihivas/).

NETLogo users circle project: Development of students' main competencies (aged 10-14) by involving future teachers, practicing teachers as mentors. The used e-learning material has been dynamically evolving (through the past 15 years through course work) and is now more than 1500 pages. The material contains microworlds for use within different disciplines of public education, illustrating modes of development and configuration, and developing competencies for modelling in different disciplines both for elementary and teacher education. The project is open to all schools, homes and entities and is continuously mentored by our students. The project has been sponsored by the NETLogo EU project (for producing an English version) and Pubic Funds for Modernisation of Public Education for operating users circle [12] (project web page - only in Hungarian - http://kihivas.inf.elte.hu/halogo).

"Colabs" Minerva project: To find ways to support children in building and testing models collaboratively across European cultures and beyond. Objectives are to provide infrastructure for collaborative work; to provide answers for guiding research questions: with *whom*, *how* and *what* kinds of knowledge should children learn at a distance and how best can they be supported in this learning; and to develop learning tools that can be transferable into other domains using the Imagine authoring system. The project was coordinated by the head of the TeaM Lab and not only ELTE students, but students from other universities also participated between 01.10.2002 and31.1.2005 (project web page: http://matchsz.inf.elte.hu/colabs/).

The project developed quite a few products that have already been commercialised or are on their way, those involving mostly our students are:

- Hungarian localized version of Imagine authoring tool [http://logo.sulinet.hu/]
- "Digital Literacy" e-learning course for children ages 9-16 – only in Hungarian – [http://sdt.sulinet.hu/])
- "Creative Classroom" CD published by Logotron in UK [http://www.logo.com/cat/view/creative_classroom.html]

In addition, some further portals have been developed and operated for research:

- ***Logo Arts* portal:** Familiarising children with modelling structures resembling contemporary art, thus drawing parallel between works of artists and mathematics modelling using the Logo programming language (portal only in Hungarian – http://team1.inf.elte.hu/art).
- ***Telling you in pictures* portal:** The project provides environment for collaborative and creative communication between groups of children from different language cultures of average age about 9-10 through different visual

assignments and creative tools (portal: http://matchsz.inf.elte.hu/colabs/colaboratories/portal/pict_com.htm).

"Kaleidoscope" Network of Excellence: Integrating existing research to develop new concepts and methodologies from a multidisciplinary and cross-cultural perspective. Ph.D and diploma students of TeaM Lab were so far involved in Joint Research Projects for: *Personalised and Collaborative Trails of Digital and Non-Digital Learning Objects; Interaction between learner's internal and external representations in multimedia environment; Building Visual Interactive Blocks for Tangible Mathematics* 01.01.2004-31.12.2007 (project web page: http://www-kaleidoscope.imag.fr/pub).

TAMI projects: The Neural Information processing Group and TeaM Lab have been involved in common research activities with the AAC foundation (Augmentative and Alternative Communication and Methodology Center) since 2003. The aim of the research is to find alternative hardware and software solutions for communication and further development for children and youth seeking help from AAC services (project web page: http://nipglab17.inf.elte.hu:8180/portal/servlet/Main).

Special education projects: TeaM Lab also has a long term R&D cooperation since 2003 with Bárczi Gusztáv Faculty of Special Education and with its connected centres for fieldwork in which we develop software tools for problematic children to aid their development in different fields. Our future teachers take part in developing software tools and visit schools to monitor results.

Capacity building developmental software project: TeaM Lab also has an ongoing development with the Hungarian Academy of Sciences Psychology Research Institute Psychophysiology Group developing diagnostic and developmental software tools for children with dyscalculia syndromes. Software development is part of course projects.

6 Conclusion

The significance of TeaM e-learning activities is mainly that they are interconnected and add up from course project work, undergraduate diploma work and PhD dissertations of students, as well as all local and international projects that TeaM Lab participates in. Thus a dynamic development is under continuous progress which is a win-win relationship between all participants, teacher training and projects.

Students experience and master innovative technology and methodologies, contribute with their own developments through active participation in an ongoing project, which are then directly implemented and mentored within public education. These ongoing e-learning projects transfer innovation into public education with a short cut, which is then evaluated through research analysis involving PhD students to gain further knowledge for future projects and developments.

Our teacher trainers not only train future teachers, but also develop mentors who can then give aid to local helpers at schools, other educational establishments involving children's activities, or parents at home, both locally and internationally.

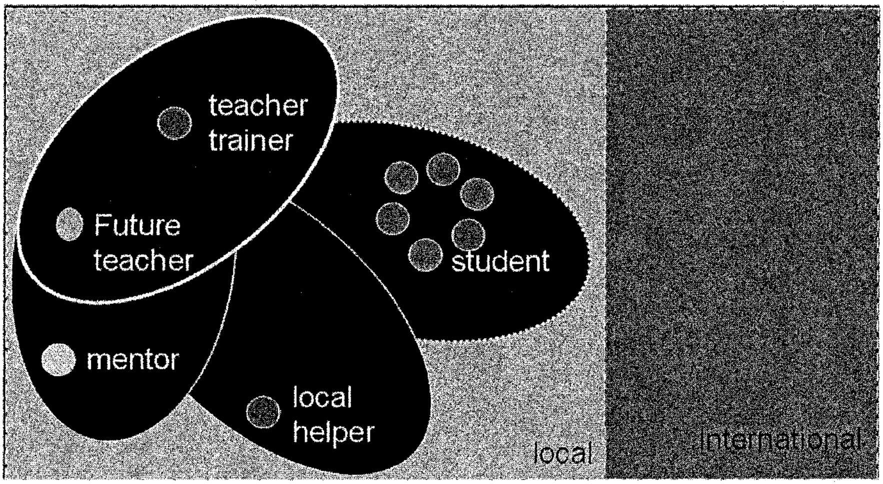

Figure 3. Our e-Learning model in the past 10 years

Our results are quite positive:

- Student teachers concentrate now more on children and their needs than the power of computer itself (even though their interests were mainly in that direction).
- Project assignments require strong connection to the National Curriculum, which is thus examined thoroughly in practical terms too.
- Student teachers must engage in the synthesis of their mastered knowledge when designing environments, microworlds and educational materials to suit needs of teachers and be able to create configurable tools to adjust to the differences of pupils.
- Project work submitted by future teachers is actually evaluated by pupils themselves, thus student teachers tend to produce higher quality work, as they are more afraid of this open evaluation than that of their trainers.
- Future teachers are able to set up empirical evaluations of educational tools that could give more exact values of purchased products.
- Future teachers are able to recognize value in all types of tools that can be used in a broad spectrum of school subjects, thus they are able to give advice to other staff members teaching different disciplines.
- Project work submitted by student teachers is more valuable, as they are able to judge more easily and filter weak points of microworlds or educational materials.
- Most of all, student teachers enjoy their studies much better and are willing to contribute more than before, since they are assured that their quality work is not just laid aside in drawers, but actually is used in effective school work to which they are proud to contribute.

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Understanding the Continued Usage of Business e-learning Courses in HK Corporations

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Abstract. Other research has investigated different aspects of e-learning, e.g. comparing the effectiveness of e-learning with traditional classroom training and on the success of IT or computer skills training. This study focused on how to ensure that individuals continue their usage of business and management e-learning courses for self-development in Hong Kong Corporations. A theoretical framework was developed based on Venkatesh's model of System Usage, Bhattacherjee's Expectation-Confirmation Model and Seddon's re-specification of DeLone and McLean's Information System Success Model. The proposed model was calibrated with 212 valid samples from five corporations in Hong Kong and was validated with 15 questionnaires from a small e-commerce company of 50 staff at a different time. The data supported the model and the model had a moderate explanatory power (R2=37%) for continued usage. The structural model was not affected by different collection periods (first collection batch vs last collection batch), sample (calibration vs validation), gender (male vs female), position (manager vs non-manager), and computer usage experience (10 years or more vs less than 10 years). However, the model was different for groups of different ages (age 36 and above vs below 36) and educational levels (university graduates vs non-university graduates). Further research and the business implications for improving the continued usage of business e-learning courses are discussed.

Key words : e-learning, user satisfaction, continued IT usage, technology acceptance, survey research, consumer behavior

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1 Introduction

Corporations in Hong Kong have increased their emphasis on e-learning in the past five years. Because of its distinctive competitive advantages, such as cost-saving for arranging staff to learn as a group from various locations, and participants can learn at their own pace at anytime anywhere, e-learning is a growing trend in the learning field. However, some corporations in Hong Kong face a problem of poor utilization of the e-learning solution which is also a concern in US (e.g. [4] and [5]).

Over the past two decades, a significant body of research has focused on identifying various factors that influence user acceptance behaviors. According to Bhattacherjee [2], the eventual success of a new technology depends not just on the initial adoption of the system but more on the users' continued usage of the IS.

There has been research on the success of using IT or computer skills training (e.g. [6] and [7]). The objective of this study is to identify the factors affecting continued usage of business and management e-learning courses at an individual level and to provide empirical validation of the proposed model. This study can provide practitioners with deeper insights on the factors that influence user satisfaction and how to encourage continued usage behaviors.

2 Key definition

The evolving definition of e-learning used in this paper is defined as *the instructional content or learning experiences delivered or enabled by internet technology to enhance an individual's knowledge and performance.* This definition is derived from the Commission on Technology and Adult Learning by the American Society for Training and Development and National Governors Association, US [8, p.7].

3 The context

Most corporations in Hong Kong prescribed business e-learning courses for staff development activity. The employees are all adult. The usage of the e-learning courses is voluntary, i.e. staff are not forced to complete any courses. The usage is also volitional, i.e. there is no barrier that would prevent the individual from learning if he or she chooses to do so. The business and management e-learning course is different from the commonly researched IT/computer training e-learning courses as the participants have to learn through interaction in different scenarios. All users in this study have had experience on using e-learning courses for at least one month.

4 Theoretical background

A significant body of research has focused on identifying various factors that influence user acceptance behaviors. In particular, the technology acceptance model

(TAM), introduced by Davis and his colleagues [9] [10]. TAM has received considerable attention and has been established as a parsimonious and powerful model for explaining and predicting usage intentions and acceptance behaviors. TAM theorizes that an individual's actual system usage is determined by behavioral intention, which is jointly determined by perceived usefulness and perceived ease of use. Perceived usefulness is the extent to which a person believes that using the technology will enhance his or her job performance. Perceived ease of use is the extent to which a person believes that using the technology will be free of effort [9]. Behavioral intention is defined as the extent to which an individual intends to perform a specific behavior [10].

Bhattacherjee [2] argued that the eventual success of a new technology is more dependent on users' continued usage of the system rather than on their initial adoption. Bhattacherjee then developed a model based on an expectation-confirmed model and empirically tested it with acceptable results. The model is rooted in the expectancy-confirmation paradigm, which regards a user's continued usage decisions similar to a consumer's repeat purchase decisions. The model predicts users' intentions to continue usage of an IT system with three antecedent constructs: (1) user satisfaction; (2) extent of user confirmation; and (3) post-adoption expectations, represented as perceived usefulness.

Recent findings on intrinsic motivation and self-efficacy in social psychology indicate that enjoyment plays important roles in determining a person's behavior. Davis et al [11] put enjoyment followed the construct of perceived ease to use. As staff has to sacrifice their personal time to learn at home, the user will look for more pleasure on using the e-learning course based on the opportunity cost concept. Hence, it is proposed that enjoyment should be the precedent construct to perceived usefulness and perceived ease of use of the model and should have more coverage than the construct of confirmation as suggested by Bhattacherjee [2] in this case. According to DeLone and Mclean [12] and Seddon [3] on IS Success Model, the construct of system quality, information quality and service quality would affect user satisfaction. In combining the recent theoretical developments, the following framework is proposed to understand how individuals will continue to use the business and management e-learning courses:

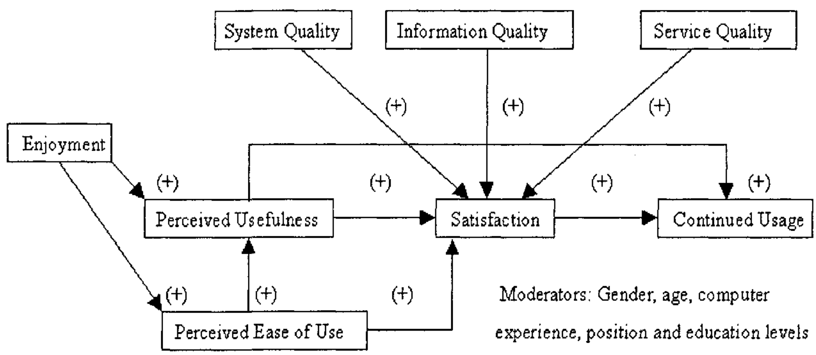


Figure 1 – The proposed theoretical model

It is proposed that enjoyment, like confirmation as defined by Bhattacherjee [2], will increase the perceived usefulness and ease of use of the system. Perceived ease of use will increase the perceived usefulness of the e-learning course. The perceived usefulness will increase the user satisfaction and that will encourage the learner to use the e-learning course again. The perceived usefulness, combining with system quality, information quality and service quality will increase the user satisfaction. The user satisfaction will lead to the continued usage of the e-learning course.

5 Research method

This research was a cross-sectional study that obtained information on variables in different contexts but at the same time. The data was collected over a short period (from Oct 2004 to Dec 2004). As it was a field experiment, there may be confounding and extraneous variables that obscured the effects of another. Hence, Structural Equation Modeling (SEM) was adopted. The goal of the SEM analysis was to determine to what extent the theoretical model was supported by sample data.

6 Data collection method and pilot test of the questionnaire

Questionnaire-based data-gathering technique was used. The items of the questionnaire were drawn from the literature. The questionnaire was also translated into Chinese to suit the needs of respondents who were not fluent in English. A pilot study of a group of 10 people was undertaken to ensure the items were adapted appropriately to the study context. The purpose was to find out potential problems and misunderstandings of instructions and question items. After the pilot test, some adjustments were necessarily made to represent the ideas clearly.

To control the variation of different types of e-learning courseware, such as from various vendors on different subjects such as language, computer skills and business, the research intended to narrow down the variation by choosing one vendor and one type of business courseware so that on instructional design, navigation and the look and feel, the courseware were standardized for comparison. The target population was a group of Hong Kong people using the business and management e-learning courses provided by a market leader in Hong Kong. The population was employees from 19 corporations. Stratified sampling was used to identify the number of sampling corporations (see Table 2).

The largest corporations in each sector were invited to participate in this research. The Human Resources Department of that invited corporation distributed the questionnaires to all the users. The participant was required to complete the questionnaire and send it directly to the researcher using a pre-stamped envelope. The six participating organizations include one multinational bank in Hong Kong, one public utility corporation, one local bank, one container service company and one local technology firm. The questionnaires collected from the sixth company, a small local e-commerce organization, were used to validate the calibrated model.

Type of Organization	No. in Population	No. of Sample
Multinational corporations	3	1
Public utility companies	3	1
Large private organization	6	2
Small local enterprises	7	2
Total	**19**	**6**

Table 2 – The selection of the stratified samples

A total of 700 questionnaires were sent to the five corporations' human resources department for onward delivery to their staff. After collecting only 176 questionnaires as at 30 November 2004, the key coordinators of the five respective organizations were asked to remind their staff to return the questionnaire. An extra 41 questionnaires were later collected as at 31 December 2004. The response rate was 31.0%. As the response rate was higher than the 20% response rate as identified by Yu and Cooper [13], non-response bias was not a serious problem in this research.

Of the collected 217 completed questionnaires, five questionnaires were found to be incomplete in some items and were discarded. Only 212 questionnaires were used for data analysis. The response rate became 30.3% that was still acceptable. According to the sample size requirement stated by Levine et al [14, p.443], it was safe to conclude that there were sufficient number of respondents to support the findings at 95% confidence level and at 7% sampling error.

The results from the first collected batch were compared to the second collected batch. It was found that there was no statistically significant difference.To overcome the potential bias and sterility of a single-method approach, this research conducted a data triangulation investigation in which a different set of data was collected at different times and strata of the study. The separate data was collected in Jan 2005 from an e-commerce company (the sixth company). 15 completed questionnaires were collected from the sixth company that had only 50 users for validation purposes. The response rate was 30% and was acceptable. It was found that there was no statistically significant difference between the calibration and validation sample.

7 Examination of the data

According to Joreskog [15], observations on a 7-category Likert scale represent responses to a set of ordered categories. This study followed the recommendation of Joreskog [15] to examine the data by LISREL.

8 Instrument validation

A confirmatory factor analyses was performed on the measurement model. The fit of the measurement model was estimated with different indices. The goodness-of-fit (GFI) and the adjusted goodness-of-fit (AGFI) were both 1.00. The values of the normalized fit index (NFI) was 0.97. The values of the non-normalized fit index (NNFI) and comparative fit index (CFI) were respectively 0.98 and 0.99 which indicated good model fit (Chau, [16]). The observed values for root mean square residual (RMSR) and root mean square error of approximation (RMSEA) were respectively 0.074 and 0.057, which were within the recommended cutoff values of 0.10 for RMSR and 0.08 for RMSEA for goodness-of-fit (Chau, [16]).

The psychometric properties of the constructs and items were summarised in Tables 3 and 4. The convergent validity of the instrument was assessed by the composite reliability and average variance extracted. The composite reliability estimate for each construct ranged from 0.83 to 1.00, suggesting an acceptable level of reliability (Hair, et al., [17]). The average variance extracted (AVE), ranging from 0.66 to 1.00, were all above the recommended 0.50 level (Hair et al., [17]). According to Fornell [18], factor loadings in excess of 0.70 could be considered excellent for convergent validity. All the factor loadings were greater than 0.70. Following Hair et al's [17] guideline, all squared multiple correlations should be above the 0.40 threshold for convergent validity. In Table 3, the squared multiple correlations of individual items were high, ranging from 0.52 to 1.00. In Table 4, the average variance extracted for each construct was greater than the squared correlations between it and all other constructs. It indicated good discriminant validity (Fornell and Larcker, [19]).

	USE	SATIS	PU	PEU	ENJ	SYSQ	IQ	SQ
USE	**0.85**							
SATIS	0.31	**1.00**						
PU	0.81	0.10	**0.97**					
PEU	0.44	0.75	0.28	**0.88**				
ENJ	0.36	0.56	0.24	0.48	**0.95**			
SYSQ	0.12	0.24	0.06	0.11	0.23	**0.83**		
IQ	0.23	0.42	0.12	0.23	0.48	0.24	**0.86**	
SQ	0.10	0.11	0.06	0.13	0.27	0.13	0.36	**0.95**

Table 4 – Construct correlation and discriminant validity

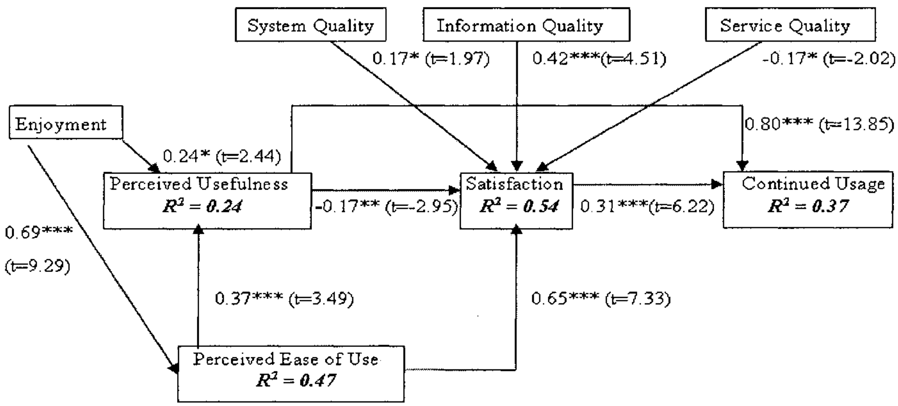
Construct		Factor Loading	Squared Multiple Correlations
Continued Usage $R^2 = 0.37$ **Reliability = 0.85 AVE* = 0.66**			
USE1	I frequently use my company's e-learning solution	0.72	0.52
USE2	I have completely integrated the e-learning solution in my personal development activity	0.78	0.61
USE3	I fully use the capabilities of the e-learning solution	0.92	0.84
Satisfaction $R^2 = 0.53$ **Reliability = 1.00 AVE = 1.00**			
SATIS1	The e-learning solution is efficient.	0.99	0.99
SATIS2	The e-learning solution is effective.	1.00	1.00
SATIS3	I am satisfied with the e-learning solution.	1.00	1.00
Perceived Usefulness $R^2 = 0.24$ **Reliability = 0.97 AVE = 0.88**			
PU1	Using e-learning improves my job performance	0.95	0.90
PU2	Using e-learning in my job increases my productivity	0.97	0.94
PU3	Using e-learning enhances my effectiveness in my job	0.94	0.88
PU4	I find e-learning to be useful in my job	0.88	0.78
Perceived Ease of Use $R^2 = 0.47$ **Reliability = 0.88 AVE = 0.70**			
PEU1	I find e-learning to be easy to use	0.77	0.59
PEU2	I find it easy to get e-learning to do what I want it to do.	0.82	0.67
PEU3	My intention to use e-learning is clear and understandable	0.92	0.85
Enjoyment **Reliability = 0.95 AVE = 0.87**			
ENJ1	I have fun using the e-learning courses	0.91	0.83
ENJ2	Using the e-learning courses is pleasant	1.00	1.00
ENJ3	I find using the e-learning courses to be enjoyable	0.88	0.77
System Quality **Reliability = 0.83 AVE = 0.72**			
SysQ1	The network connection to internet has been satisfactory while accessing	0.92	0.84
SysQ2	The rate at which the information displayed is enough	0.75	0.57
Information Quality **Reliability = 0.86 AVE = 0.67**			
IQ1	I understand the terms used.	0.76	0.58
IQ3	The content relates well to my learning needs.	0.84	0.70
IQ4	The content is accurate	0.85	0.72
Service Quality **Reliability = 0.95 AVE = 0.85**			
SQ7	I found my IT/HR department to provide consistently good solutions	0.85	0.72
SQ9	My IT/HR department provides service as I require it.	0.96	0.92
SQ10	My IT/HR department delivers support in a timely manner.	0.95	0.91

AVE = Average Variance Extracted

Table 3 –Summary of Psychometric Properties of Construct and Items

9 Empirical results

According to Joreskog [6], robust diagonal weighted least squares (DWLS) estimation method was recommended to estimate the coefficients of the associations among the variables. All the hypothesized paths were significant. In summary, the proposed model accounted for 37% of the variance in users' continuance usage, 54% of the variance in user satisfaction, 24% of the variance in perceived usefulness and 47% of the variance in perceived ease of use.



* for p<0.05 (i.e. t=1.96)
** for p<0.01 (i.e. t=2.58)
*** for p<0.001 (i.e. t=3.29)

Figure 2 – The results of the proposed theoretical model

The model was compared for different groups of people. It was found that there was invariance across the male and female respondents, across managers and non-managers, and across respondents with less than 10 years experience in using computer as compared with respondents with 10 years or more experience in using computer. However, the model was different between groups of people who were aged 36 and above and group of people who were below 36, and between groups of people who were university graduates and non-university graduates.

10 Discussion

Two major factors, user satisfaction and perceived usefulness, were found to be significant in affecting the continued usage of the business and management e-learning course. Hence, the developer of the e-learning course should be assured that the users are satisfied with the solution and with relevant and useful information in the course. The user satisfaction is positively related to the perceived ease of use of the system, information quality and system quality but negatively related to service quality and perceived usefulness. If the respondent needs more technical service from the companies, it will lower the satisfaction for using the e-learning course. Hence, the corporation should ensure that the e-learning courses are easy to operate, with relevant information and can be downloaded smoothly by ensuring a stable network flow. In addition, a prompt response to the technical enquiry was also needed.

Interestingly, if the user has a high-perceived usefulness of the e-learning course, they may be dissatisfied. It may be because of the limitation of the content that may not be truly interactive like a normal classroom. Based on adult learning theory, respondents expect to have more immediate feedback on their interaction with other participants in the classroom rather than using e-learning course for self-study.

According to this research, enjoyment is a key construct that affects the perceived usefulness and perceived ease of use. It reinforces the importance of the psychological factor in learning.

The proposed model is quite robust as it is not affected by different collection periods (first collection batch vs last collection batch) and sample (calibrated vs validation). It is interesting to know that the model is not affected by gender (male vs female), position (manager vs non-manager), and computer usage experience (10 years or more vs less than 10 years). However, the model is different between groups of different age (aged 36 and above vs below 36) and educational level (university graduates vs non-university graduates). It shows there may be some difference in the model when respondents are of different education level and of different age group. However, the present analysis tool cannot state where the difference is.

11 Conclusion

This is a first attempt to explore the factors that influence the continued usage of a business e-learning course in Hong Kong Corporations. The proposed model has a moderate explanatory power for the continued usage (R^2=37%). The model fitted well with the data and has a high degree of validity and reliability.

Enjoyment will affect the perceived usefulness and the perceived ease of use of the e-learning courses. The perceived usefulness, perceived ease of use, system quality, information quality and service quality can enhance the user satisfaction on using the e-learning course. Assured of the user satisfaction and the perceived usefulness of the courses, respondents will continue to use the e-learning courses.

12 Limitation of this research

This research is a cross-sectional research. It would be more beneficial to observe the change of the user expectation, thus the subsequent change of the user satisfaction and the continued usage, say within a year. It is commonly accepted that the user's expectation would change afterward. It will certainly lower the satisfaction level and the usage pattern. Future research can put more emphasis on the integration of the human factor interaction and social influence on the continual usage of the system.

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Knowledge Details in Web Forums: How High or Low above the Ground?

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Abstract. While entertainment web forums provide a dynamic medium for interaction, not many researchers feel the need to go deeply into the contents. One of the reasons behind this attitude lies on a widely perceived assumption that web forums do not deal with knowledge matter and have the inclination to take place only as small talk. In this paper, we will mainly inspect the components of knowledge as are being handled by the *six service-men* of Kipling's 5W1H framework. Based on our observation on a *learning zone* that contains 35 forum topics and 789 messages in a web forum (http://asamboi.org), we found that at least several topics were dealing with deep knowledge contents. From our analysis, we have found that the depth of knowledge details is reasonably significant particularly when responding to specific question demand. On average the depth of details obtained were ranked as 'Who' *Siapa*, 'What' *Apa*, 'How' *Bagaimana*, 'Why' *Kenapa*, 'Where' *Mana* and 'When' *Bila* once sorted descendingly. We conclude that web forums are a good web-resource for digital age learning styles as it provides detailed knowledge for networked learning.

1 Introduction

Web forums serve as a means for discussions and exchanging of ideas in a positive environment, but the degree of knowledge content involved is viewed as near to the ground. This situation often leads to the assumption that web forums are full of less useful discourse where the only significant thing is its insignificance.

Based on www.e-keluarga.com, branded as the *Family Information Media* in Malaysian cyberspace, Asamboi.org is positioned first on its ranking [1]. This result

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was possibly due to the high poll of web users who admired Asamboi.org very much (well-known *Entertainment Community* web forum). However, from our point of view it is important to assess the web forum's discourse contents relative to the depth of its information and not based on its popularity. Based on Kipling's 5W1H, our attempt is to analyze knowledge details by exploratory gauging of the presence of specific information appearing in such discourse.

2 Kipling Method, the 5W1H Framework Utilization & Interpretation in the Malay Language

Various frameworks are under study to create a set of standard data categories that can be used for the analysis and description of knowledge. In the area of discourse analysis, intensive studies are going under the umbrella of the International Standards Organization (ISO) Technical Committee 37 (TC37), Sub-Committee 4 (SC4) [2]. Work under the Thematic Domain Group 3 (TDG3) of ISO/TC37/SC4 on "Semantic Content Representation" is expected to produce a useful set of data categories for description of discourse relations, dialogue acts, referential structures and links. These studies, however, are still under development and not available yet.

In this article, we adopt the widely known 5W1H framework for this purpose. 5W1H is also known as the Kipling Method from its originator, the Nobel Laureate of Literature in 1906, Rudyard Kipling [3]. This 5W1H framework deals with six keywords that are also known as the *six service-men*; 'who', 'what', 'where', 'when', 'why' and 'how'. To understand the meaning of 5W1H in the Malay language, in Table 1, the interpretations are presented very briefly with its literal meaning and example.

Table 1. 5W1H Interpretation

English	Malay	Example
Who	Siapa	*Orang itu siapa?* similar to 'who is that person?'
What	Apa	*Apa yang awak makan?* similar to 'what do you eat?'
Where	Mana	*Mana awak mahu pergi?* similar to 'where do you want to go?'
When	Bila	*Bila perlu saya pergi?* similar to 'when should I go?'
Why	Kenapa	*Kenapa awak perlu belajar?* similar to 'why do you need to study?'
How	Bagaimana	*Bagaimana perkara itu terjadi?* Similar to 'how did it happen?'

The major advantage of this approach is its ease of application. Even for a simplistic approach, the notion of question expressions are accepted as sophisticated classes of questions, especially when involving how, why and what-if [4] as this requires complicated rules for semantic content analysis. Specifically, its capacity to facilitate the understanding of details in written text or spoken dialogue has proved significant in applying this type of question expressions.

On the other hand, we also found that this framework could create a very lenient rule as it offers six keywords that can easily be attached to any possible words in order to create question expressions. The tendency to create very general types of questions meant for one specific topic is also high. We believe that this is the limitation of the approach since it leads to very open-ended non-specific discussions. To avoid this, we must make sure that the relation between the topic of discussions and its answers must be taken into account. Hence, our challenge is to investigate whether these messages contain clearly stated and objective knowledge that leads to a meaningful discourse.

3 Knowledge Details Analysis

Our study is focused on one Forum Zone, so-called *Zon Pembelajaran* or Learning Zone, that contains 35 forum topics and holds a total number of 789 messages (as of 05/01/2005, 1530hrs). This is part of the content for Asamboi.org, an *entertainment community web forum* in Malaysian cyberspace (http://asamboi.org).

Here is an explanation of the weighting method that was used for analysis. As the points are of *nominal* type for all six variables of 5W1H, some messages may hold answers to more than one specific question type. For example, in Message 1, this phrase is answering a *'bagaimana'* or 'how' question. Here the underlined words represent the answers for the question, and an answer occurs three times. Because the analysis looks for the presence of at least one answer, then assigning '1' as a presence is more suitable, rather than allotting '3' for it.

Message 1: *masukkan Cd lepas tu restart pc... tp pastikan boot priority letak cdrom as first boot device*
(put in CD and restart PC... But make sure the boot priority is set to cdrom as first boot device)

As for Message 2 below, the underlined words are only a suggestion that means 'first try'. These words are not providing answers to 5W1H together with the rest of the words in this message.

Message 2: *try dulu .. kalau per per nanti tanyer a saya pon dah lama tak buat tanyer kekawan yang biase buat*
(First try.. if have anything ask it's been a long time I didn't do it ask other friends that normally do it)

4 Analysis & Results

From our analysis, we simplify the results by tabulating the relevant information in Table 2. However, to comply with the maximum page requirement for this paper, only four of 35 forum topics are shown here. The full forum topics and scores can be found at http://gii.nagaokaut.ac.jp/~zaidi/IFIPTable2.htm

Forum topic number one relates to the selection of higher-level learning entry points, such as universities, polytechnics, colleges and others. 'Who' and 'what' are found to have relatively higher scores compared to the rest. Here, most messages have both elements and this phenomenon occurred since some discussions have messages that not only answer the question of 'what' but also need to have 'who' as a function to back-up their suggestion. Here most messages include their friends' or their own experiences, which are set down together similar to story telling. Story telling is accepted as a practical technique for knowledge disclosure, communication and cultural intervention as stated here [5]. As the topic also discusses their preferred destination, timing and specific reason after they have completed their studies in schools, details for 'where', 'when' and 'why' also have relatively higher percentage.

Table 2. Forum Messages and Depth of Details

No	Forum Topic Title*[i]	No of messages	Details Type & Percentage (%)					
			Who	What	Where	When	Why	How
1	universiti,politeknik, kolej dan lain2?	26	77	73	65	46	46	35
2	Berbaloi ke study kat OVERSEA?	41	41	15	20	10	61	39
3	mata pelajaran seks di sekolah....	62	48	23	11	5	32	58
4	Betul ke orang yang gi kelas tambahan nie pemalas ?	32	59	34	25	0	78	16

**Titles were taken as it is from http://asamboi.org*

Topic number two concerns the matter of whether it is worth studying overseas. The initiator started the forum by exposing the issue of extremely high expenses for studying abroad compared to locally, as well as the fact that graduates received almost similar income during recruitment. Most messages include explanations of why it is better to go abroad and why it is good to stay in the country. Hence, the responses were mostly on the 'why' for the matter concerned, and here the score is found to be 61%.

A forum topic entitled *'mata pelajaran sex di sekolah'* or 'sex subjects in school' has the depth of details 'how'. It is interesting to see that the discussion started as merely asking for comments on the pros and cons of having sex education in schools. However, more than half of the total messages include 'how' and towards the end of the messages, the forum members decided to compile their suggestions and submit it to the education office (yet the results of this action are not stated anywhere in the forum). Here, the 'how' in implementing sex education includes how to create a proper name for the subject so that students will feel at ease when learning it, and suggesting the role of parents (or close family members) to deal with this specific education topic.

The fourth topic is about whether people who go for extra classes are lazy. Debate on the 'why' element covered more than 75% of the dialogues. The main rationale is because most forum members are against the statement of the message initiator at the first place. In most of the messages, the reasons why students go to supplementary classes are given (laziness is not a factor why people go for extra classes) and it is frequently opposing to the forum title.

From this brief explanation, all *six service-men* (5W1H) played an important role in 4 forum topics even with diverse scores. Every topic has its own distinctive demand on different *service-men* and this has shown that all *six men* serve a useful function. On average, 'who' took the biggest portion of work (53%) carried out for these 161 messages, and the smallest was 'when' (12%). The highest-percentage working *service-men* (who) occurred possibly because of referencing stories to any person (generally known or unknown by them, such as a real person's name). Specifically for this study, it was infrequent to get the lowest-percentage working *service-men* (when) to work more because not many topics have strong concern to it.

5 Conclusions

Web Forum discussions organized better than normal oral conversations viewed from the knowledge description framework, probably because non face-to-face conversation requires more explicit statement of background knowledge. On the other hand, such transfer of knowledge is very much influenced by the very friendly interactions among forum members.

A big advantage of a web forum compared to oral discussion is the fact that it can provide link information. Through this, participants can learn from a vast pool of knowledge by participating in the forum. It does not require going to a library or referring to dictionary pages. Assessing the effectiveness of disseminating knowledge via web forums is a point to look at in the future and could be one exciting challenge.

In this paper, we have gained understanding for recognizing the discourse properties of messages using the 5W1H approach. This has provided an answer to the question in the title of this paper.

Although the issues discussed in this paper center on the Malay language, still it has demonstrated the importance of building a knowledge extraction and analysis system. Our next step will be developing an agent that will carry out knowledge detail analysis and assessment using Natural Language Processing (NLP). This agent will be developed specifically for accessing web forum environments accordingly to their knowledge depth.

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[ii] 1. University, polytechnic, college and others; 2. Is it worth studying at overseas?; 3. Sex subjects in school; 4. Is it true, people who go to extra classes are lazy?

Partial Distance-Learning Training for Information Technology Higher Education Trainers

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Abstract. Teachers must be able to adapt to a rapidly changing IT knowledge and technology. This requirement is further compounded by the need that this knowledge and technology be incorporated in the curriculum at the same rate. This paper presents a strategic approach for updating curriculum and technical know-how of information technology through training the IT trainers. This approach is expected to help modernize the IT training in the developing country by educating the youth who are at the receiving end of this training. In order to ensure the economic feasibility of this approach, teaching methods conducted were based on a combination of traditional methods and modern distance learning techniques.

1 Introduction

Sustaining economic development is one of the main concerns of any developing nation. Years ago, labor and land were focal points of a healthy economy. They were dominating for many years, but since natural and energy resources were discovered; energy resources became the identity of a wealthy economic system. The technological development in the twentieth century lead many nations to change toward establishing an economic system based on knowledge and information; hence the birth of knowledge-based economy. Knowledge-based economy started to overtake both physical-based and energy-based economies. The reason for that shift is that knowledge is a never-ending source, whereas, natural and energy resources are limited [1].

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This paper elaborates on an attempt to establish a foundation of knowledge-based economy in Oman and to encourage formation of essential ingredients to achieve United Nations Millennium Development Goals (MDGs) that require cooperation with the private and public sectors to make available the benefits of new technologies, especially information and communications technologies [2]. To achieve this goal, the team working in this project has targeted information technology higher education trainers for training using a partial distance teaching approach [3]. Distance learning is defined as the type of learning for which the instructor and the student are separated by either time or place or both, whereas, traditional learning requires the availability of both students and teachers in the same room at the same time [4].

2 Distance learning

Through distance learning, universities are able to accept a larger number of students to register in a course and to optimize the use of resources that would normally be required for conventional teaching techniques [5]. Distance learning can be convenient for students with disabilities [6]. There are different types of distance learning such as: mail course, web-based instruction, or video and/or audio tapes [7].

2.1 Benefits of distance learning

Distance learning is an effective approach since communication between people all around the world is possible due to all the technologies available. Distance learning can be beneficial in terms of quantity and quality, budget saving, flexibility, convenience, and support [8-10].

Distance learning also helps the students to be more organized and build their abilities to engage in long-life learning, which is very critical not only for students, but for teachers as well [8-10].

2.2 Challenges to distance learning

Although distance learning has become an attractive approach, the drop rate of distance learning students is higher than traditional classroom students. This high drop rate is due to the lack of motivation and self-discipline for some students enrolled in distance learning programs. However, there are still many challenges that affect the growth of distance learning approaches, such as course materials, scalability, exam monitoring, and labs [6, 10, 11].

3 Strategic plan for IT dissemination

Some statistical results showed that the penetration level of internet usage in the Oman population is around 10.2% [12]. This percentage indicates that the level of internet knowledge among Omani people is not widely spread. In order to achieve a massive expansion in the use of information technology by all components of the society, a strategic plan was identified and developed to train a segment of the population that is in a front position to transfer this know-how to others. Information technology instructors in different training departments of various private and public institutions were identified as potential members of the population segment to be trained as IT trainers for Oman.

4 Skill survey

The potential trainers, consisting of 80 teachers, were surveyed to know their web, computer hardware, and networking skills. Based on these surveys, the team identified the weaknesses that needed to be addressed and what was required to structure a curriculum to retrain them. Since most of the trainers' teachers had the same weaknesses, then even teachers of the teachers required retraining in order to guarantee the same level of standards for the future teachers.

4.1 Web skills know-how survey

The web skills survey was not restricted to web browsing only; it also included the ability of the trainees to design web pages using Microsoft FrontPage or any HTML editor. Many web site designers use programs such as Flash or GIF to add attractive features to their web pages. Since this project aims to train the trainers, it is very important to know their levels using Microsoft Power Point.

4.2 Computer skills know-how survey

The Internet has actually materialized mainly because of the invention of computers. Therefore, the knowledge level of the teachers was surveyed to evaluate their computer skills. The survey conducted has shown the abilities of trainees in computer assembly, operating systems installation and troubleshooting, hardware troubleshooting, and configuring Internet connections.

4.3 Networking skills know-how survey

The survey conducted shows the trainees' level in network design, network background theory, implementation, and troubleshooting. Figure 1 summaries the statistics obtained for these surveys.

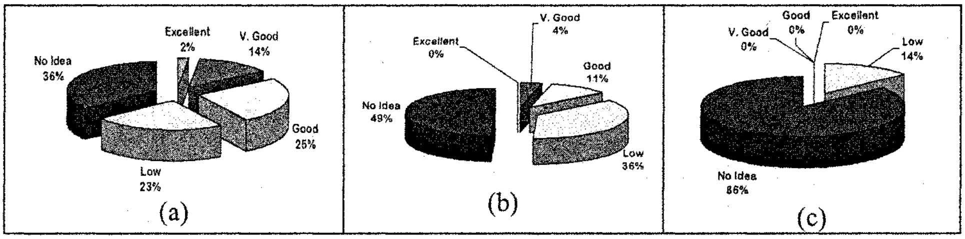

Figure 4. (a) Statistics of web skills know-how survey (b) Statistics of computer skills know-how survey (c) Statistics of networking skills know-how survey [3].

Analyzing the statistics obtained in these surveys shows that at least 60% of the teachers have a little or no web skills, computer skills, or networking skills. Possible reasons for these high percentages are the rapid changes in technology, teachers' adaptation with the internet, and their education background. However, when it comes to network design the percentage doesn't appear to be surprising, because out of the whole world's population only 14.6 % knows how to **USE** the internet, which means that the percentage of people who know how to design a network is below 14.6% [12].

5 IT training and results

An IT training plan was developed by the team that covers the weaknesses surveyed. This plan consists of:

1) **CISCO HP IT Essentials (part I) Program Curriculum** will be followed in the first part of the project. This curriculum is based on distance learning. It contains online material that helps the trainee in his/her study. Some animations are used in clarifying some of the online material (to know more about the curriculum see [13]).
2) **An IT syllabus developed by the team members,** which will be followed in the second stage of the project. It is based on traditional teaching. The syllabus will contain an introduction to networking, presentation methods, and multimedia &web-based techniques.

This training program covers the weaknesses surveyed and it tends to raise the ICT level of the participants. Teachers who didn't have enough ability in any of the skills surveyed have a good understanding now that they have participated in this program that required them to do several tests/exams to guarantee that they have benefited from these courses.

This plan took into account that the trainers after finishing this curriculum will deliver what they learned to other teachers and students. This will guarantee the dissemination of IT throughout the country.

6 Conclusion

It is anticipated that a successful completion of this project will stimulate extensive use of information technology in all areas of the national economy, including industry, education, trade and services. The team undertaking this project is interacting with the Ministries of Education and Higher Education to ensure compatibility of aims and benefits of information technology to the country.

It is the belief of the team working in this project that this work offers efficient and cost-effective means to disseminate ICT know-how in the Sultanate of Oman. It also works towards ensuring gender equality in ICT.

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Collaboration Model in E-Learning for Universities Based on Agents

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Abstract. The paper presents the basic requirements that must cover distance education processes ("e-learning") in universities. We show the concepts of instruction design, an adaptive learning model for evaluating necessities, accreditation, and quality proposal. The experience indicates that to obtain good results we should evaluate the differences between the criteria of the professor and the criteria of the student about: the educative aspects, the user reaction (in each perspective), the reading aspects (in the student) and complementary material. Thus, collaboration and quality are managed when the learning process is based on design, the designer, the professor, participation level, student profile and his characteristics, the motivations and evaluations. We will need continuous reflection and evaluation for the organizations and the structured learning programs, having looked for educative yield and productive development. The paper is our contribution to work with ethical issues and human collaboration for the information society

1 Introduction

"Depend on the binomial education/communication conception; it will be the use of tools in education and teaching. There are two ways to understand them and to assume this couple: the directional and vertical, and another one that considers the pupil such as a subject of a process in which student is learning with others. Firstly,

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the use of means will reproduce the one direction and the impossibility of logic relation. Secondly, that use will be made in a space whose protagonists are true interlocutors." [5] The university plays a decisive role in the development of citizens and modern societies, as measured by the levels of social, cultural and economic development, active citizenship and ethical values. In addition universities must have policies that guarantee commonality in both contents and programs in order to obtain permanent learning as a basis for the continuation of learning all through life. The alternative of remote classes (virtual formation or e-learning), efficient tools and the improvement of the quality appear like fluid experiences through the web, but we are looking them in permanent ways. We define e-learning, electronic learning, as technological solutions that integrate software and hardware to promote the acquisition and operation of knowledge, abilities, skills, capacities and collaboration between the users. This is an approach to a new way of collaboration for distance necessities in order to evaluate the contents and the design of learning programs.

2 Instruction design

In 1985, Gagne [4] distinguished two types of conditions, internal and external. The internal ones include attention, motivation and memory. The external ones are factors that surround their behavior, including the environment and the time of the events that affect the stimulus. The instruction design includes a sequence of nine educational events and their processes of learning [4].

The instruction design must include: (1) Analyze requirements, (2) Select means, and (3) Design the educational events. The educational technologist must have present the following concepts to develop instruction methods: (1) the abilities at the beginning and each new learned ability that will be constructed based on previous abilities, (2) the analysis phase must identify and describe abilities and knowledge for an educational objective, (3) the objectives of the last level are dominated before a higher level, (4) the objectives must be written in concrete terms of the behavior, and (5) positive reinforcement is repeated. The recommended steps are given in [4].

In the traditional model of the university we work to protect ideas, investigations and experimentations that lead to us to create knowledge. Remote education allows new value added for the society: (1) some people cannot mobilize themselves for work, (2) some people are marginalized by physical and corporal problems, (3) those that look for education in other countries, and (4) those that cannot pay the cost of actual education.

3 Model of programs "e-learning"

The Mind-Mapping for Web Instruction and Learning [3] is based on three components: (1) Object of learning, (2) Strategies of learning, and (3) Design of outlooks for learning. They help in the processes of learning such as personal abilities, declaratory knowledge, and problem solution, among others. For each learning process we identify an appropriate strategy and construct the groups that represent associated events.

The authors notice that great capacity of collaboration between the students must exist to introduce them into the object of course development. Nevertheless the collaboration does not appear as an important part in the structure of design, and the model does not consider the student as a process center.

4 Learning process in virtual education or “e-learning”

In the definition of e-leaning shown in section 1, the student must be included as the center of process learning, and the human collaboration as the fundamental support for the awaited success. "The Virtual University term would have to include a systemic concept" [7], where it is possible to capture knowledge, research, develop projects, supply society solutions, participate in forums, diverse problems, specialized events, scientific events, cultural events, etc. The first problem is human contact necessity; people need to be in contact with other people, to share with them their activities, which means to share their problems, hopes, and solutions.

5 Adapted model of IEEE platform

We must assure the quality level of actual education, eliminating the possibilities that students pass through nonexistent instruction in an e-learning program. Risks and desertions always exist. We must promote a new type of student, one making more effort, and who will have to change from a passive receiver to a constructive asset in the learning process. A designer must identify significant profiles of students, such as age, language, knowledge, learning strategy preferred, time available, motivation, experience, etc. Motivation is provided by the professor when he observes deficiencies, negligence or poor points in a student and then explains to the student that he must make an additional effort and how he must do so. Perhaps this does not happen in e-learning the way we know it, but we will have to take care to identify these situations. Adapting the IEEE model about "Learning Technology Support Architecture System Components" (LTSASC) we included two processes: we can call reload capacity in (1) collaborative work process and the formation of student communities; (2) a process of educative networks, where human and social activities are integrated (see Figure 1).

We must count with measured mechanisms and evaluation of results, and then be able to support increasing demand without losing quality [1]. We know that similar learning technologies do not have similar predictable results. Their effects are determined by the decisions that people in charge take from the educative policies, and these decisions are in many cases determined by the paradigm model of a university, that implicitly or explicitly has the political people in charge.

6 Proposal of agents

Figure 1 shows the proposal for the new processes:

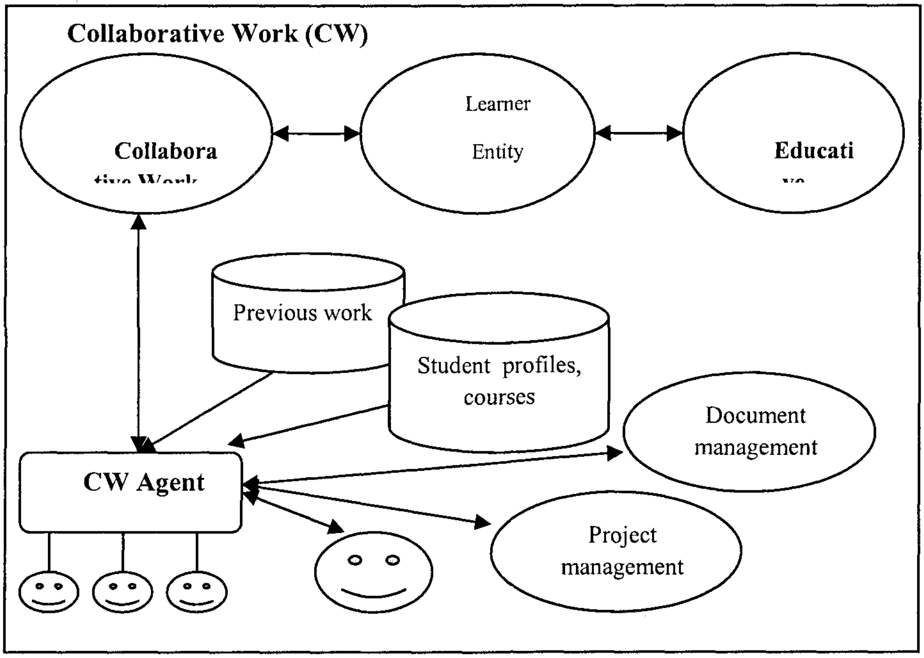

Figure 1. Proposal of agents for collaborative work.

The collaborative work agent model will be designed to capture useful information referred to: (1) formation of groups, with the knowledge of student profiles. They have obtained previous works and valued a balance between the proposed selection. This selection will have to be stored for future projects; (2) the agent will manage digital documents constructed with the support of algorithms that tell if a document has been opened by the student and to which page the student has advanced in their reading, and then how much time he has dedicated to each page. With these elements we will be able to obtain advance indicators and to analyze strategy types to recommend to the students; and (3) project management: it is possible projects repeat themselves, and the agent evaluates the validity of projects with previous considerations proposed by the tutors, as the content, goals and the scene of application that corresponds to the project viability.

A similar model is proposed for the agents for the Network of Educative Collaboration (human and social). The Educative Networks are social networks. The agents have different roles to fulfill related to the human side of students. It is necessary to prepare the design with moral and ethical components, and there is a reason for making a deeper analysis in order to decide if we can allow different types of behaviors of the students so that they trust. At the moment the design will be open to receive communications and to propose interactions with students for friendship subjects, culture, sports, entertainment, and social aid, among others, where the values will be to distinguish and to capture them, like affection and satisfaction that they give and receive from their environment.

7 Conclusions

Our approach is that the student can learn to identify moral, ethical and human questions that definitively always have been in learning. We looked for the center of the learning process in the students, and human collaboration with its surroundings, to construct learning examples in different disciplines that can be reused and be improved, to promote collaboration among students. The learning atmospheres must adapt their behavior to students, motivating collaborative work and the construction of social activity networks. For each process we must explore social and cultural interchanges, new ways of collaboration, in freedom and with ethical responsibility. The systems also must provide intelligence for facilitating and managing the learning activities of students, the collaboration among students, and the interactions among students, teachers and the learning objects Too much of the work we have to do is related to confronting the social demands about education in the university, and among them we must improve the quality and ethics issues in order to educate students in ways to confront the future successfully in future generations.

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Engineering Modular Web-based Education Systems to Support EML Units of Learning

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Abstract. Educational Modeling Languages (EMLs) have been proposed to support the modeling of units of learning enabling the description of different pedagogical approaches. Eventually, such models are intended to support the operation of appropriate computer systems, controlling and managing the corresponding units of learning. This paper considers EMLs involving a set of independent perspectives. Our purpose is to use this set of perspectives to facilitate the development of Web-based education systems that are able to support the execution of EML models. As a result, we obtain a modular architecture where different pedagogical approaches can be supported.

1 Introduction

Educational Modeling languages (EMLs) [3] were proposed to support the learning design (modeling) of units of learning. The main idea underlying these specifications is not to constrain the educational design by focusing on a certain class of instruction or pedagogical approach. Following this principle, the IMS *Learning Design* (LD) Specification [2] was proposed as a new e-learning standard. Eventually, the models of units of learning will be processed by appropriate computational systems to provide the intended educational experiences. As a result, EMLs offer a promising view for the future development of web-based educational systems, as they enable the separation of pedagogical and technological concerns: educational authors (e.g. teachers) could focus on the modeling of units of learning, while technology developers (e.g. software engineers, programmers) could centre on the provision of computer applications.

This paper proposes a component-based architecture for web-based education systems that support the execution of a particular kind of EML model. Our proposal

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involves a meta-model based on a separation of concerns approach, to support the design of units of learning in a set of more or less independent perspectives.

2 Perspectives in educational processes

To deal with the complexity of the whole modeling of units of learning, we propose to decompose this problem into a number of partial models, each one focusing on a certain issue, namely perspectives. A perspective is defined as a feature that involves a certain purpose and that can be analyzed independently. The first perspectives identified in educational processes are provided by the answers to the questions *who?*, *what?*, and *when?*: (i) *organizational perspective* (who are the participants (learners and staff) involved in each activity? What roles do they play? How are they organized?); (ii) *functional perspective* (What are the goals to be achieved in each activity? What are the participants intended to do? Do they create documents? Do they transfer information to other participants?); (iii) *process perspective* (When are activities intended to be attained? In which order are tasks sequenced?). Each perspective is concerned with a concrete feature. Following this approach we have identified twelve perspectives. Six of them have been directly taken from the workflow domain: *functional, process, information, operational, organizational* and *resource.* In addition, six more perspectives have been considered to support collaborative and educational process modeling: *causal, temporal, authorization, interaction, awareness* and *manual intervention.* To obtain a more complete description of the perspectives see [1].

3 The architecture

In this section we present the main features of a component-based architecture for the development of adaptive web-based education systems that support such a meta-model. The proposed architecture (c.f. Figure 1) is composed of three main blocks following a typical three-tier scheme: a *Web Engine*, an *EML Execution Engine* and a *Web Client.* In addition, there is a *Setup and Administration* function devoted to the management of the educational resources and the instantiation of the elements.

3.1 The web engine

The *Web Engine* plays the role of the back-end tier, providing backup and supporting functionalities. More specifically:

- The *Data Base* provides a persistence service maintaining administrative information such as the name, password and profile of each participant (e.g. preferences, portfolio data), the documents and contents managed by the participants, information about the active units of learning and their models, properties and variables, etc.
- The *Security Manager* provides temporal authentication certificates to the participants to enable their access to the available applications. This service is

required to control the access of participants only to the applications and resources assigned to the instance of the unit of learning they are performing, and not to the applications of other instances.

- The *Rule Manager* provides Event-Condition-Action (ECA) rules management to support dependencies in the perspectives. This provides basic event functionality enabling event propagation, filtering, processing, etc.

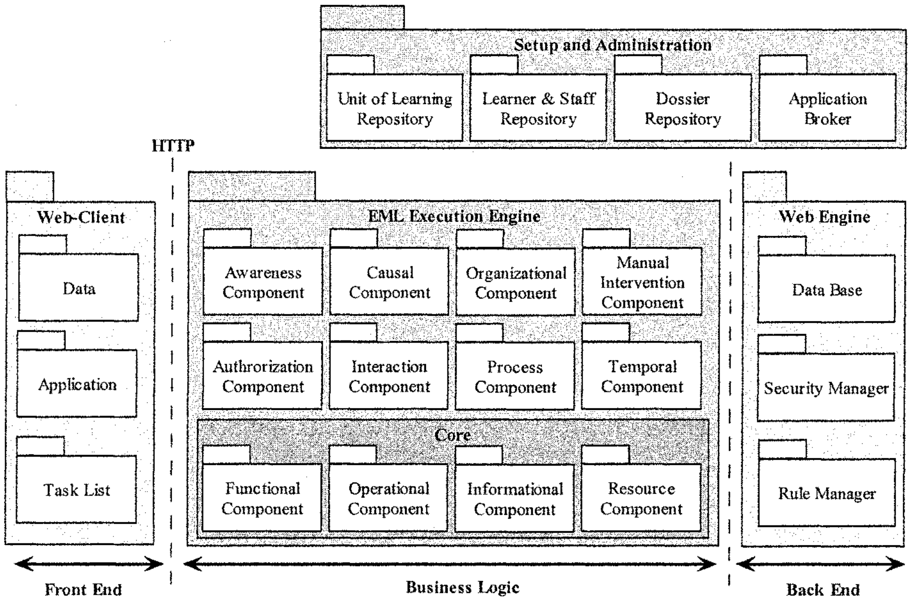

Figure 1. Main components of the proposed architecture

3.2 The EML execution engine

The *EML execution engine* is the logic-tier responsible for managing the educational practices accordingly to the learning designs (education models). This engine determines the activities that can be performed by each participant, the tools and resources available in each activity environment, the conditions to use such tools and interact with other participants, etc. All this management and control functionality is considered in separate components in accordance with the perspectives identified.

The proposed architecture considers a core set of components and several extension components. At the core of the architecture several components provide basic educational functionality in accordance with a set of perspectives required to enable a minimum support. Additional components implement features concerned with specific perspectives that are not strictly required for a basic functionality. This design localizes the changes required to tailor a web-based educational system to the component that implements it. Additionally, the same perspective may be supported by different components providing different degrees of support. For example, the

Process Perspective involves several categories of control flow, ranging from basic to advanced control structures. A system may be upgraded by replacing a component at a basic level by another component with more comprehensive support.

The core. The engine architecture adopts a minimalist approach. At the core of the system, four separate components allow instructional designers to define and execute educational practices modeled in accordance with a basic set of perspectives, required to provide minimum support:

- The *Functional Component* provides the basic mechanism to support and control the execution of activities. This is the main component of the architecture, as it maintains the execution state of educational practices and interacts with other components to support functionalities managed in the corresponding perspectives.
- The *Resource Component* is concerned with the assignment and management of the participant or participants responsible for their achievement of the activity.
- *The Informational Component* is devoted to provide and manage the data and artifacts to be used in the activity.
- The *Operational Component* is intended to manage the integration of external applications and services. It enables participants to access the applications and services that may be used in educational activities.

The extensions. These components provide the functionalities identified in the other perspectives that are not strictly required in some educational practices:

- The *Authorization Component* is concerned with the permissions (e.g. authorizations, prohibitions, obligations, dispensations) that are assigned to participants to use or access resources, applications, etc.
- The *Interaction Component* is devoted to the management of the interaction between participants and services in communications and collaborations.
- The *Process Component* is used to control the order in which the activities may be accessed by participants. Activities are initiated by the *Functional Component* but the order in which they are proposed may be controlled by this component.
- The *Temporal Component* manages the time dependencies that affect the enabling of activities. For example, controlling that a group of activities are initiated at the same time.
- The *Awareness Component* provides information about the status of running educational processes. This component separates *how* the system tracks the execution from *what* it does with this information. In this way, educational designers can add awareness specifications only when their educational practice needs this functionality.
- The *Causal Component* provides information about the purpose and features of the educational practice. It is descriptive information such as meta-data, learning goals, pre-requisites, etc.
- The *Organizational Component* enables the support of groups, the arrangement of participants, the maintenance of data about participants, etc. Its main purpose is to maintain information that may be used by other components.
- The *Manual Intervention Component* allows authorized users to make decisions on the modeling of the unit of learning while it is being executed. This component provides the mechanisms for stopping, rewinding and resuming running processes, etc. In effect, it is devoted to support dynamic and emergent behavior.

3.3 The web client

The *Web Client* provides the front-tier where the participant interacts with the system. This interface is controlled by the *EML Execution Engine* (through the *Functional Component*) to present the available activities, tools and information. We have identified the following sections in the *Web Client*:

- A *Task List* is required to present the activities that are proposed to the participant. Task lists may present different representations (e.g. a dynamic tree, a list), purpose (e.g. pending tasks, performed tasks), etc.
- The *Data* section provides an appropriate environment to support data access and operation by participants. During an educational practice different kinds of data or information (e.g. personal properties, variables) may be used by participants that gain access to them through this section
- The *Application* section is concerned with the rendering and control of the applications used during educational practices in the activity environment.

4 Conclusions

This paper presents a component-based architecture for the development of web-based education systems. The architecture presents a component-based approach based in the separation of modeling concerns or perspectives. This approach has several advantages over traditional web-based educational systems. First, its simplicity makes it easier to understand the system. Second, each component encapsulates a design decision. This facilitates the customizing or replacing of individual components. For example, developers can extend the process component. Thirdly, it is possible to add advanced features by adding new components.

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Gesture Friendly Interfaces for Classroom Teaching with Thinking Tools

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Abstract. Thinking tools are typically designed for students working on their own computers. When used from the front of a classroom, the complex graphical user interfaces of these tools can interfere with an instructor's ability to lecture effectively and to use natural gestures. A thinking tool for the grade 9 mathematics topic of "relationships" has been developed with a more gesture-friendly interface. This gesture-friendly interface allows a teacher to focus more on interacting with students, creating engaging visualizations, and using natural hand and arm gestures as part of the lecture.

1 Introduction

The design of thinking tools has primarily been done from the perspective of the student. Designers have considered many issues such as determining what would help a student learn the material and how the student would want to interact with the new concepts. Although this student perspective is clearly important, it has largely occluded another important set of issues connected with the teacher perspective. A tool that is designed for individual students to use on their own computers may not be suitable for a teacher to use from the front of a classroom.

From the student's perspective, it is important for thinking tools to have an interactive component. To engage the student and to encourage independent inquiry, a student must be able to interact with and receive feedback from the tool. A

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common form of feedback is to see how a change in one model effects changes in another model [1]. For example, a tool may try to exploit a student's intuitive understanding of a physical model such as riding an escalator to help develop the student's understanding of an abstract mathematical concept such as a line equation. By being able to change a variable in one representation (e.g. height), the student will be able to see the effects in the other representation (e.g. y-coordinate).

From the teacher's perspective, an interface that allows rich student interactions will likely be quite difficult to use from the front of a classroom. In fact, a design goal for a thinking tool is to fully engage a (student) user in its operation and interactions. In a classroom environment that has a wall-sized screen and an instructor's PC located in a discreet corner of the room, the concentration required to manipulate the fine interface controls of the tool can absorb so much of the teacher's focus that they become detached from the classroom screen and their students. This disconnect can negatively affect the attentiveness of the students and the clarity of the teacher's presentation.

When presenting new material or making the first demonstration of the tool to the students it can be useful to focus the students' attention onto one aspect of the tool at a time. For example, a teacher may first want to demonstrate how the height of a passenger riding an escalator changes with time, and then demonstrate how the y-coordinate of a line equation changes with time. To identify one of two objects in normal, face-to-face conversations, people will often point [3]. However, if the teacher's hands and visual attention are fully engaged in operating the tool, he/she will be unable to point and to convey ideas through gestures. Without the ability to use gestures, speakers often compensate by using more complex descriptions [3].

Complex descriptions can imply complex concepts, so it may not be highly effective to use existing thinking tools as classroom teaching tools. A gesture-friendly interface (GFI) provides a "classroom mode" in which the control of a key visual component of the thinking tool is bound to a simple action such as pressing the space bar. With a GFI, a teacher can more easily focus on the students and use a free arm to perform natural gestures during a classroom presentation.

2 Background

Gesture-friendly interfaces are primarily intended for thinking tools which provide students with a significant opportunity for interaction and self-inquiry. As dynamic, interactive components, thinking tools are a critical component of learning objects that have been successful for more complex mathematical concepts [2][11]. A recommended design element for thinking tools is to have multiple representations with "dyna-linking" [1] so that each model moves in tandem regardless of which model is being manipulated. By interacting with these models, a student can, for example, use intuitive knowledge of a physical model to build a deeper understanding of the underlying abstract mathematical model.

From this research on design, there is also a growing awareness that "a prescriptive taxonomy and framework" [11, p158] is required to help match education objectives with the most suitable information visualization technique. For example, extensions to MathWorlds [10] include physical movements because "kinesthetic explorations directly involve bodily understanding" [10, p17].

However, one of the interface components of MathWorlds uses button clicks to step through a time sequence – a gesture that few people will make with their hands when they are thinking or talking about events through time.

Physical ideas (such as movement) are actually embodied in abstract mathematical concepts through the use of fictive motion [7]. Subsequently, language alone cannot independently capture all of the dynamic aspects of some mathematical ideas. When directly interacting with the computer, the idea of fictive motion implies that click-and-drag sliders may be more effective than button clicks to "move" (a dynamic concept) down a number line (a static concept).

Using sliders and other more engaging interface components will not necessarily add any benefits to a classroom presentation. Students will neither perform the motion nor see it being performed, so they may miss key elements of the knowledge objectification process that were not communicated aurally by the teacher [9]. Further, the manipulation of sliders takes more concentration than the clicking of buttons, so the teacher's classroom lecture can suffer an additional distraction due to this design decision that primarily considers student usage.

If a teacher loses the ability to use gestures, he/she may have other cognitive functions impeded such as speech production [4], or at the least, will likely have to compensate with more complex descriptions of concepts that would normally be conveyed by gesture [3]. These side effects caused by the loss of gesture can negatively affect a teacher's ability to present the material, a student's absorption of the material, and a teacher's interest in using thinking tools. Overall, teachers are still most comfortable with technologies that facilitate "face-to-face whole class teaching" [8]. The goal of gesture-friendly interfaces is to take existing educational tools and make them more suitable for classroom teaching.

3 Thinking tool design

For the topic of "relationships" in the Ontario curriculum for mathematics [6], a learning object has been designed around the situation of choosing a cell phone plan. In this example, there are three available cell phone plans that can each have different fixed monthly service charges (i.e. y-intercept) and per minute rates (i.e. slope). The thinking tool embedded in the learning object allows students to analyze the effects of changing the monthly service charges, the per minute rates, and the minutes used (see Figure 1). These real-world components have been selected to match the key (abstract) concepts of intercepts, slopes, and line intersections.

The developed thinking tool uses dyna-linking [1] to connect the graphical and mathematical representations of the concept. With this linking, students can examine how changes to the (more abstract) line equations can affect the visually more concrete lines on the graph, and vice-versa. For example, clicking and dragging the left end-point of a line on the graph will simultaneously change the y-intercept in the corresponding line equation. Also, increasing or decreasing the slope in a line equation will simultaneously "rotate" the corresponding line on the graph. These linked, interactive components can help build a student's intuition on the concepts that connect the two representations.

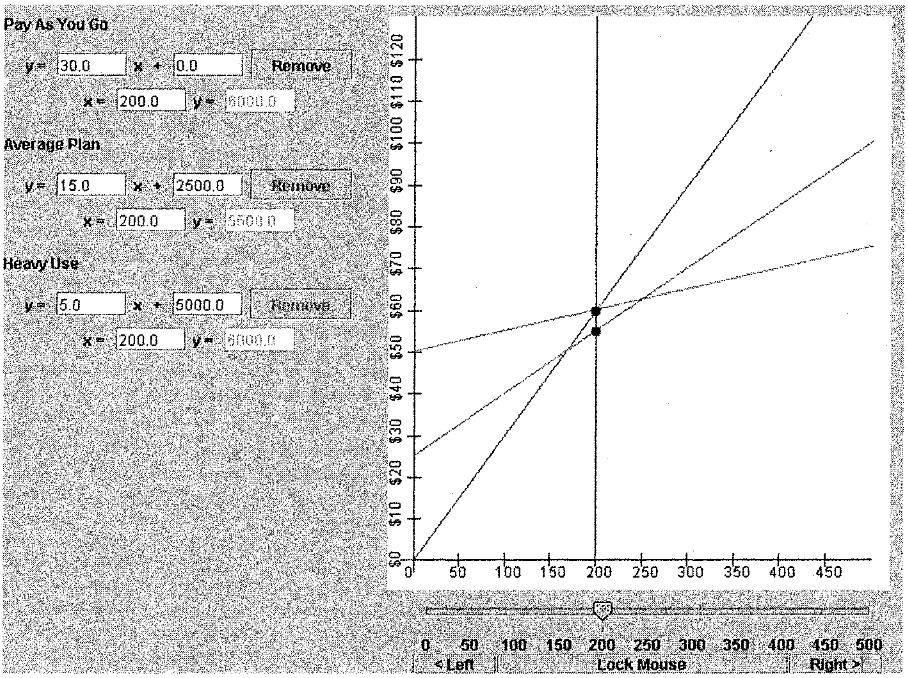

Figure 5. To activate the thinking tool's "classroom mode", the instructor can press the "Lock Mouse" button. When activated, the gesture-friendly interface allows left-button and right-button mouse clicks (on the graph) to increase or decrease the number of minutes to the next multiple of 50 minutes, or to the next line intersection if it is less than 50 minutes away.

4 Gesture-friendly interface design

To develop a GFI, the key feature of a classroom presentation must be determined. With the cell phone plans, a practical question that students will be familiar with is to determine which is the best plan (i.e. least expensive). The answer to this question depends on the number of minutes, and by varying the minutes, a teacher can show how different plans can be better for different amounts of usage. It can then be shown that the best plan changes at a line intersection, and that the location of line intersections depends on the monthly service charges (y-intercepts) and per minute rates (slopes) of the cell phone plans (graphical lines and line equations).

A classroom presentation of the above material requires that the number of minutes can be easily varied by the teacher. If the teacher is using the slider, then his/her attention will be on his/her own PC's screen, and it will be difficult to point out the key features that the students should observe on the classroom screen. To make the developed thinking tool more suitable for classroom presentations, the interface component of left and right mouse button clicks is used because it is more gesture friendly than the standard GUI slider. Specifically, it is much easier to simultaneously click a button with one hand and gesture with the other hand than it is to click and drag and gesture at the same time. With a GFI, a teacher should be able to incorporate gestures into the lecture more easily, and this will enable them to interact with the classroom screen and the students more naturally and effectively.

5 Summary

It is important to acknowledge that many teachers are more comfortable (and more effective) with face-to-face whole class teaching [8]. Face-to-face whole class teaching benefits from multi-modal forms of communication such as strong visualizations, physical embodiment of ideas, and dynamic interaction. To facilitate these modes of communication, educational technologies require easier control interfaces that are designed for classroom use. Gesture-friendly interfaces are a low-cost and technically trivial solution to this problem that can be supported by the existing technical infrastructure in a typical (Ontario) classroom.

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National Qualification Systems Integration using Ontologies

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Abstract. This work presents the use of ontologies as a way to tackle the problem of integration of qualification systems in order to enable the transparency and mobility of students at European level. For this, qualification systems at post-secondary non-academic levels of nine EU countries have been formalized in terms of profile, activities, competences, learning outcomes, etc., first using UML for a human-readable model and then using OWL for a machine-processable one. In addition, concrete qualification profiles have been used as a case study to check the models' correctness.

1 Introduction

The transparency of qualifications and mobility of students among countries has turned out to be a relevant topic in recent years, especially in the European context. In fact the European Union has several initiatives in this sense: the program Socrates--Erasmus and European Credit Transfer System (E.C.T.S) [6], plus a set of laws and treaties devoted to the promotion of the equity with the increase of education and training in order to make, no later than 2010, the European Society of Knowledge become the most competitive in the world.

For its success, first it should be investigated how transparency, comparability, transferability and recognition of competences and/or qualifications can be carried out between different countries and at different levels. In order to enable this transparency in terms of competency recognition, it is required first to provide integration among the underlying information systems that manage the information on each school, organization and country.

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There exists a semantic heterogeneity problem across the different national qualification systems. The connection capable of actually guaranteeing the transparency and mobility of professional qualifications strictly relies on the availability of a formal representation of the underlying models and their structure in terms of competences, formative units, learning outcomes, etc. This would allow the promotion of mutual understanding of these systems at EU level, the possibility to make comparisons and establish analogies among their concepts, and finally to enable the interoperation of such national systems.

The main scope of this work is the use of ontologies to provide *Common Access to the Information* regarding the qualification systems of nine European countries, namely France, Germany, Greece, Ireland, Italy, Netherlands, Romania, Slovakia and Spain. The considered systems regard the Vocational Education and Training (VET) area at the post-secondary non-academic level.

1.1 The Maastricht Treaty

The VET process, known as the Bruges-Copenhagen process (Copenhagen Declaration of 2002 [1]), refers to the Maastricht Treaty. The process of Bruges-Copenhagen foresees the increase of education and training in order to promote the European Society of Knowledge. A significant starting point is represented by the following declaration, born inside a debate of the technical group for credit transfer. *"Investigating how transparency, comparability, transferability and recognition of competences and/or qualifications, between different countries and at different levels, could be promoted by developing reference levels, common principles for certification, and common measures, including a credit transfer system for vocational education and training".*

The *citizen student's mobility* is now done mostly in higher education (H.E.), while in vocational educational training (VET) it is more a declaration of intents than a praxis. The VET student has enjoyed support for mobility just in the specific case of the internship abroad, while during the transit among educational institutions (especially for what concerns acceptance to a University) rules for the equipollence of qualifications are applied (Convention of Paris - 11 December 1953 [7]). European Universities, for what concerns the European program Socrates – Erasmus, faced the problem and found a possible solution by building an instrument that can be functional for that goal: a credit system called European Credit Transfer System (E.C.T.S). The efficacy of this system is demonstrated by its widespread application that, since 1997, has involved a large number of students and more than 1.200 European academic organizations, becoming an important point for the innovation of didactics in European university education, which is still very nonhomogeneous.

The necessity of building a similar system for VET led to the definition of the European Credit System for VET (E.C.V.E.T.)[8], which is able to support students' and workers' mobility. It is a first step towards learners' mobility, but still not enough as it only enables recognition in terms of workload and courses taken abroad by students but does not explain how these foreign courses fit in the local national system and whether they map (partially or totally) to the national professional profiles and their programmes in order to recognize the equipollences. Therefore, technologies that truly enable the integration of VET systems at a more fine-grained level (e.g., in terms of objectives, competences, content) are required.

1.2 Ontologies as a way for providing interoperation

According to Gruber, ontology can be defined as "*A Formal Explicit Specification of a Shared Conceptualization*" [2]. It is a new tool intended more as a new way of modelling rather than a new technology, but that can provide unexpected possibilities of applications, in terms of integration and inter-operation. In our case the specific benefits from ontology use are: 1) Sharing common understanding of the qualification systems (at the VET level), their structure and information (knowledge base); 2) Enabling reuse of VET knowledge as systems evolve and need to be adaptable and easily integrable with other systems; 3) Making explicit the assumptions on each national VET system and thus making it easier for a newer person to understand them; 4) Promoting the consistency and lack of ambiguity within each national VET system; and 5) Enabling interoperability among the different systems through their formalization, allowing easy finding of similar concepts and the establishment of equivalences among their constructs.

2 Construction methodology

2.1 Initial document gathering & UML formalization

This first step involved collecting and analyzing all the relevant information looking towards the future construction of a corresponding visual diagram model for each national VET system [3]. This involved gathering at different levels from each country:

- *The national educational system.* An overview of the general educational system of the country, specifying the different stages and paths that can be followed by the learner. This provides an idea on how the national VET system is positioned within the national context as a whole.
- *The post-secondary non-academic education.* Overview of the post-secondary non-academic system as a whole, detailing the different types of schools within this educational level. The information was required to better understand the different alternatives at this stage for then choosing a specific one.
- *The post-secondary non-academic education system analyzed for the project.* Detailed description of the particular VET system chosen to be modeled among the different alternatives at the post-secondary non-academic level of each country.
- *The profile's constitutive parts and description of concepts.* Detailed information on the professional profile and curriculum structure within the VET alternative chosen.

The Unified Modelling Language (UML) [4], a well-known formal graphical representation, was selected for the models' construction, representing all the conceptual elements identified within each VET system. It was considered crucial to provide a human-readable and intuitive way of model specification, as most of the partners involved in the work were not familiar with systems modelling. Thus, dedicated graphical models for France, Germany, Greece, Ireland, Italy, Netherlands, Romania, Slovakia and Spain have been designed. A full description of each of these can be obtained from [3].

2.2 Template construction & case study compilation

The second step involved the construction of the proper set of forms (templates in MS-Word) for the UML models for each country. The scope in constructing this template per model was twofold; 1) to check the UML diagram's correctness through the template, especially considering that not many of the partners involved were familiar with the UML language and its formalities, and 2) to collect specific case studies (concrete vocational profiles) used to check and support the formal model's correctness (forms and UML diagrams) and to provide a common knowledge base useful for simulating interoperability and transparency of qualifications.

Therefore it was considered opportune to develop a form representing the formal model, but now in a more familiar format for all the partners. In other words, the form actually presents a tabular format of the UML diagram it corresponds to. In this way it was easy for the rest of the partners to understand the modeling and check, through the form, its correctness. Of course this activity was carried out in several iterations. The forms were referred to as knowledge base templates, and they present the same core elements identified within the UML diagrams.

The step of case study compilation could also leverage possible inconsistencies in the models not detected up to now. In fact partners could easily make their concrete profiles or curriculums (cases of study) fit in the corresponding template form and in cases of difficulties check if the inconsistency was due to a form (and therefore model) problem or was because of a study case described not following the reference documentation (official norms, decrees, etc.).

The next step was the migration of this paper-format knowledge base to a form more useful for computer programs, which is explained in the following sections.

2.3 Ontology construction

This step involved the construction of the ontologies using as starting point the UML models produced as a first formalization for each of the ten VET systems. By using the Ontology Web Language (OWL) as the language for describing the ontologies and the Protégé tool for carrying out this process, all the necessary conditions were met. OWL is a new language for the Semantic Web, developed by the World Wide Web Consortium (W3C). Protégé is the most popular tool for ontology construction and was developed by Stanford's Medical Informatics Section [5].

Building an ontology with OWL involves the definition of three specific elements: Classes, Properties and Individuals. While the classes and their properties form a model in a machine-understandable format, the individuals correspond to the instances or data described by that model. For each national model, the OWL classes and properties were taken from the corresponding UML model or form structure. The instances, however, were taken from the forms content, that is, the cases of study. Finally, a next step is the definition and formalization of a meta-language to allow the mapping or translation among the different models in order to enable the comparison of curriculums under different national systems.

3 Conclusions

This work presents the use of ontologies as a way to tackle the problem of integration of qualification systems not in terms of workload (as credit systems do) but at a semantic level (e.g. content and competence contrast). The qualification systems of nine EU countries have been considered, all of them at the post-secondary non-academic level (VET). Key elements have been the use of UML as a visual aid for the models, and template forms to ensure the understanding of the models and their correctness.

The formalized models allow a clear and unambiguous understanding of the qualification systems analyzed, enabling mutual understanding and the comparison of the elements of such systems. Concrete qualification profiles have been used as study cases to check the correctness of each of the obtained models.

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Research on Open Source Software Intended to Promote its Usage in Education

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Abstract. The paper deals with the use of open source software in education. Open source software is used more and more all over the world. Linux, Mozilla, MySQL, OpenOffice.org etc. are very well-known packages. A lot of open source programs are developed especially for educational purposes: virtual learning environments, editors, simulators, microworlds, subject-based learning applications, etc. The main problem of this field is to involve educators and policy makers to disseminate effectively information about open source, and to bring students and teachers together for improving open code. The investigations on open source are being fulfilled in a few Lithuanian institutions. The main objectives are to validate the economic and pedagogical utility of open source software in schools.

1 Introduction

The vision of the open source community is to produce better software than the traditional closed model, in which only a very few programmers can see the source and everybody else must blindly use an opaque block of bits. "The basic idea behind open source is very simple: When programmers can read, redistribute, and modify the source code for a piece of software, the software evolves. People improve it, people adapt it, people fix bugs. And this can happen at a speed that, if one is used to the slow pace of conventional software development, seems astonishing" is declared in an open source initiative site [8].

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The main feature of open source software lies in the possibility to use the code of program applications. Besides this open source provides the following possibilities [1]: a) to use the software in a desirable way, b) to adapt the software to one's needs, to explore it, to correct the detected bugs, and to improve its functionality, and c) to distribute the software [5, 6].

Open source software is very important in education: 1) the license is free and can be used in all institutions without restrictions, 2) the license does not restrict anyone from making use of the program in a specific field of endeavour, 3) applications may be improved, adapted, localized, etc. faster and easier, generally without long negotiation procedures, and 4) open source is real stuff for investigation and analyses of code for novice programmers and everyone else who wants to improve in building software.

The problem of the use of illegal software and piracy is experienced to a varying degree by all countries in the world. Countries try to find different solutions to the problem according to their financial capabilities, cultural and intellectual awareness of people, and traditions and methods of dissemination of information [3]. Using open source software is one of the most straightforward and effective methods to combat the use of illegal software.

Open source software not only helps in tackling the problem of illegal use of software but also has a more powerful mission: it allows the modification of program code, quick correction of detected bugs and uniting the efforts of a number of programmers.

Open source software may be quickly localised without any negotiation obstacles. However the degree of open source software internationalization is lower than that of commercial software, and the translations of a lot of open source software that is published on the internet are incomplete and, sometimes, just in the initial stage of translation [4, 7].

2 The Lithuanian study on open source

Lithuanian state policy has a quite positive approach to open source software: various workshops and seminars are being held, appropriate resolutions that recommend implementation of open documents (based on open standards) are being adopted, and different initiatives on open source are being sponsored. A study on open source [9] was done to evaluate how the ideas of open source reach schools and how teachers and pupils use open source software in practice. The scope of the study allowed focusing on more specific research, *i.e.,* the analysis of open source software used in education.

The goal of the study Open Source in Education was to analyse the situation of open source software in Lithuania as well as in other European countries: how open source software is used in education, what are the main projects and initiatives, and how open source applications are adapted, localised and supported.

Basically the study of open source software was carried out in two directions: 1) analysis of articles, documentation and collection of different information related to open source software in education; and 2) a questionnaire survey was conducted in Lithuanian schools and the results were analysed, systemised and described.

The survey of schools regarding open source software was based on the research approach with the entire predefined model of work and empirical research [2].

The following objectives were formulated in order to reach the goal: 1) to analyse scientific, methodological and information sources on open source software and to discuss their theoretical aspects, 2) to investigate the methods of development, localisation and distribution in the European Union and other countries, 3) to analyse the development of open source software in educational systems of various countries, 4) to carry out the survey (questionnaire survey) in Lithuanian secondary schools regarding open source software, and 5) to describe the economic and educational benefits of open source software and to develop recommendations.

The population chosen for the study was composed of all secondary schools (511) and gymnasia (92) in Lithuania. A simple random sample of 23 gymnasia and 31 secondary schools was selected for the survey. The population studied in the students' research was composed of all twelfth grade students of these schools. The two-level cluster sample plan was used: the systematic sample plan was used individually in every twelfth grade class where every fifth student was selected from the class-list starting with the second student on the list.

3 Open source software in secondary schools

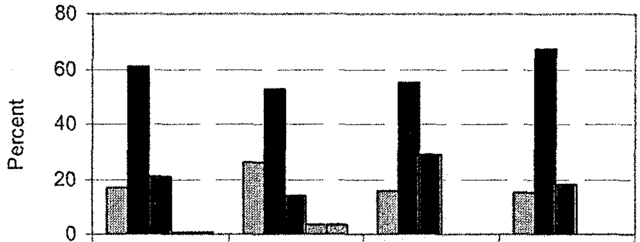
On average Lithuanian comprehensive schools and gymnasia have 24 computers each. Results of the study imply that the best situation regarding the number of available computers was in gymnasia (approx. 35 computers each) and the worst one was in rural secondary schools (approx. 20 computers each). All schools have access to the internet, and 41% of Lithuanian schools have their own servers. Nearly 40% of these schools use the Linux operating system.

One pack of OpenOffice.org (containing a CD with the documentation) was appropriated for each school and provided for each Board of Education. However the OpenOffice.org suite was installed in approximately 2 school computers.

The survey has shown that even 29% of secondary schools in cities introduce just the Microsoft Office packs, although both the curricula and the textbooks constantly refer to open source applications OpenOffice.org and Mozilla as well. A total of 61% of all schools just briefly discuss the open source programs and use only the Microsoft applications (Figure 1) (Secondary C – Secondary schools in cities, Secondary D – Secondary schools in districts).

The choice of open source applications is mostly prompted by the need to introduce alternative software to students; this answer was chosen by 69% of school teachers. The other important reason for the use of open source software lies upon the fact that it is free of charge; consequently schools may save money on licenses (56%). The other reasons were less important.

Even 85% of teachers think that the spread of open source software is considerably insufficient. As the main reason for this, teachers suggest the lack of literature on working with open source software (this answer was chosen by 52% of teachers), the lack of information on open source software (37%), the conviction that some problems may occur during exchange of data with Microsoft users (40%), and the lack of time to practice open source software (39%).



	All schools	Gymnasiums	Secondary C	Secondary D
1 ans.	16.82	25.87	15.66	14.90
2 ans.	60.99	52.93	55.07	67.00
3 ans.	21.09	14.02	29.27	18.10
4 ans.	0.55	3.59	0.00	0.00
5 ans.	0.55	3.59	0.00	0.00

Figure 1. Do you introduce both commercial and open source software to students? Yes, we introduce both types of the software (*1 ans*). Partially yes: we briefly discuss open source, though we use just Microsoft software (*2 ans*). No, we introduce just Microsoft software (*3 ans*). No, we introduce just open source software (*4 ans*). Other (*5 ans*).

In 2005–2006 the optional programming exam based on using the Free Pascal environment in secondary schools is scheduled. At the moment Turbo Pascal or Borland Pascal is being often used in schools. The research indicates that in schools that employ advanced teachers of information technology and computer specialists-engineers the FPK compiler is widely used (67%), while schools in cities and districts use the FPK compiler much less, respectively 33% and 28%.

According to the answers it may be assumed that the issues of software legality are being quite widely discussed in schools. Besides this, it appears that schools also quite fairly know the organizations promoting open source programs; 65% of all respondents do believe that the open source movement will develop in the future.

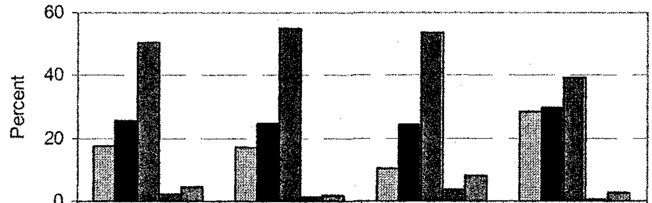
Schools are much more interested in stable and properly localized open source programs than in every localization version that may be of lower quality. Additionally, schools are very interested in printed manuals for software.

4 Students attitudes towards open source software

According to the study, 44% of all students have never heard about open source software, although their textbooks contain appropriate information. Most students become aware of open source programs from their friends (31%) and teachers (27%) and 9% have found open source software on the internet. According to students (70%), the most attractive feature of such applications is that they are free of charge and may be legally used. Other features were less attractive: possibility to improve them (18%), user-friendly environment (21%), and better virus resistance (12%).

Students, like teachers, would prefer stable and localized open source software (77%). Differently from teachers, students are equally friendly to both types of open source software's dissemination: via the internet (38%) and with printed description (32%). Nevertheless students from gymnasia prefer the internet (51%). Almost all students are equally interested in localization of open source software.

Most students (67%) have no open source software on their computers. Just the OpenOffice.org suite is somewhat more interesting to them (19%), but 43% have friends and acquaintances who use open source software. Most (64%) stated that open source programs are used too little during the classes because of the lack of appropriate information; 50% of the students responded that they get acquainted just with Microsoft office suite during the classes (Figure 2).



	All schools	Gymnasiums	Secondary C	Secondary D
1 ans.	17,39	16,94	10,54	28,29
2 ans.	25,78	24,60	24,22	29,73
3 ans.	50,35	55,16	53,52	39,12
4 ans.	2,03	1,44	3,69	0,33
5 ans.	4,44	1,86	8,03	2,53

Figure 2. Do you get acquainted both Microsoft and open source programs OpenOffice.org and Mozilla during the classes? Yes, teacher introduces both types of software (*1 ans*). Partially yes: we briefly discuss open source, though we use just Microsoft software (*2 ans*). No, we get acquainted just with Microsoft software (*3 ans*), No, we get acquainted just with open source software (*4 ans*). Other (*5 ans*).

5 Conclusions

Considering the situation related to the use of open source software, and bearing in mind the results of the study on matters related to open source software in schools of Lithuania, the guidelines for improving the existing situation were elaborated:

(a) The development of open source software in the country reduces the prices of commercial software and gives impetus for the translation of software into the local language. It is necessary to take care of cultural and linguistic quality of open source software, and this matter should not be entirely left to the enthusiasts.

(b) The promotion and support for open source software should help solve the problem of the legality of software. Since open source software does not have to be bought, the funds saved can be better invested into the improvement, adaptation and maintenance of open source software.

(c) Officially drawn up documents or other information must be available both for users of commercial and open source software so that the users of open source software have the same opportunities as others. Documents and internet services must be provided according to open source formats.

(d) As many as 20 different versions of Linux that are adapted to teaching have been developed in various countries, and they are used in individual countries or their groups. It should be required to analyse them and determine which one would be appropriate to be localised and used in schools.

(f) Students should be introduced to general purpose software of both types: commercial software necessary for teaching and learning as well as to equivalent open source software. When examinations on information technologies are prepared for general education schools, it is necessary to provide the possibility to use general purpose software of both types: commercial software and open source software.

(g) To ensure that schools receive open source software of good quality, it is necessary to implement quality assurance measures (testing, reviewing in terms of functionality, language, design, etc.) at all stages of software development from selection thorough to testing of localised software.

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Use of Morphisms as a Tool to Help Learning Object Oriented Concepts

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Abstract. Software design implies searching for and establishing an adequate morphism between the real world and the desired software. Morphisms establish correspondences between different domains while some properties are preserved, at the same time. It allows seeing different things as the same, taking the substitute image for the real one. The more adjusted to reality the morphism is, the better the system models the real situation. We propose the use of morphisms as a pedagogical tool in order to teach object-oriented concepts and also to promote better software design. We developed a course based on the explicit use of morphisms. Through experimentation, we compared the results with an equivalent course not using morphisms. From the results we may infer that using morphisms helps to develop strategies to analyze and to construct adequate software models.

1 Teaching and Learning Object Oriented Concepts

Education is no longer primarily the one-way transmission of information and knowledge [1]. Faculty must understand the different ways in which students learn, so they can adapt teaching styles to the learning style most effective for individual students, preparing students for a lifetime of learning [2]. Data or propositions, on one hand, and skills or procedures on the other, are taught in teaching systems. Those two learning ways are easily managed, weighed up and assessed [3]. However, as indicated by Pazos [4], students should be also prepared to synthesize, to set up and to contrast conjectures and to use their creativity.

Students should be taught how to think and act independently. This will allow them to gain more knowledge with increasing skill and dexterity [5]. Learning

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involves domain-specific and domain-transcending knowledge. The availability of prior knowledge is a crucial factor, but meta-cognitive knowledge such as task knowledge, self-knowledge and strategic knowledge is also important to the learning process [6]. As Papert indicates, when students enter a new knowledge domain, they usually encounter a multitude of new ideas [3]. Pazos [4], quoting Papert, refers to the concept of "powerful ideas". Among them, it is important to emphasize morphisms, "ductions" (deductions, inductions, retroductions and abductions) and recursion. Morphisms establish correspondences between different domains while preserving and enforcing some properties. Morphisms are more detailed and specific than the usual notion of abstraction. The use of morphisms allows seeing different things as the same, taking the substitute image for the real one.

In this work we propose the explicit use of morphisms as a tool to approach issues relative to the utility of powerful ideas, allowing an improvement in both quality and performance of the learning process. Particularly, we focused on the introductory programming course, Computer Science 1 (CS1) in order to enhance the opportunities for the students to become successful in learning design and programming and, therefore, obtaining adequate models and programs.

Teaching object-oriented (OO) problem-solving and programming has proved to be more difficult than expected [7]. Many students find the conceptual issues involved in OO programming hard to understand [8]. One of the major problems when teaching an introductory course in OO problem solving and programming is the lack of suitable and proved methods to teach OO concepts and programming [7]. Bruce stresses that there is still insufficient data to evaluate how effective are pedagogical tools (such as pedagogical IDEs, special libraries providing useful classes or microworlds) in introductory courses [9].

There are several approaches to teaching programming courses. Some of them are basically related to the course organization: lectures versus lab work, individual versus collaborative work [10] or objects from the very beginning with supplemental instruction [7]. Other approaches, are oriented to methodology, for instance the use of extreme programming practices [11,12], CRC-Cards [13] or software tools, such as simulation [8] or visualization tools [14]. Additionally, problem-solving strategies such as structuring, abstraction and formalisation, planning and revising, are important [13]. McCracken *et al.* observed that students often skip the early stages in the problem-solving process and concentrate on implementation activities, rather than activities such as planning, designing or testing [15].

As are Huet *et al.* [10], we are actively involved in trying to enhance the students' learning experience through reflection on teaching approach and trying new ideas to help students succeed. Use of morphisms as a tool might help to develop mental models and to give metacognitive support, as well as to promote planning activities and better software design.

2 Computer Science 1 and Morphisms

The course CS1 at Universidad ORT Uruguay introduces students to programming and to the paradigm of OO programming. Performance expectations are to identify, explain, and use classes and objects and to develop programs in an OO manner. The course applications are developed in Java. The summarised plan of CS1 is: weeks 1-3: variables, control structures and pseudocode; week 4: introduction to classes and objects; standard classes; weeks 5-8: creation of classes, aliases, relationships between classes; week 9: inheritance; weeks 10-12: collections, exceptions, sort and search; and weeks 13-15: advanced use of collections. Each week of the course includes 4 theory hours (60 minutes each) and 2 practice hours (in laboratory).

The usual CS1 course includes lectures/demonstrations and separate laboratory sessions. It is based on learning theoretical and practical content taught with a fundamentally descriptive strategy. Our proposal uses morphisms to enhance the students' learning. Our hypothesis was that learning with morphisms improves the learning by increasing students' ability to model and solve assigned problems.

In a morphisms-based course, the concepts about morphisms are introduced in the 8th week. After that, programming examples and exercises are solved by focusing on morphism concepts. In each example and exercise, the students analyze and propose a model. Then, each operation and representation is carefully studied. Using morphisms explicitly helps in elaborating specifications, as it requires determining which elements of the domain will match which elements of the model and which are the valid operations available. The gaps between the model and the real problem are detected and solutions are discussed. Practical examples include, for instance, modelling a temperature class, designing a system for house budget or representing withdrawals and deposits into a bank account.

In addition, other examples are presented to reinforce the idea. In week 11 the "JAM" [16] exercise is proposed with the intention that students discover the morphism themselves. This exercise is isomorphous to the well known game Tic-Tac-Toe. In the following weeks, additional work about morphisms is done. In each instance, an effort is made to establish relations with the original domain. For instance, the so-called "Year 2000 Date Problem" is analyzed, which provides an example of how a careful study of the behavior of operations in different domains should be a prerequisite in modelling and programming. In this case, a basic calendar operation, the "next day" operation behaves undesirably in the digital domain because of an inadequate representation.

3 Experimentation and Results

This section aims to document an empirical comparison carried out with two different teaching methodologies, namely, standard and morphisms-based. We wanted to assess if the morphisms-based methodology gave students better skills in software design than the standard theory-practice courses.

Two student groups took part in the experiment. Students were randomly distributed and they belonged to the same age group (18 to 20 years old). They began having no prior programming experience and not being currently employed. Group I (15 students) received the usual, standard course. Group II (16 students) received the same course plus theoretical material and exercises about morphisms. Solving strategies in Group II were based on morphisms. Each week, at least 20 minutes of a class were dedicated to these topics. Also, the strategy for solving problems was focused on detecting the morphism.

The use of morphisms hypothetically helps to develop a better model of a situation. The independent variable in our experiment is the morphisms training. The dependent variable, which indicates if the treatment had some effect, is the modelling capacity. This capacity is analysed in relation to: a) Model analysis: beginning with a given reality model, identify possible problems; b) Data representation for particular cases: analyse and define the representation of particular types of data; and c) Creation of a domains' model: representation of a domain, detecting principal classes and relationships as well as attributes and methods.

Two tests of three questions each were given to each student in each group, the first in week 8 and the second at course's end (week 15). In each test, one question was aimed to each referred point (a, b and c) in the preceding paragraph.

Both tests were graded using ordinal scales. Each question was graded from 0 to 6. The samples were then compared using the Mann-Whitney and the Sign test [17]. In the first question, according to the Sign test, an improvement of reality grasping was detected in Group II. Regarding the second question, groups were found different (Mann Whitney; $\alpha = 0.05, 0.10$) in the first test. When test scores were analysed, Group I had a high proportion (80%) of high level results (4, 5 or 6 points), while Group II only had 7 students in these conditions (43.75%). In the second test, however, no significant statistical differences were found between the groups; it may be inferred that training helped to develop skills for adequate data representation in Group II. For the third question, no differences were found in the first test, but in the second one Group II showed significant differences. 40% of Group I students got high values (4, 5 or 6), while 75% of the Group II students got similar results.

Therefore, from the Sign test and Mann-Whitney [17] test results, we may infer that using morphisms allowed an improvement of skills in modeling a given situation, helped to represent data accurately and contributed positively to develop skills for constructing a domain model.

4 Conclusion and Future Work

The use of morphisms is presented in this paper as a useful tool to help developing learning strategies for analyzing and constructing software models. Through experimentation, it was found that students who participated in the morphisms-based course obtained better results in topics related to modeling than students of the standard course. A new experiment will be carried out in 2006 in order to try to confirm that these results can be replicated. Also, as an additional element, a software system for promoting model related skills based on the explicit use of morphisms is being developed and will be used in future courses.

It is proposed that future investigations study, besides morphisms, the influence of ductions on learning. In this way, some conclusions might be drawn as to which of these two powerful ideas has a larger positive impact on learning, or whether both together interact, for instance in an additive or multiplicative way.

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Student's Approach to Linear Programming Modeling

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Abstract. Software design implies searching for and establishing an adequate morphism between the real world and the desired software. Morphisms establish correspondences between different domains while some properties are preserved, at the same time. It allows seeing different things as the same, taking the substitute image for the real one. The more adjusted to reality the morphism is, the better the system models the real situation. We propose the use of morphisms as a pedagogical tool in order to teach object-oriented concepts and also to promote better software design. We developed a course based on the explicit use of morphisms. Through experimentation, we compared the results with an equivalent course not using morphisms. From the results we may infer that using morphisms helps to develop strategies to analyze and to construct adequate software models.

1 Introduction

This study aims to understand how students acquire the ability to model linear programming (LP) problems. Our motivation is to improve LP teaching through the employment of better teaching methods and modeling languages.

Current studies on teaching methods denote a dissatisfaction with traditional operations research (OR) courses and propose multiple changes [9,10]. Murphy and Pachandam [7] studied experimentally the impact of teaching methods on the student's acquisition of modeling skills. Their schema earlier approach provides a framework to organize knowledge based on analogies and what is demonstrated to

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be the most effective method. Stevens and Palocsay [12] studied the difficulty of verbal problem solving and demonstrated that a translation approach consisting of successive phrase reformulations to formulate verbally a constraint improves the success of LP modeling.

Modeling languages have evolved through three stages: solver-oriented (such as MPS), analyst-oriented (such as AMPL), and visual (such as MGPL) [5]. Algebraic languages such as AMPL [2] are the most popular today. LP languages can be essentially different from the point of view of the quantity of work, ability and understanding required from the LP analyst [4]. Two criteria have been proposed to measure the analyst's effort: Murphy *et al.* [6] define *work intensiveness* as the amount of detailed work required from the analyst, and Geoffrion [3] declares *ease of use* as a required property of modeling tools.

The need for testing potential languages has been stated by several authors for a long time [5,7,8,11], but no such studies have been published to the best of our knowledge. The available knowledge about the modeling languages and teaching process is scarce in the area of LP modeling. Therefore, the goal of the quasi-experiment herein described is to test the criteria for measuring the effectiveness of a modeling process. We intentionally avoid experimental jargon to make this research more understandable to the readers.

Section 2 describes the results of evaluating the AMPL language, discussing briefly issues of modeling efficiency and style. The article finishes with conclusions and future work.

2 Experimental study

A characterization of the modeling process should describe how an analyst models a problem using a specific language. Comparative characterizations can improve the teaching process, and/or give feedback on how the language should be. Thus, the experimental study should respond to the following questions: How do participants perform and what are their major difficulties? How do participants model?

2.1 Did students learn LP modeling?

Fifty-six computer science students participated in the experiment, 50 male and six female, with an average age of 21 years. Their average cumulative grade has a mean of 59%. None of the students had previous LP training. The experiment began with training and continued with performance measurement in laboratory sessions. The training took four sessions. The teaching method was based on schema formation and analogical reasoning that is shown to be the most effective [7]. The most common problem types are included in the training: production, blending, transportation, assignment, and fixed costs treatment [2,13].

Training effectiveness was measured at the last session through a test that asks participants to identify the correct formulation of model parts in AMPL. Most students recognized the correct model but picked a syntactically wrong version over a syntactically correct one. It was expected that this problem would be overcome when working in front of a computer.

Afterwards, participants had 6 laboratory sessions. The first session introduced them to the use of a modeling environment, and the following ones measured their individual modeling performance for increasingly complex problems. Students did not receive any feedback on their work, so they developed their own quality control methods. The modeled problems belong to problem types covered in training and are adapted from well known textbooks [2,13] to be solvable in less than 1.5 hrs. The modeled problems will be hereafter be called "swimmers", "mining", "generators" (electrical), "forest" and "warehouse" and were presented in the same order as named here. Modeling performance is characterized by the following two aspects:

- **Quality**: closeness of the obtained model to the optimal model (rank: 0-100).
- **Solution**: indication of the fact that a solution can or can not be obtained from the model (rank: 0 or 1).

Students' performance in each laboratory varies from very bad to excellent (Table 1), but taking into account the increasing problem complexity, it can be said that students really learned LP modeling. Most participants developed acceptable models, but less than half of the students reached any solution except in one problem ("swimmers"), where 50% of the participants found a solution. The model quality is similar throughout all the laboratory sessions: there is no significant quality difference between them except for the "forest" problem, whose significantly lower model quality is probably due to its difficulty.

Table 2. Quality and solution rate

Variable	Swimmers	Mining	Generators	Forest	Warehouse
Quality mean (σ)	62.7 (28.2)	58.9 (16.8)	55.8 (15.1)	45.34 (8.1)	56.2 (24.8)
Solution (%)	50	33.9	30.4	21.4	30.4

Students had more difficulties defining constraints, then variables and objective functions. In fact, the difference between the students who reach a solution and those who could merely develop an acceptable model is explained by the ability to recognize those model components. This result is noteworthy because the problem statements actually make the component identification easy according to the instructors. Therefore, it seems that a solid algebraic background is necessary but not sufficient for effective learning of LP modeling.

2.2 How did students model?

The modeling style was studied by considering the number of iterations and executions and their relation with quality and solution. These two numbers were collected through a log file recorded for each laboratory session of each student.

- **Iterations**: number of model trials whether or not resulting in errors.
- **Executions**: number of model executions leading to a solution of the problem.

Students who reached a solution presented a high number of executions for all problems. The number of executions was alike across all laboratory sessions with the exception of the "forest" problem (Table 2). This difference can be explained by the comparatively bigger data volume of the "forest" problem. However, some students never passed the syntax revisions, which means that they never got to execute their models.

Table 3. Number of iterations and executions

Variable	Swimmers Mean (σ)	Mining Mean (σ)	Generators Mean (σ)	Forest Mean (σ)	Warehouse Mean (σ)
Iterations	19.7 (11.6)	17.2 (13.9)	17.0 (17.1)	8.7 (11.3)	12.2 (10.7)
Executions	6.1 (4.8)	5.2 (6.9)	6.9 (11.9)	3.3 (6.2)	3.9 (5.6)

Table 2 also indicates that students sustained a high number of iterations throughout the laboratory sessions. All students had syntax problems, but only some of them corrected their errors through trial-and-error; all other students were unable to solve the syntax problems or simply did not know how to model.

The higher the number of executions, the higher is the quality of the model and the achievement of the solution. Therefore, some students develop an iterative style that allows them to improve their models and reach a solution.

3 Conclusions

The presented experiment allows measuring different aspects of the modeling process. Its most important findings are:

- Most students develop acceptable models, but less than half of them reach any solution due to syntax and semantics errors.
- Syntax errors are not a minor issue in AMPL; students do not master the syntax.
- Students always use the trial-and-error approach to solve syntax and semantics errors, instead of using the syntax guide.
- Modeling is difficult for the students.

The teaching of LP modeling with algebraic languages can be improved by the findings of this experiment. The reinforcement of schema formation should improve the modeling skills and diminish the number of semantics errors, while the reinforcement of syntax or the creation of languages with better syntax should diminish the number of iterations. Both aspects lead to time savings and therefore should improve the models' quality.

This research established and tested objective factors to evaluate the effort required from LP analysts: model quality, solution, number of iterations and number of executions. The experiment findings are consistent with existing studies [7,12]. Clearly, the method needs to be tested with other languages, and ongoing work is evaluating a visual LP language [1] with the same treatment, enabling later comparison between both languages. Of course, the answer to the question of which language is better suited for an LP analyst requires further testing with other languages and other audiences.

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Web Teaching and Learning Programming Environment Based on Plan Method and Constructs

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Abstract. Plan integrations and misconception of programming language constructs have been two major errors of novice programmers. A good design model can have a great impact on the effectiveness of these systems. A plan is an abstraction that visually provides a solution to a problem or to a sub-problem representing a problem from its macro level down to its micro level. Any important concept is a plan and it is up to the educator and level of learner to decide a particular plan. A plan can be visually represented by a dot, a geometric shape or an image. The Web Visual Learning System (WVLS) divides the process of learning and its enforcement into three selectable phases known as plan observation, plan integration, and plan creation. WVLS initially provides a library of sample problems (plans) working with all three phases. A learner can observe the process of solving a problem, become involved in a partial solution, or solve the problem entirely from beginning to end. A mixture of learning strategies and techniques is incorporated in WVLS to satisfy a wide range of learners. WVLS will identify and report the cause of problems to the learner. A systematic approach to analysing a solution based on plan relationships indicates whether a plan is missing, misplaced, malformed, or has a misconception.

1 Web tools for a learning design

In the design of a learning system on the web, like any other web system, there are a number of tools available. With the current technology, learning a web tool should be as easy as learning word processing. A common available web tool could be Microsoft Office FrontPage or even Microsoft Word when a document is saved as a

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web page. Alternatively, a sophisticated learning system can be created using Dreamweaver and Flash from Macromedia company. WebPages created with FrontPage, Word, or any other web tool automatically generate HTML (Hyper Text Markup Language) tags which are the backbone of every webpage [4]. To view a webpage's HTML, one can right-click on the mouse to view the source. By viewing a sample source, it is possible to figure out some of the styles and approaches in the design of a learning system. While it is not necessary to learn HTML tags to build a learning system, learning (memorizing) the 10 most important commands of HTML makes up about 90 percent of all web page design [1].

By adding a little program, which is called a script, to HTML, it is possible to make the learning system powerful and innovative. Two known script languages are JavaScript and VBScript; most designers choose JavaScript over VBScript. While it is not necessary to become a programmer, with a little knowledge of common built-in script functions, one can make a better learning system. Many novice designers become frustrated and overwhelmed with the current web tools and surrounding technology. The same group has also enjoyed the learning and experience as a result. While some stayed with their own design, others ask professional designers to design the new learning system, with one difference that they were able to delegate the instruction and build a customized web learning system. An important lesson learned from the design a web learning system is to separate what is important and what is less important. Designers should focus on the major issues rather than getting involved in the jargon of instructions and details.

2 Problem, plan, visualization, and web

Breaking down a problem into smaller units, makes the problem easier to understand and easier to solve. Therefore, a plan to solve a problem is set aside and sub-plans are made for sub-problems. Once the plan is broken down into sub-plans, then each sub-plan can be tackled separately. To build a learning system one needs to identify the plans, explain the plans using a language that is easy to understand, and propose a plan solution.

Visualization plays an important role in illustrating the plan and sub-plan and their relationships. A plan is an abstraction that represents the solution to a problem, such as the entire solution or the smallest component that is crucial to solving a sub-problem. The plan abstraction applies information hiding so that the learner is not overwhelmed with information that is not necessary at the moment. WVLS is an environment that provides an incremental way of learning and problem solving, rather than requiring the problem to be solved all at once. WVLS assures the learner's capability and assesses the learner's problem at an early stage and grows as the learner grows.

Another example of an interactive web-based system is Environment for Learning to Program (ELP), which helps teaching programming to the novice by not having the need for a program development environment and installation of programming language. Using ELP, students use template exercises through the web to build their programming and problem solving skills [6].

2.1 Phase 1 of learning: Plan observation

By observing how a problem is solved step by step, the learner will be able to repeat the solution process over and over until it is understood. Plan observation enforces the retention of the plan and enables the learner to relate it to other similar situations. The WVLS plan observation phase is an automatic process that illustrates the steps involved in a task, starting with the initial specifications of the problem to its final solution. In the plan observation phase, the learner goes through the entire process of problem solving such as plan decomposition and plan integration and can repeat the process as many times as needed.

2.2 Phase 2 of learning: Plan integration

A problem's solution consists of several sub-plans that must be integrated correctly to form the final solution. After breaking down the plans, it is important for the learner to understand the relationship between the plans such as how these plans are put together and their spatial relationships. WVLS has four ways to integrate plans: an appended plan, an interleaved plan, a branched plan, or an embedded plan. Plan integration is a good test to ensure and examine the understanding of the solution of the problem at an abstract level, rather than its detailed steps.

2.3 Phase 3 of learning: Plan creation

In order to solve a problem entirely, a learner must start from problem specification and requirements to plan decomposition, plan integration, and finally testing the correctness of the plan and its explanation. The learner is responsible for creating a plan and demonstrating problem-solving skills. The problem could be one that already exists in the WVLS library, or it could be a new problem. If the problem exists in the system, there are three incremental learning scenarios: 1) full access 2) limited access 3) denied access.

When a learner requests to create a new plan that is not part of the system library, the entire WVLS will be at the service of the learner, including all phases. However, the new plan may consist of several sub-plans that already exist in the system and are shared by other plans. Shared sub-plans can be reused as they are or modified to suit the purpose. In order to assist the learner, WVLS will monitor and profile the learner as problem-solving steps are taking place. The system is intention based and will collect clues and make suggestions along the way.

3 VPCL: A WVLS for novice programmers

VPCL (Visual Plan Construct Language) is a tool for teaching beginner and novice programmers. Textual representation of programs and sub-programs (functions) contributes to misconceptions of how sub-programs interact with each other. Visual plan representation has resolved some of these problems. Plans are independent of programming functions. It is emphasized that a function is a plan, but a plan is not necessarily a function. Functions (sub-programs) have restraints on how they are used and how they interact with each other. A plan does not have these restrictions. Plans can either be dependent or independent of the programming language used. One task of VPCL is focused in terms of plans and sub-plans structurally, to build abstraction on each level and not overwhelm the learner. The idea of plan programming has been used in different ways as early as the mid eighties [5]. A novice programmer's support environment using plans can be created using hypertext to show the relationship between plans as well as breaking down the program to the smallest piece possible [3].

The plan creation phase of VPCL deals with writing actual programming code. In this phase, the user is given problem specifications and is required to develop all the steps to arrive at a solution. To translate a problem into a written program, several plans will be needed. These plans may exist and need to be modified or may be created from scratch. After all necessary plans are created, the plans must be integrated, and then the program is executed.

Several learning strategies and systematic ways of evaluating the learner's problem solving skills are incorporated in VPCL. The effectiveness of VPCL as a learning and instructional tool has been shown by the result of empirical studies on novice programmers [2].

4 Conclusion and future work

WVLS ensures the understanding of the subject matter by taking advantage of the web and visualization and using three incremental phases of learning. Different levels of abstraction are applied at each phase in order not to distract the learner from reaching the main goal. WVLS promotes a standard way to communicate by decomposing a plan, integrating plans, and investigating the cause of errors and building a new plan. The WVLS visualization and standardization bridges the gap of misconceptions. While WVLS has been tested on novice programmers, it is a generic environment that can be applied to other problem-solving disciplines. Future work on WVLS can be done to build an expert system in reporting errors, assisting the learner, and profiling the learner more accurately.

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Some Aspects of Application of Software Agents in Information Retrieval in Virtual–Based Educational Environments

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Abstract. The problem of information retrieval has attracted increasing attention in recent years. The amount of information sources via networks has grown and is still rapidly growing. Although existing search engines provide rapid retrieval systems, they give limited assistance to consumers in finding the relevant information they need. Intelligent software agents prove to be the necessary tool in improving the effectiveness and efficiency of retrieval. The paper presents concepts about software agents and discusses their advantages in optimizing the retrieval process. This study explores the application of software agents in information retrieval processes in web-based applications for online learning systems. The research was done at Technical University of Varna, and an interactive system new for Bulgaria is proposed..

1 Introduction

Internet technologies and software agents are becoming increasingly important in online learning systems [4]. Web-based training and the use of agents offer the opportunities to enhance traditional courses, encourage life-long learning and enable more people to join the learning society.

Software agents prove to be the necessary tool in improving the effectiveness and efficiency of retrieval in these systems. Software agents give much promise, especially their ability to improve and intensify collaboration amongst distributed systems. Agents collaborate in a dynamic environment and interact from different sources in Internet-based systems [6]. There must be a defined model for communication concerning all jointly-working agents. In order to standardize a

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model many proofs of its characteristics and suitability for different software agents are needed. This summary overview is directed specifically in the area of retrieval in web-based learning applications.

2 Goal of the observation

In this paper software agents find application in the retrieving process in virtual educational system. The search criteria are: number of times a keywords appears, proximity of the keywords to each other and proximity of the keywords to the beginning of the document. As with search engines on the web, online databases have problems with their retrieval mechanism, such as finding appropriate subject keywords, a large number of hits along with failure to reduce the retrieval sets, zero hits and failure to increase the retrieval sets, and failure to understand the cataloging rules. For locating matching terms and phrases, online retrieval systems are quite powerful. Processing enormous amounts of documents would be extremely costly, and therefore developing better search techniques provides a realistic solution to the existing problems.

Technical University of Varna is beginning to develop a package of software tools for supporting processes of development of such virtual environments for education. These tools also help agent construction for information retrieval.

This paper proposes a system based on software agents for improving information retrieval performance. The outlined objectives are:

- to develop a methodology for agent learning of user preferences in every user session. The agent will make its own base on the user's preferences and the information content of the queries and the documents.
- to integrate an information retrieval algorithm, a user preference algorithm, an existing search and an agent.

A great amount of work has gone into the modeling of agents but currently available techniques are not so perfect as to produce human-like interactions on a very high level.

There are three basic concepts for building agents [9]. The first approach in building agents consists of making the agent an integrated part of the end program. Its advantage is that the user trusts the agent because the rules are determined. The problem here is with the competence. The agent must be employed effectively by the user, so the user must have enough knowledge. In the second approach, "knowledge-based", the agent has extensive domain-specific information about the application. Here, again competence is a problem because this approach has big requirements on the knowledge of the engineer.

3 Procedures and methodology

The goal of the present research is using this approach to create a methodology for agent learning. During the tests of the investigation at the start, the agent is equipped with a basic knowledge background and later on it passes through an "educational" process while working for the user.

The procedures of learning require "rehearsal" actions from the agent. So, the use of the application includes cyclic and reiterative steps leading to repetitive behavior. These regularities are potentially different for different users.

With every experience the agent gradually develops its abilities within the actions of the user or among users. The learning approach adopted allows the agent to explain its behavior in a way with which the user is familiar, namely in terms of past situations similar to the current situation..

During the investigation the learning approach proved its advantages over the above mentioned two approaches. It doesn't require a lot of work from the end-user and application developer. The agent adaptation to the user can be done more easily. So this approach facilitates and helps in transferring information and know-how among the different users of a community.

The system allows total monitoring of the teaching and learning process. The instruments make possible views of the syllabuses, study schedules, academic calendar and other useful information for teachers and students. Also there are a library and a search tool. Organized forums give possibility for discussions. Teachers have at their disposal modules for creating courses and tests. The advantage is the acceptation of different formats in which the course material is produced. The system works also in an intranet.

4 Results and discussion

The main results from the application of agents in retrieving processes in the online learning system can be described in the following aspects:

- All students use an agent for searching information databases on the web for new information of relevance. The agent is educated by feeding with new keywords. This results in an ever-changing library of articles of interest to students of the field, which the students can access also after having left the university;
- Agents working through the students' web-browsers are also implemented. They work in several ways. Some are based on searching the Internet through, e.g., Google, and found documents are marked as "of value" or "of no value" by the students. The agent keeps this in mind and sorts the documents. The agent tracks the most often visited web sites from each student and retrieves the latest update for these web pages, so that it becomes possible for each student to read them every day without waiting for them to be downloaded from the Internet. Also, at all times the agent analyses the contents of the web page the student is reading and makes a list of other similar pages for the user to read after finishing the present page.
- E-mail agents are introduced for the e-mail application. In the previous years all information for all students was sent to large groups and then the students had to find the e-mails they needed. At the present, it's only necessary for the students to tell to the agents what information they are interested in, so that the agents can select the needed e-mails. Also, the agents look at the pattern of how the

students read their e-mail from their families and friends and sort the mail according to these points of interest.

The agent keeps all actions the user performs for a certain period of time. The agent analyzes the action log and it makes a search for patterns of behaviour. When the agent finds such patterns it will offer to automate them for the user.

The functions of the agents are different but they are all coordinated through the user interface agent, so that the student experiences interaction with a single agent. A user can create one or many agents and train them by means of examples of articles that should or should not be selected. The agents can be divided according to the field– business, computer studies, management, etc.

An agent is initialized by giving it some positive and negative examples of articles to be retrieved. Full-text analyses are used by the agent to retrieve the words in the text that may be relevant. It remembers the structured information about the article, such as the author, source, assignation, etc. The user can program the agent by completing some templates of articles that should be selected.

5 Evaluation of the system by users

In order to define and check the users' opinions on the system an inquiry has been carried out among them. It reveals approval of the applications. Even while testing the system the students show growing interest and motivation for learning, and higher results in the examination procedures. In the feedback some remarks and recommendations have been made by the users and during the trial period they are tested.

Users enjoy working with the system and find it very useful. The basic restriction given from the system is that it is limited to keywords only. In this context, the methods for deeper semantic analysis of texts will optimize the performance of the system and this deeper representation can be learned by using the same statistical learning techniques as are currently used for relevant keywords.

6 Conclusion

The software agents that were used gradually learn how to improve in assisting the user and increasing their competency, accumulating knowledge by: observing and imitating the user; receiving positive and negative feedback from the user; and taking instructions from the user and asking other agents for advice.

The agent technology that was used has the capability and potential for optimizing and modernizing learning and teaching processes in Bulgarian universities in the pre-accession stage for the country. A new education system is gaining speed in Bulgaria that is not based only on humans and traditional methods but on intelligent agents providing just-in-time mentored learning.

Future research still needs to be carried out into methodologies for design, implementation and adoption in the field of education, collaborative learning theories, and verification of systems to maintain their stability in performance and operation. Aside from the difficulties in actually constructing software agents for education, exploring the development of intelligent agents is worthy in that it helps further our understanding of instruction.

The suggested system is in a period of adoption in the Technical University of Varna, and it is part of an automated information system (AIS) implemented at the university for the aims of university management, covering different aspects of the administrative, scientific and teaching activities. It aims at improving the effectiveness of the work of all units in the university, and the present study contributes in this direction.

Application of software agents is an important step in renewing the educational system in Bulgaria and developing new forms of web-based learning systems, such as distance learning and long-life-learning.

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Remote Lab Experiments: Opening Possibilities for Distance Learning in Engineering Fields

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Abstract. Remote experimentation laboratories are systems based on real equipment, allowing students to perform practical work through a computer connected to the internet. In engineering fields lab activities play a fundamental role. Distance learning has not demonstrated good results in engineering fields because traditional lab activities cannot be covered by this paradigm. These activities can be set for one or for a group of students who work from different locations. All these configurations lead to considering a flexible model that covers all possibilities (for an individual or a group). An inter-continental network of remote laboratories supported by both European and Latin American institutions of higher education has been formed. In this network context, a learning collaborative model for students working from different locations has been defined. The first considerations are presented.

1 Introduction

The technological advances of the last decade have brought many changes to our society. The accelerated development of information technologies (IT) has brought about new learning paradigms in education. One of those paradigms is e-learning. It is the use of network technologies to create, foster, deliver, and facilitate learning, anytime and anywhere. This paradigm has been mainly used in fields where

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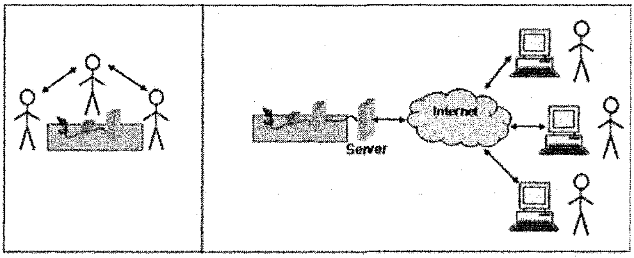
practical activities are not required. However, in engineering fields practical activities (labs) are absolutely necessary. Experimentation laboratories must be part of any engineering program. We have been working on remote experimentation laboratories in order to include engineering fields in the e-learning paradigm.

Remote experimentation arises from different motivations:

- It allows teachers to better demonstrate physical concepts during a traditional lecture, by simply connecting to the remote lab and running the experiments;
- It is an economic solution for distance learning courses in engineering fields;
- It allows access to expensive equipment (e.g., an electron microscope) on a 24-hour, 7-day basis, giving students the opportunity to use it;
- It allows collaborative work, although this set-up brings additional requirements, especially an interaction model between students. The existence of synchronous and asynchronous communication tools is required.

Once the remote experiment has been implemented, it is necessary to define the methodology that will be used in order for the students to use the experiment in a pedagogical sense. Figure 1 (left side) shows the traditional scenario (present) for a laboratory experiment, where face-to-face interaction plays a fundamental role. On the other hand, a distributed scenario (right side) shows new elements that are necessary for implementing a remote experimentation experience: synchronous and asynchronous interaction, technical issues, time difference, and cultural aspects.



Figurel. Configuration for a typical lab practice (left) and a remote lab practice (right).

This article presents the efforts of an integration project for creating a network of remote experiment labs in engineering fields. The methodology aspects are very important. A collaborative model for groups of students who work from different places is presented. In the rest of the paper section 2 provides some more background on remote experimentation, section 3 presents the network composition and project goals, section 4 highlights the methodology used for remote experiments between students from different universities, and section 5 concludes the paper.

2 Remote labs background

The use of Computer Based Learning (CBL), widely associated with similar expressions such as e-learning and distance learning, is widespread among universities. Within engineering, the educational community has felt the need for more powerful combinations: linking educational contents from several sources;

links from text documents to hands-on modules such as simulations, and finally to real-world experiments [1]. The World Wide Web (WWW) and its associated technologies provided the platform for large-scale implementation of such concepts and ideas, including the free offer of educational materials to the entire engineering community [2]. On the last topic, the first references to making an entire undergraduate lab available through the WWW, date back to the mid 90's. Aktan [3] claims his real-time remote-access control engineering teaching lab to be the first undergraduate lab with complete internet access. Esche [4] describes a more recent undergraduate lab with a strong emphasis on pedagogical issues and enabling technologies. Considering the scenario in Figure 1 (right side), additional questions are raised if the remote experiment calls for collaborative work [5-7]. Since teamwork is one of the most valued aspects of lab practice, such a scheme should benefit from having students from several universities working together to achieve a certain learning objective. In our opinion, cost figures are generally not perceived in the same way by different universities, and thus the number of potential users may diminish substantially. This situation fails to observe the basic principle of inclusion, and so, in our opinion and concerning IT, universities should cooperate on a no-cost basis by sharing e-services among themselves. This idea was at the inception of a proposal to the ALFA II program, entitled Remote Experimentation Network, yielding an inter-university peer-to-peer e-service (RexNet-yippee).

3 The ALFA-II RexNet-yippee project

The project goals are to share, harmonize, and spread current skills on remote experimentation. The consortium is formed by two balanced groups from Europe and Latin America, each headed by an Institution of Higher Education with coordination duties. They are: the Polytechnic Institute of Porto (IIPP), the University of Porto (UP), the University of Bremen (UB), the Technical University of Berlin (TUB), the University of Dundee (UD), the Federal University of Santa Catarina (UFSC), the Federal University of Rio Grande do Sul (UFRGS), the Catholic University of Chile (PUC), the Catholic University of Temuco (UCTemuco), the Institute of Technology and Higher Education of Monterrey (ITESM), Mexico. Besides the social interaction, all partners are encouraged to promote the development of new remote experiments and to harmonize the interface to each remote experiment (or lab), namely of those already available [8-12].

4 Collaborative model for remote experimentation

In our view, the social involvement of at least one highly motivated player deeply involved in remote experimentation is key to the success of such a peer-to-peer network. It is precisely the human/social factor that ultimately makes the difference: if users know that the system is open to a large community with a high chance of interacting with people from other countries and also that there is a common basis for understanding, namely the subjects addressed by the practical work in a given remote experiment, then motivation increases and the level of skepticism towards a remote approach decreases. The combination of higher motivation and lower skepticism undoubtedly increases the educational value of remote experimentation.

A very important role is played by the methodology that will be used for defining the activities associated with a remote experiment. A model that guides the configuration of the main issues to keep in mind is required. These issues are:

- Number of participants: to define if the lab is individual or for a group. For groups we assume the students would work in a distributed scenario.
- Interaction tools: all possible interactions must be considered (students-students, student-tutor, tutor-students, student-contents).
- Other tools: beside interaction tools, many other tools support the activity. The following should be considered: coordination module for accessing the experiment (schedule), discussion forum, text chat, voice chat, videoconference, content management, etc. All these tools could be joined in some Learning Management System (LMS) in order to facilitate the location and use of them.

Also, it is necessary to keep in mind that these issues are directly associated with lab activity. These can be divided from two points of view; one on the contents or materials associated with the lab, and the other on the interaction among participants.

Regarding the course's contents, the following needs to be considered:

a) theoretical guide of the experiment: it considers all necessary theory for understanding and carrying out the experiment;
b) laboratory guide: it specifies the activities that must be performed step by step;
c) experiment help: it includes help from the technology point of view. It should be included in the experiment interface;
d) expected results guide: it specifies the report expected, that is, the result of the experiment (sections, format, delivery instructions, etc.).

The following elements should be considered for the interaction:

a) First interaction: assuming it's the first time the group members work together, an asynchronous interaction must be considered. A discussion forum where each student introduces himself/herself must be set. Also, one or two synchronous sessions with chat and videoconference tools should be considered. The results of this first interaction are the knowledge of the group members, the role and task to be carried out by each student, and the global work schedule.
b) Interaction during the experiment: besides the experiment interaction interface, the synchronous interaction tools must be considered.

This model has been implemented recently for a remote lab in computer science. It involves students from UCTemuco (Chile) and students from ITESM (Mexico). The LMS EDUCA is being used for interaction between students and tutors [13].

5 Conclusion

In conclusion, we believe that in addition to the listed benefits and challenges associated with a peer-to-peer network of remote labs, it is possible for others to exist or arise, depending on the type of remote lab in question or on the natural technological advances that often solve old problems and always create new ones.

New possibilities in distance learning for engineering fields are opened. This approach could be expanded to other fields that require experimentation as an important aspect of the learning process.

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Credibility: Norwegian Students Evaluate Media Studies Web Sites

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Abstract. This paper investigates Norwegian university students' evaluations of web site credibility and site authors' vested interests with respect to a text-based academic site and an informational site with commercial support. Credibility ratings were higher for some aspects of the academic site even though the non-academic sit was rated more highly in presentation design and currency. Negative correlations emerged between academic level and confidence in deciding web site credibility and in detecting misrepresentations.

1 Introduction

Why do people accept or believe information that they read on the World Wide Web? Upon what basis do web users make determinations that some information is acceptable or believable and some is not? These questions are especially important as students, educators and the general public rely more and more upon web-based information.

In this work, we investigate credibility (i.e., information accuracy and veracity) determinations as students evaluate information on the web and web sites generally. To provide background, the following major points emerged previous research in this area:

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- Educational levels affect credibility determinations, with those more highly educated in a field (e.g., scientists) particular content rating popular media sources less highly than do less educational preparation in the field [8].
- University-level students have limited understandings of the concept of "vested interests," particularly they relate it to web site authors' non-commercial/educational interests [6] [4].
- It appears that cultural and socio-political contexts can affect credibility determinations, a finding that emerges from work in Singapore and should be explored in other cultural contexts.

In response to these points, particularly the latter, the present study examines the credibility judgments of university students in Norway. Of particular interest are cross-cultural dimensions and determinations of students in different content areas, information science and media studies. A question that guided this research was whether they might have considered credibility aspects of web site information and vested interests of web site authors or information sources to a greater extent than students in other fields who may focus less on information sources.

2 Method

2.1 Participants

Participants consisted of 45 students (25 females and 20 males) from a university in Norway. The mean age was 26.27. The students were in the following fields: 27 in information science, 16 in media studies, and 2 in other fields. Fourteen were in B.A. programs, 22 in M.A. programs, and 5 in Ph.D. programs.

2.2 Materials

Materials consisted of a survey that presented two web sites for rating: an academic site focusing on audience studies and a nonacademic site that provides film reviews according to era.

Participants used 5-point Likert scales to rate the sites on 17 characteristics related to credibility that emerged from previous research [2]. They also rated vested interests of web site authors, and provided self-ratings in response to 5 questions about various aspects of confidence and competence (e.g., confidence in deciding that a web site's information is accurate or truthful).

2.3 Procedure

Surveys were distributed in several media studies and information science classes and collected at the end of class, or afterward.

3 Results and discussion

3.1 Participants' ratings of the two web sites

Examination of ratings for the two different web sites revealed interesting differences (See Table 2). First, web site 1 was rated more highly on many dimensions commonly associated with credibility, including the following characteristics: objective ($M = 3.58$ for academic site 1, versus 2.86 for nonacademic site 2), references (M = 3.7 site 1; M = 2.16 site 2), and author identification (M = 3.42 site 1; M = 2.57 site 2). We interpret these findings cautiously, as examination of mean differences is limited. However, it would appear that participants were taking many other aspects into account besides solely design aspects in making determinations about specific aspects of credibility.

In contrast, web site 2 was rated more highly on design-related elements, including information/presentation design ($M = 3.16$) in contrast to site 1 ($M = 1.82$). Also web site 2 was rated as slightly more clear ($M = 3.43$) than site 1 ($M = 2.91$). It appears that students regarded aspects of design separately from other aspects of credibility. Web site 2 was also rated as more up-to-date ($M = 3.59$) in than site 1 ($M = 3.07$). Web site 2 appeared to be regularly updated.

With respect to vested interests, participants rated the first site as more unbiased/objective ($M = 3.33$) than site 2 ($M = 2.8$). The second was rated as more commercial ($M = 3.39$) than site 1 ($M = 1.71$). The second site was also rated more highly on bias ($M = 3.02$) than site 1 ($M = 2.56$), and personal opinion/agenda ($M = 3.6$) than site 1 ($M = 2.91$).

3.2 Confidence and competence ratings

Participants provided reasonably high self-ratings for the following: confidence in deciding a web site's information is accurate or truthful ($M = 3.47$), confidence in detecting misrepresentations on web sites in general ($M = 3.16$), and competence in evaluating the validity of information on the web in general ($M = 3.38$). These high ratings would be expected of university students.

However, they rated themselves less highly for the following: confidence in detecting misrepresentations in the web sites given in this questionnaire ($M = 2.80$), and competence in evaluating the validity of information about the topic in the given web sites ($M = 2.80$). It is possible that students were less familiar with topics like audience studies (although this is a topic covered in the media studies curriculum) or students are less likely to associate credibility determinations with content in this area, or in film studies, or film reviews.

3.3 Culture and gender

One-way ANOVAs on confidence and competence ratings revealed no significant differences emerged between men and women. This finding is not unexpected, as "in the annual UNDP Human Development Reports Norway...has for several consecutive years been ranked as the world's leading nation in...gender equality" [1].

3.4 Correlations

Pearson product-moment correlations were carried out between demographic variables (i.e., gender, age, field of study, academic level) and confidence and competence ratings. Two interesting *negative* correlations emerged between academic level and confidence in deciding whether a web site's information is accurate or truthful $r(39) = -.34$ ($p<.05$), and academic level and confidence in detecting misrepresentations in the web sites given in this questionnaire $r(39) = -.35$ ($p<.05$). Similarly, a negative correlation between academic level and competence in evaluating the validity of information on the web in general approached significance $r(39) = -.30$ ($p=.057$). These findings indicate that the higher the academic level, the *less* confidence participants have in deciding a web site's information is accurate, or in detecting misrepresentations in the web sites given in the questionnaire. Additionally, it suggests that the higher the academic level, the less competence people feel they have in evaluating the validity of information on the web in general.

It is very likely that these findings can be explained by considering the work of Kruger and Dunning [9], who found that less knowledgeable people in certain nonacademic areas tended to over-inflate their confidence in areas where they had the least knowledge. In contrast, experts underestimate confidence in areas where they knew most. Kruger and Dunning attributed this to experts' tendencies to over-estimate the knowledge of their peers in contrast to themselves. This also relates to the well-known truism: The more you know, the more you know what you don't know.

4 Summary and conclusion

In examining university students credibility determinations of two web sites related to media studies, major findings indicated that students differentiated between presentation/design aspects of web sites and other aspects generally considered to be more central to credibility, such as objectivity and accuracy. This could be considered to be somewhat different from the findings reported by Fogg et al. [3]. Additionally, we found that the more educated students were (as determined by academic level) the less confidence they had in certain aspects of credibility determinations, such as detecting whether a web site's information is true. Although this could appear counterintuitive, it does support the work of Kruger and Dunning [9] and suggests that the more knowledgeable one is, the more critical one is likely to be as one uses information from the web.

Finally, although we carried out this study in Norway, we did not find general evidence of cultural differences in comparison to our previous studies in the U.S., nor did we find evidence of any gender differences. However, asking more general open-ended questions might result in comments that would be more indicative of individuals' aspects of understanding and approaches to the process of credibility determinations. This is a recommended goal for future research in this area.

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A Collaborative Learning Approach And its Evaluation

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Abstract. The use of new technologies does not mean that the applied education model is modern. New technologies can be used in a way that follows the traditional education model, with all its deficiencies. The collaborative education model involves students in reflection, participation, and construction of their knowledge, or to collaboratively learn. This article aims to present mechanisms to stimulate collaborative learning, in present education, through the aid of virtual learning environments.

1 Introduction

Traditional teaching methods are being criticized, mostly because of two characteristics. The first one is that they are centered on the role of the teachers, who are considered the only ones who have knowledge and, as such, are able to transmit it. The second one is the preference for lectures, with few student-teacher or student-student interactions. This characteristic has the disadvantage that students remain passive, just listening, memorizing and repeating what they are supposed to learn. Thus, the traditional teaching model seems incompatible with the modern workplace, which requires people with teamwork, critical thinking and communication skills 3 6. Besides that, the concept of learning has also changed: "learning is not to receive knowledge, but to make sense of knowledge and to promote in a learner an independent mind that can inform, reflect and even challenge conventional knowledge wisdom" 3. Thus, in the new teaching model students and teachers have an active role. Knowledge is shared and built. The learning process occurs collaboratively. Each student, besides being responsible for his/her own learning, contributes to his/her classmates' learning.

One option we have to implement this new learning and teaching model is to apply information technologies and the Internet, aiming to change the ways "schools work, teachers teach, and students learn" 2. For example, an aid tool to the traditional present classes can be a Virtual Learning Environment (VLE). A VLE can be defined as a system that groups different tools and facilities, empowering

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learning activities through the Internet, or “a program or set of programs that operates over a network and supports users as they undertake tasks or participate in processes related to learning” 2. Through their communication facilities, such as forums, chats and document sharing areas, “the use of the Internet and the web can help the constructivist theory because it is possible to build a Learning by Doing environment that also combines the constructivist approach and cooperative learning”6. Many published proposals consider the web and VLEs as powerful tools that offer teachers resources to change the way they work, motivating a more interactive learning process. Sala 6 proposed a group development of a database. Laffey et al 2 present a framework showing how a VLE or a Network Learning System (NLS) could be used to improve education, but they do not present any results of the proposed framework.

However, simply grouping students and using a VLE does not imply that we have modern collaborative learning (4, 5, 8). Even applying a VLE, a teacher can be adopting a traditional teaching method. For example, there are teachers who use VLEs just to make available texts and activities for their students. The teacher is the only one responsible for transmitting information. There are no discussions, no interactions among students and no knowledge building by the students.

This paper presents an application of VLE as tools to aid existing classes. It is organized as follows. In Section 2 we present our proposal and case study results, and in Section 3, we present our conclusions and future work.

2 A Collaborative approach with VLE

2.1 Learnloop

There are many available Virtual Learning Environments, for example, Moodle[8], Whiteboard[9] and WebCT[10]. Some of them are free software. The Western Cooperative for Educational Telecommunications (WCET) presents, in its site Edutools[11], a comparison among many of these VLEs. Thanks to a number of already implemented resources, five years ago the Instituto de Informática of Pontifícia Universidade Católica de Minas Gerais (PUC Minas) chose the free software Learnloop[12]. During the five years since adoption, many improvements were incorporated to the original version (http://www.inf.pucminas.br) 1. Presently it has been adopted by nine courses or near 4,000 graduate and post-graduate students.

[8] http://moodle.org/

[9] http://whiteboard.sourceforge.net/

[10] http://www.webct.com/

[11] http://www.edutools.info/course/compare/

[12] http://www.learnloop.org

2.2 A collaborative proposal

The proposal presented in this section aims to introduce students to do research and to produce a paper in group. To accomplish the proposed activities, it is important to specify a unique general theme for all students of a class. It can be divided into three main activities:

First activity: survey. During the period of a month and a half, each student must post at least one contribution per week in the class forum, in Learnloop. This contribution can be a reference to a technical paper that (s)he had selected, with at least five main ideas, or a justified criticism to a paper referenced by a classmate.

Second activity: scope definition. This activity requires that students be organized in groups. It should be completed with the aid of the Learnloop group resource. For each student group, a group is also created in Learnloop with at least three resources: messages among group members, forum and a virtual disk to share files. The objective of this activity is to develop a unique work plan per group, composed of: group organization, paper scope, paper structure and selected references.

Third activity: paper elaboration. To fulfill this activity, students continue to use Learnloop groups. Each one will be responsible for a paper section or sub-section. The group leader will have to organize the paper, and (s)he will also have to write the introduction and conclusion of the paper. Because of that, (s)he does not write any other part of the paper.

2.3 Proposal evaluation

The proposed collaborative model was implemented in a class of 26 students, organized in six groups. The main advantage of this model is that it compels every student to participate. Although the activities must be done as a group, the grades are given individually. As the teacher can track all the students' activities in Learnloop, the following problems can be eliminated or, at least, diminished:

Students lost with the great amount of information available in the web. The forum discussion completed during the first activity contributes to the development of their critical abilities, before choosing the scope of their paper and selecting the best references for the paper they are supposed to write.

Difficulties to meet. Learnloop, as other VLEs, offers flexibility of time and space to discuss ideas.

Paper written only when the deadline is getting close. The proposed approach makes students work during all the class periods.

Students who do not collaborate. The only problem we face is that anyone can ask or pay for another to log in Learnloop with his/her username and to do his/her activities in his/her name. A solution to this problem is to apply a test or ask the students to orally present their contributions.

Plagiarism. The number of classmates or web copies diminishes, because the discussions, along with the teacher's tracking, inhibit students from just copying others works/ideas.

From our experience, we can see that even virtually, students have great difficulties in working in groups. There is no need for the teacher to remain logged in. The tracking could be done once in a day and (s)he can participate when necessary. But unfortunately, if the teacher keeps logged off for a long period and does not remind students of the importance of working together, students have a great tendency to stay in the traditional passive position.

Table 1 presents the number of posted contributions, during the third activity, for each group. As we can see, in spite of being almost obliged to work collaboratively, the number of student participations is kind of low. We can point to two reasons for this situation. The first one is that some contributions were very extensive, deeply evaluating all group work. The second one is that some students have much difficulty in working in a group. As we assigned some group exercises during some classes, we could observe students' attitudes. And we could observe that students who do not work well in a group virtually are the same who do not contribute presently.

Student grades were proportional to their collaboration in group work. Their grades are also summarized in Table 1. It is important to emphasize that although the work was to be done in a group, 60% of the grade was individually evaluated, considering the quality of the contributions. 40% of the grade was evaluated considering the teamwork and final paper presented by the group (cohesion and quality). There are two results that deserve explanations. The low average grade of group 3 can be justified by two low individual grades, due to light cases of plagiarism. The good grade of group 6 was a consequence of the high level contributions of two members of the group.

Table 1. Number of contributions during the third activity, considering both the students who have completed the assignment (C) and the ones who have not completed the assignment (NC). The group grades are considering only students who have completed the assignment.

Group number	Group size		Post numbers		Avg post numbers		Grade		
	NC	C	NC	C	NC	C	Avg	Low	High
1	4	3	20	17	5.00	5.67	17.0	15.5	19.5
2	4	3	13	11	3.25	3.67	10.0	7.0	14.0
3	3	3	23	23	7.67	7.67	13.7	12.0	15.0
4	5	5	15	15	3.00	3.00	10.0	6.0	15.5
5	5	3	11	11	2.20	3.67	11.7	9.0	13.0
6	5	5	18	18	3.60	3.60	14.2	11.0	19.0
Total	26	22	100	95	3.85	4.32	-	-	-

3 Conclusions

In this paper we presented an application model of VLEs, aiming to improve: (i) student-student and student-teacher communications through information sharing and exchange; (ii) team working; (iii) the development of critical abilities of the students; and (iv) progressive evaluation in which the teachers are able to track students' activities and can evaluate them during their development. Although the model was adapted to the specific activity of paper writing, it can be extended and adapted to other group activities. For example, after designing a computer system, each member could be responsible for a module, and doubts and corrections could be discussed through a forum. As future work, we propose to offer teachers tools to make easier the tracking and evaluation of students' activities.

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Experiences From Virtual Learning in Upper Secondary Schools in Finland

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Abstract. In every country there has been a lot of worry and discussions how to make sure that the schoolchildren and the student can acquire sufficient skills and efficacy in using computers to be more efficient and productive in their studies and later in their professional career. One of the answers to this challenge in Finland has been the National Information Society Programme supporting the procurement of computers, building computer networks, training teachers and creating methods of teaching in a computer intensive environment. The programme has been running for ten years now, and there are a wide range of experiences from failures to brilliant successes. The most important lesson learned is that the technical networking, mental networking and organizational networking should take place simultaneously as well as the teacher understanding about the special role of ICT in education.

1 The Information Society Programme

The strategic importance of ICT in business and in education has been growing fast during the previous two decades. This process led to the idea to have a national programme advancing the use of ICT much more effectively in education. As a consequence the Finnish Information Society programme was launched in 1996 and since then the Finnish government has provided noticeable funding to the Finnish educational institutes, including the general education schools, to make ICT an effective tool in education. The programme is comprised of several subprogrammes during three strategy periods focusing on various goals. The latest strategy period covers the years 2004 through 2006 [1].

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The main goal of the national information society strategies has been to support a well balanced development of the use of ICT in all levels of education and in all the factors contributing to its success. Therefore there have been four subprogrammes ,each supporting its equally important factor of development.

The main parts of the programme have been

- Pedagogical ICT training for the teachers
- ICT intensive teaching methods development
- Computers for the schools
- Network connections for the schools

It is interesting to see that the two pedagogically-oriented subprogrammes first on the list go hand in hand with the technical development programmes. This means that the ministry has understood that all pedagogical development in using ICT in education requires proper technical facilities. What is missing are the technical and pedagogical support to use ICT in a regular classroom situation at schools and the learning material. The ICT support for the schools is a serious challenge because the municipalities and cities are reluctant to provide funding for that purpose. The availability of learning material is, however, reasonable because there are a number of initiatives in several organizations and among book publishers to create digital learning material to schools. Resources are available from several sources.

One of the main ideas in the theoretical background of the information society processes is the importance of the student's own initiative in the learning process. The students should develop their ideas by their own thinking, testing their mental structures and conceptions of reality and creating at the same time a correct mental construction of the reality. Learning cannot be effective without the student actively conducting studies [2]. Teaching might be important in a classroom but learning is the core activity in education. The ICT is considered an important tool for moving the emphasis in the classroom situation from teaching to studying, practicing and learning. The Internet provides a huge source of facts and learning material, but the teachers are hesitating to use the Internet because of the abundance of incorrect material that might confuse the students.

2 Technology

The question of the penetration of technology to school is important. Many times the focus in developing the school is on the pedagogy and teaching methods. It is, however, obvious that only in a highly computer-intensive environment can the technology move to the background processes adopting a real role as a tool. I consider a learning environment to be ICT-intensive if there are fewer than 3 students per one computer which is connected to the Internet and available for the students.

The technology is advancing very fast, creating new possibilities for the schools such as intelligent black boards or white boards, wireless communication, mobile TV, virtual presence, virtual classes, etc. However, the schools are quite sparsely funded everywhere in the world and it is highly improbable that schools will be the first to adopt new technologies. This is the case also in Finland, but it can also be a relief to the teachers to have a bit slower pace. The teachers normally familiarize themselves with new technologies during the regular annual in-service training.

The high ICT penetration in the schools opens new possibilities to organise tests, exams and many kinds of performance evaluations using the computers provided by the schools, but it is possible also to use the students' own laptop computers or computers from some other sources. In every case the schools have to make sure that cheating is made difficult and the penalty for cheating is high. Denmark has a lot of experience in organizing exams where the students are allowed to use computers. In those cases it is always advisable to let the students use any additional material they might want, but not the Internet, because when using the Internet it is not certain who is the real author of the given answers in the exam.

3 The virtual school networks

At the moment the focus in the virtual school is on the school networks using ICT to share the expertise and resources in producing high quality educational services. The studies in the upper secondary schools in Finland are based solely on passing one or several courses in each subject. The length of each course is 38 lesson hours. The whole upper secondary school curriculum is comprised of 75 courses with 45 mandatory and 30 optional courses, and a national final exam. Normally there is quite a large collection of optional courses available for students in each of the schools. To produce all these courses for students is a heavy economical burden for the school. Therefore schools have found it more economically feasible to organize this large variety of courses together with other schools using ICT.

The precondition for this kind of cooperation is the availability of computers and networks in the school. There should also be special rooms available for those groups of students using virtual methods while studying their courses. One of the most popular methods at the moment is to create a virtual learning group connecting smaller groups from many schools. This virtual group is using videoconferencing to communicate, and the teacher can be in any of the schools. There might also be several teachers or no teacher at all in the videoconferencing session, or the teacher can participate in a very flexible way. In almost all the cases that I know there is one teacher present all the time.

For an average teacher to become a virtual teacher, being comfortable with all the technology, it seems to require qualified teachers with reasonable experience in using computers and networks, a short training in using videoconferencing technically, a longer training to use videoconferencing in a pedagogically meaningful way, and about three year's time working as a virtual teacher. Of course after three years of virtual teaching the teacher is equally comfortable with the Internet, email, the learning platforms and many other possibilities provided by ICT.

The learning results when using the virtual methods seem to be comparable with the learning using conventional methods. Of course, it is relatively difficult to collect reliable statistical data because normally there is no test group of students available. The students are normally much more comfortable with the new methods, and there are only a very few complaints. The general atmosphere in a school seems to be improving, and the cooperation between the teachers is increasing, if the school is actively pursuing a new attitude in education. The school leadership is important, and the school leader is wise to encourage teachers' own initiative and support the growth of each individual teacher's expertise and empowerment [3]. Sometimes so-called strong leadership in the school can cause a lot of damage when blocking the empowerment process in the school and preventing the teachers' professional growth.

4 The challenges

Generally the Finnish schools are quite small, resulting in high expenses when making sure that all the subjects are taught according to the requirements of the national curriculum, and that all the teachers in every subject are fully qualified. Therefore the schools are continuously pursuing new ways of providing high quality education with fewer expenses. The virtual teaching methods might be at least a partial solution.

The fast development of the social and economical situation in the country induces special requirements to the quality of education. The contents of the learning materials should be updated fast, the in-service training of the teachers should be continuous, and new developments in the society should filter without delay to the school. When the school students leave their school they should be fully prepared to meet the challenges of society.

A special challenge in Finland, compared with almost all the other European countries, are the vast sparsely-populated areas where the schools are small, expenses high and the difficulties in providing the families with high quality educational services are severe. These challenges are continuously increasing because of the internal migration from rural areas to urban areas.

5 General

The Finnish Information Society Programme has meant a huge leap in the development of ICT-intensive teaching and learning environments for the Finnish schools. Almost all the schools are connected to the Internet by fast connections, the computers are available in the Finnish schools in big numbers, the teachers are trained to use the computers and the Internet in their lessons in a pedagogically meaningful way, and the students can use the computers and networks for their studies both in school and at home.

The schools and the teacher have adopted a number of new methods in working in a computer-intensive educational environment, and the students are learning many of those skills needed in the future when the work places, tasks and the working environment are genuinely different from what they are now. I think that this is the only acceptable way to develop education.

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Information Security in an E-learning Environment

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Abstract. In the last few years the education environment underwent a paradigm shift due to the rapid growth in technology. This growth made it possible for the education environment to utilize electronic services to enhance their education methods. It is, however, vital that all education environments (traditional or new ones) ensure that all resources (lectures, students and information) are properly protected against any possible security threats. This paper identifies technical and procedural (non-technical) information security countermeasures that could enhance the security of information within the education environments.

1 Introduction

Information security has become a much-discussed subject all over the world in the last few years. All institutions (including educational institutions) should realize that information is an extremely valuable resource and must be protected at all cost. Information security is therefore no longer a luxury, but a necessity in all institutions. A great deal of research has already been conducted in educational environments. However, one aspect that has not received much attention is the important role of *Information Security,* especially in newer education environments such as the e-learning environment. Information must be protected due to the development of newer technologies that could be used in an attempt to compromise the security of information. The first part of this paper focuses primarily on the difference between a traditional educational environment and the e-learning environment in regards to securing information against unauthorized access. The second part of the paper

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provides different technical and procedural countermeasures that could be used as guidelines to protect information within the e-learning environment.

2 Traditional educational environment vs. e-learning

Educational institutions use different environments to educate students. This paper will primarily focus on two well-known environments, the traditional environment and the e-learning environment. The rest of this section will provide a brief overview of each environment and investigate to what extent information security is needed within these two education environments.

2.1 Traditional education environment

The traditional education environment (as depicted in Figure 1) has been around for many years and is found all around the globe. This educational environment consists of a central physical teaching facility (institution) which consists of lectures, students and databases. These databases could consist of public as well as sensitive information.

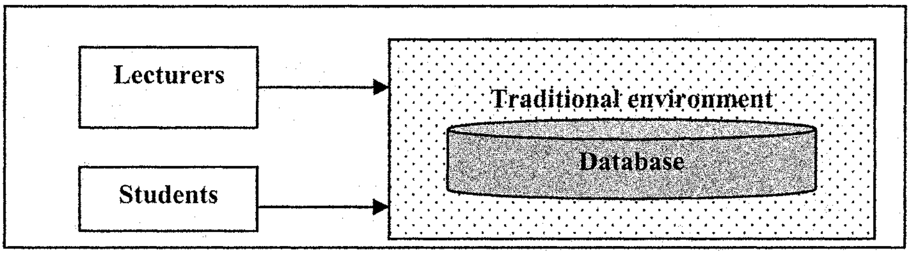

Figure 1. Traditional education environment

Information security is adequately addressed within a traditional environment due to the fact that traditional education environments are mostly restricted to one physical location. This means that lecturers and students as well as the databases are grouped together in a closed system environment where information security threats could be kept to a minimum. For example, all students must identify (ID or student card) themselves before they are admitted to the examination. This ensures that lecturers are certain that the students who are writing the exam are the students who enrolled for that specific course. This will eliminate the possibility that any other person can pretend to be a student and write the examination on behalf of that student.

This changed when educational institutions decided to change their traditional way of education and incorporate newer technologies to be able to provide education electronically over the Internet. This method of education is called e-Learning (electronic learning).

2.2 E-learning environment

E-learning can be defined as technology-based learning in which learning material is delivered electronically to remote learners via a computer network [5]. E-learning (or Internet-based learning) could be seen as a professional level of education but with the advantages of lower time and cost [3]. Some other advantages of e-learning include larger learner population, shortage of qualified training staff and lower cost of campus maintenance, up-to-date information and accessibility [1][3]. In a typical e-learning environment the lecturers, students and information are in different geographical locations (as depicted in Figure 2) and are connected via the Internet.

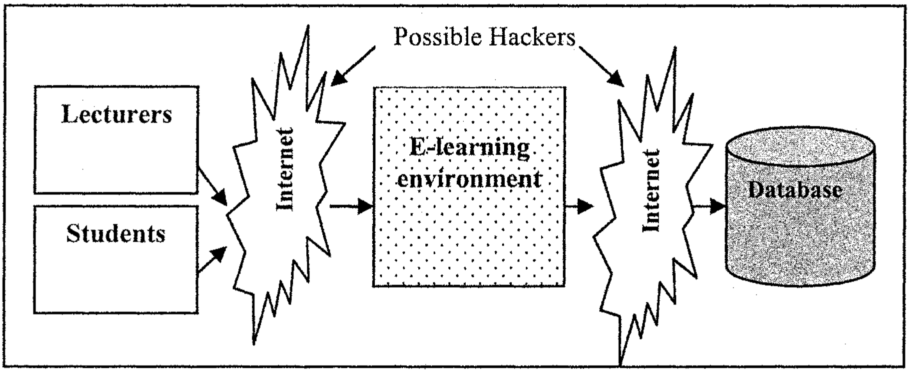

Figure 2: E-learning environment

A lot of research has been done regarding the *advantages* of e-learning. However, not much attention is given to the important role that information security plays within the e-learning environment. Information security is vital for any e-learning environment due to the fact that e-learning is fundamentally dependent on information and communication technologies (ICT). The use of ICT in the e-learning environment opens doors to many possible (information security) risks that could compromise the whole e-learning environment. It is this dependency on the Internet (the lifeline of e-learning) that contributes to the greatest information security risk. Consider some examples where information could be compromised:

- A student could intercept another student's work and resubmit it as his/her own work.
- A student could obtain unauthorized access to the examination marks database and change his/her examination mark, or the marks of any of the other students.
- A student could receive assistance while writing the examination.

These are only a few of the illegal actions that could occur within the e-learning environment if information security measures are not appropriately implemented. These actions could occur due to malicious intent or by plain ignorance on the part of the user on how to properly secure the information they work with. Both of these issues should be addressed before information would be secure.

3 Countermeasure

With the increasing information security threats within the e-learning environment as indicated above, institutions should implement technical as well as procedural information security countermeasures to ensure the availability, integrity and confidentiality of their information.

3.1 Technical countermeasures

According to Von Solms (an international information security specialist) there are six technical countermeasures that should be adhered to when implementing information security within any education environment [4]. Implementing these countermeasures will help to ensure that lecturers and students as well as data (such as student marks and financial information) are properly protected against possible security incidents. These information security countermeasures are:

- *Identification and Authentication* – ensuring that the user is who he/she claims to be and to ensure which access is granted to the user.
- *Authorization* – ensuring that the user has the authority to access the system or information.
- *Confidentiality* – ensuring that information is not disclosed to any unauthorized people.
- *Integrity* – ensuring that the information is unchanged and in its original form.
- Non-repudiation – ensuring that a person cannot take an action that can be denied later on.
- *Availably* – ensuring that the information is available at any given time.

These six information security countermeasures are primarily seen as technical information security countermeasures due to their technical orientation (for example encryption, access control lists and message authentication codes). However, information security is not only a technical issue but a business issue as well. The next subsection investigates different business or procedural information security countermeasures.

3.2 Procedural countermeasures

It is pivotal that information security is not only seen as a technical issue but also as a procedural or a business one. This section provides four procedural information security countermeasures that will address the business side of securing information within e-learning. These countermeasures are:

- Ensure Information Security Governance – Get approval and buy-in from top management who are ultimately responsible for information security.
- Implement an E-learning Information Security Policy - An e-learning information security policy should be used as a guideline to *what* must be managed and *how* this should be done regarding information security.

- Establish an E-learning Security Risk Management Plan - Top management of educational institutions should provide platforms for integrated educational, learning and assessment environments to minimize any possible information security risks and threats.
- Proper Monitoring of Information Security measures - Information security compliance monitoring is about finding out if information security related procedures and processes are implemented and are working as they should.

These countermeasures (technical and procedural) should not only be adopted in the e-learning environment but also be implemented and enforced.

3.3 Identifying stakeholders and assigning roles and responsibilities

In the shift between the traditional and e-learning environments, the roles of lecturers and students have changed. Not only have the roles of some role players changed, but new role players are also emerging. It is therefore vital that institutions identify these stakeholders and ensure that they are properly made aware of their roles and responsibilities towards securing the information they work with.

4 Conclusion

E-learning depends on the Internet, which on its own contributes to many information security threats. It is therefore vital that all e-learning environments should ensure that information security countermeasures (technical and procedural) are properly understood and implemented as well as possible.

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Teaching Supervisory Control Based on a Web Portal and a System of Laboratory Tasks

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Abstract This paper was written based on experience with teaching subjects on control systems and industrial automation at technical universities. The paper presents proven methods on how to organize and moderate an educational process with an active participation of students during theoretical and practical work over the web. Such an approach does not limit the number nor the location of participants-students, teachers or consultant workers. The international and multicultural dimension is also the most challenging one, since the cooperation can be worldwide. The work with students requires a continuous development of syllabi, since the evolution and adaptation to the changing world is continuous too. The system is open to all the participants and the nature of all of the parties involved in the system can be corporate, scientific, social or educational. The software tools used for the area of supervisory control are presented in the paper, as well as ways on how to promote this work so that new members can use it.

1 Introduction

New theoretical knowledge, software, hardware and communication technology bring the challenge of improving existing, and designing new, ways of interaction between students and teachers of technical universities and improving the methodology for teaching models and their implementations for various enterprises where the future graduates will go.

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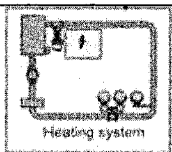
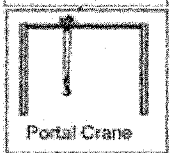
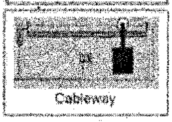
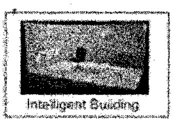
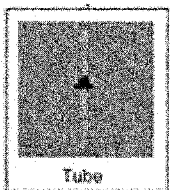
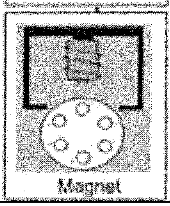
Although the syllabi at the universities may differ, the technical means, software and hardware tools, and the experience from working with them are becoming a common basis for work. The idea of sharing experiences over the web is not new, so it is just a matter of finding those common means and methods and developing cooperation, which can last long and from which everyone can benefit.

2 Physical models of technological processes

The physical models represent a concrete implementation environment, which includes hardware, software and communication subsystems. Their task is to help the students to learn the fundamentals of automation, logical functions, continuous and discrete control and information technologies implemented within control.

Table 4. Examples of Physical Models Used in Laboratories

Model Name	*Visualization*	*Model Functions*
Heating system		• Control of required power of pump • Required positioning of a valve • Real value of heat, pressure, temperatures and flow
Portal crane		• Control of a required position • Measuring real values
Cableway		• Control of a required position within the extent of -40/+ 40 cm • Measuring real values
Intelligent house		• Actual temperature in the room • Actual heat of the heater • Actual light intensity in the room • Actual state of fan/cooler • Required temperature • Required light intensity
Tube model		• Control of an object's required position in the tube • Measuring real values
Magnet		• Control of an object's required parameters • Measuring real values in the circuit

These physical models were built and developed over a period of time, during which their functionalities have proven the necessity of being used as demonstration tasks.

With the new technologies being implemented into the university laboratories it is now possible to create and maintain a virtual world based on a network of connected physical models, each of them with different communication protocols, database systems, control methods, and software tools implemented. Table 1 shows an overview of physical models.

3 Information industrial portal

A portal is browser-based and has the commonality of features that make it an attractive option for providing a view into a plant and its processes. These vital features include:

- information aggregation capabilities,
- common navigation tools,
- security reliability,
- extensibility and scalability of the entire system,
- multi-lingual capabilities,
- ease of use, user friendly environment,
- lower cost for providing real time information,
- views into multiple sites.

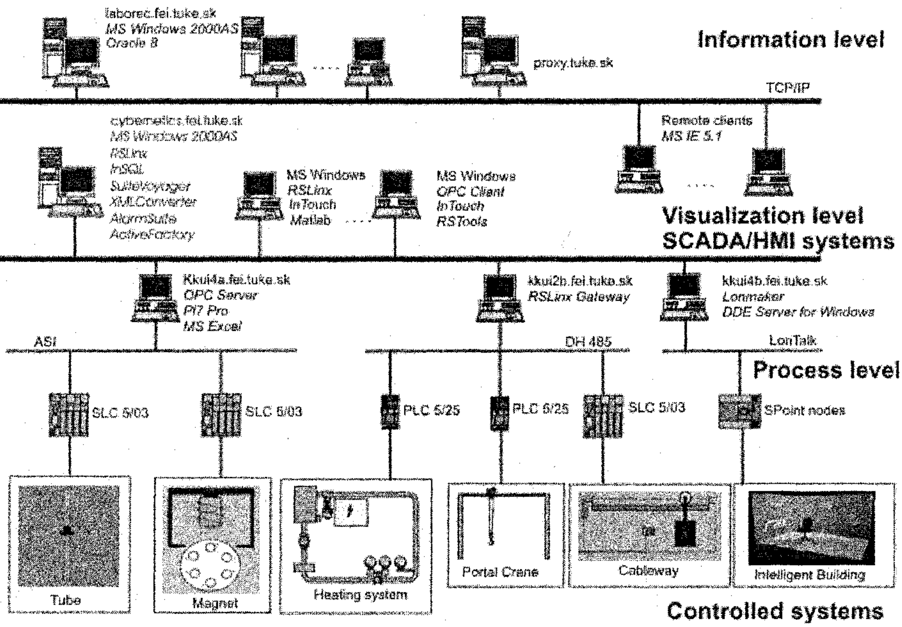


Figure 6. A part of the system architecture.

Figure 1 shows the hierarchical levels representing different tasks. The Control Systems level consists of physical models being physically constructed, built and configured for communication with a higher level, where they were programmed with either logical functions for two-state control or PID algorithms.

At the Process level the main task is the control and data acquisition, and transfers of data in both directions. The communication protocols and drivers must be set based on the hardware and software tools available at each laboratory.

The Visualisation level represents a very comfortable task for the development of an application design in the SCADA/HMI (Supervisory Control and Data Acquisition/Human Machine Interface) system environment. This work requires skills in designing visualization screens and knowledge of up-to-date technology.

Some of the parts of logical and physical models have been published in [1].

4 Results achieved

The portal <http://cybernetics.fei.tuke.sk/SuiteVoyager> provides its users, students and teachers with:

- Theoretical knowledge represented by a tutorial on the introduction to theories, a model description, a user manual of supervisory control, and exercises with physical models.
- Practical experience provided from monitoring and supervisory control with the visualization of scenes, alarms, trends of the variables provided by the designed applications.

Each controlled model has its designed consistent view in the following structure:

- **tutorial**:
  - start – short description, photo or web cam, panorama.
  - model description – logical and physical models of the whole controlled system, and its integration within the information system.
  - supervisory control – the user manual for HMI with demonstration video.
  - exercise with the functionalities of a model.
- **visualization** – multi views, with control panels for supervisory control, indicators, alarm status and acknowledgment, live video via web cam.
- **alarms** – multi views, with current, historical alarms.
- **history** – adjustable history trend, portal history trend (30 min), portal history trend (8 hrs).

A model of TVM, to monitor and control a laboratory model of an air-heating aggregate, was created. This application was created with the SCADA/HMI program InTouch 8. For communication between the model and application in InTouch, an ActiveX component was created. The TVM application was translated into XML and is available on internet information portal SuiteVoyager also. Users with access rights may watch measured variables and control the model just with the help of the internet browser.

From an education point of view the application provides:

- regulation of temperature by action intervention of the fan.
- list of prepared schemes of control.
- window enabling settings of communication.

5 Conclusion

The concept of a virtual laboratory is not new. Virtual labs use software simulation of physical devices and systems. Remote labs offer remote access to real physical laboratory systems, e.g., to equipment, instruments and educational models, with the goal of their monitoring and control. The educational aspects are as important as the technological ones.

The remote labs provide students with the possibility of monitoring the current situation and historical data with the help of only a basic web browser. It is available from the address http://cybernetics.fei.tuke.sk/CyberVirtLab, and the system will gradually develop. It suits the purpose of supporting learning courses by the ability to share facilities of expensive instruments and equipment. This teaching method is implemented into a real industrial portal environment, which brings a further advantage: the students learn the environment, which they will work with after graduating from the university and going into industry. The industrial information portal has proven its functionality when teaching control systems with the help of the web.

Acknowledgement

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Role of Online Supportive Environment in Professional Development of In-service Teachers - Case of TELMAE

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Abstract. The paper provides a structured overview drawing on the results of the first four years of a country-wide activity focused on professional development of science teachers. This activity, organized by the Laboratory of Distance Education, Charles University in Prague within the framework of the State Information Policy (SIP) in Education Program, started in 2001, and it has become one of the top online learning activities in the country. The paper introduces the whole developed system of in-service teacher training on a "voluntary basis" and focuses on the TELMAE Science Teachers' Online Supportive Environment, developed also at the Laboratory of Distance Education at Charles University. The TELMAE supportive environment incorporates several features and communication, information, monitoring and controlling tools used for management and coordination of distributed systems of online courses. The key factors of the project are discussed at the end of the paper.

1 The state information policy in education program - outcomes

The government of the Czech Republic has adopted formal public policies, in particular the State Information Policy (SIP) in Education, aimed at moving its society from a post-industrial model to an information and knowledge-based society. "*The basic objective of the state information policy is to foster and develop an information society and thereby to create the prerequisites for improving the quality of life of individual citizens....*" [1]. The adaptation will come through expanded use of computers and their attendant technologies, such as the internet and networking, by all governmental sectors, including education.

In short, the initiative is to serve as a modernizing influence for Czech society as well as serving its global interests by bringing the country in line with European Commission initiatives.

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1.1 State information policy in education

One of the general aims is the inclusion of ICT in the education system, which is supposed to enable the development of a real Information Society. From this perspective, the Ministry of Education's main strategies are [2]:

1. Provision of schools and libraries with computers connected to the Internet.
2. Presence of an ICT coordinator in each school to help teachers and pupils use the technology as a resource for teaching and learning.
3. A shift in emphasis in teacher training, moving from a methodology concerned with the transmission of information to one concerned with problem-solving and greater emphasis on the use of ICT.
4. Introduction of programs for lifelong learning.
5. Introduction of programs to encourage teachers, researchers and manufacturers to discover efficient ways of using ICT.
6. Analysis and assessment of ICT policy.

In the following we will focus mainly on teacher education, in service training and other ways of professional development with respect to the main objective – to emphasize effective use of ICT in the classroom.

1.2 The three-level pyramidal concept

The key and the most surprising fact are that the SIP In Education program assumed the training of more then 200,000 teachers, including those at the pre-primary education level, within approximately 3-4 years. That is why the State Information Policy adopted the three-level pyramidal model for in-service teacher training:

1. The basic level has been offered to in service teachers since 2002 with the main focus on obtaining basic ICT skills and knowledge on a level comparable to the ECDL (word-processing, calculus, spreadsheets, browsing and effective searching for information, etc.).
2. The intermediate level *("P"-level courses)* is more conceptual, subject oriented and focused mainly on the use of ICT in the classroom. The intermediate level, again, has been offered to all teachers, but only 25 % of them will get funding from the budget of the SIP.
3. The specialized courses *("S"-level courses)* are focused on specific topics and teachers′ needs.

1.3 ICT in science modules

Science represents only about one third of the intermediate section P *("P"-level courses)* and of course a part of the specialized section S *("S"-level courses)*. The laboratory of Distance Education, Charles University in Prague, became the official SIP in Education Program guarantor for the science modules in 2002. The responsibilities were the following:

- To manage the training of approximately 10,000 in-service physics teachers in the period of three years (this represents the training of hundreds of tutors, development of a reliable supportive environment for disseminating information, for efficient communication, for registration and payment, etc.).

- To guarantee the quality of the conceptual and content scheme and supportive materials, and the reliability of the online learning environment, including the learning object repositories.
- To guarantee the quality of the course outcomes (public accessibility and control). The guarantor is responsible for reviewing and publishing all final projects, which requires the development and providing of a reliable web-based publishing environment, the management of editorial boards and controlling the workflow.

The organizational, conceptual and content schemes of "P" level courses within the SIP in Education Program vary a lot. In the following we present the "ICT in Science" courses scheme.

In the case of ICT in science the best participants of "P" level courses might become lecturers under some special conditions and requirements. The teachers, who fill the requirements may organize their own courses, both the face-to-face and online parts. To ensure the quality, reliability and permanent accessibility of the whole training system, the online part is provided by the laboratory as a guarantor, the course runs are also under the supervision of the course guarantor; and the course outcomes are under public control (the participants' and lecturers' projects must be accessible by the public).

2 TELMAE online supportive and publishing environment

Students (in-service teachers) interact with the supportive environment of TELMAE throughout the whole course. The supportive environment TELMAE includes

1. different kinds of sources: databases of learning objects (so called Learning Object Repository); large variety of open edited databases filled in with different kind of useful information; online journals, tools for publishing, editing and reviewing (cross review).
2. a large variety of tools: tools for communication (both synchronous and asynchronous); tools for monitoring and controlling; tools for online registration, etc.
3. various other services and tools according the user role.

Management of the online parts of the courses, communication and feedback are provided by the Learning Space system (pilot runs also in Moodle Open Source LMS).

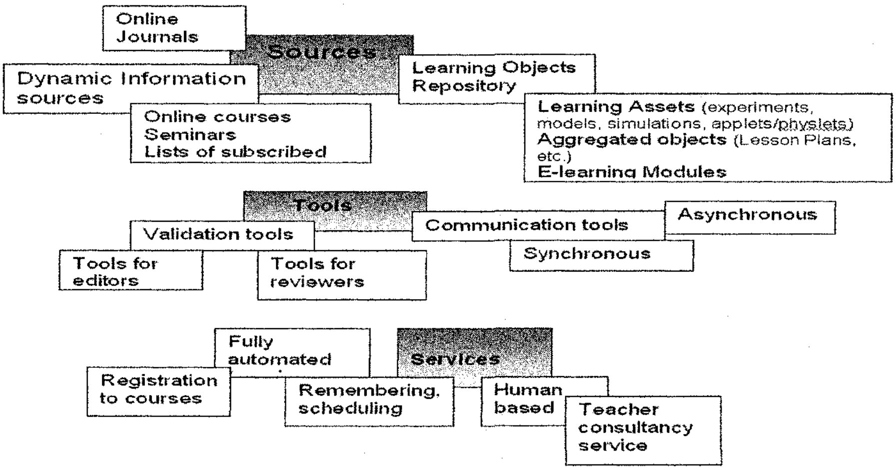

Figure 7. The basic scheme of the Telmae LOR and supportive environment

The online supportive environment TELMAE serves as a reliable source of information (in the Czech language) for students, as well as an environment where it is possible to publish one's own ideas – e.g., " recipe" simple experiments or lesson plans.

3 Selected outcomes in particular

More than five hundred students/teachers' projects have already been published on the TELMAE Learning Object Repository EDUPORT. Each student's work (lesson plan) is reviewed by two independent reviewers, in the same way as all the work done or contributed by common users, contracted authors and "P" level course instructors. In the case of physics and chemistry, reviewers are selected from physics and chemistry experts and experienced teachers of each subject area or teachers with long-term practice. Not all contributed projects are approved by the reviewers; so far one-half of the students′ projects have been published.

4 Conclusions - experience

In-service teachers do not seem to have major problems with laboratory work done during seminars or with managing the virtual environment, either the supportive environment or the online course itself. Students′ attitudes differ though, primarily because of psychological barriers and distance from the study (insufficient self-discipline). Often it is also a slow internet connection that causes problems in the online part of study. Despite these issues, the majority of students are able to complete the courses successfully. Some of the older students manage to overcome the above mentioned barrier for the first time during the course, and since they are well experienced teachers, their results then become examples for other students (see contributed projects on TELMAE). One of the major mistakes observed is students′

"effort" to use ICT in class just for the sake of using it, no matter whether it has any contribution to learning or not. Overall, it is crucial to pay attention to expertise, active constructivist approach to learning and "sensitive" incorporation of ICT to appropriate areas and learning situations.

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An Integrated Pedagogical Approach for Distance Learning Courses: Curriculum, ICT and Management

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Abstract. Distance learning courses need intensive planning that, in turn, requires the integration of knowledge and expertise in different areas and levels such as curriculum, ICTs and course management. This paper presents an integrated approach for distance learning course planning that derives from pedagogical research the basic directives to integrate the process variables such as curriculum, ICT options and management. It is argued that distance learning projects always have some research activity involved, since the operation model construction always requires the identification of course characteristics and specificities in order to face the challenges imposed by this teaching method and take advantage of ICT technologies in a specific socio-economical context. In practical terms, course implementation is focused on pedagogical-driven decisions based on a flexible curriculum model suitable for different implementation scenarios and course characteristics. The integrated approach has been used in various high capillary courses (humanities, mathematics, others) with limited ICT resources.

1 Introduction

Distance learning pedagogical models have revealed themselves as a valuable teaching approach for attending geographically dispersed mass educational demands, even when located in remote regions where face-to-face (F2F) educational services are not frequently available and ICT resources are scarce or eventually unavailable [1,3]. Distance learning courses have faced serious challenges with respect to the adopted pedagogical model and ICT options when their target is focused on large audiences with diversified demands and high capillarity.

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Martins, J.S.B., Quadros, T., 2006, in International Federation for Information Processing, Volume 210, Education for the 21st Century-Impact of ICT and Digital Resources, eds. D. Kumar, and Turner J., (Boston: Springer), pp. 363–367.

It is argued in this paper that for the definition of a flexible pedagogical model adapted to distance learning it is essential to consider the requirements of the distance learning methods with respect to face-to-face ones. Also, the pedagogical model and the technological options adopted have to be adjusted, eventually case by case, to the specificities of the target audience and specific course characteristics. With respect to course implementation and operation, the approach adopted should additionally be integrated in terms of curriculum, ICTs and management.

In order to illustrate these principles a specific model will be presented and discussed for the pedagogical approach developed and adopted by University Salvador - Unifacs that is intended mainly for graduate and post-graduate courses in areas such as humanities, engineering and computer science. The discussed model was worked out as a research activity developed prior to course implementation by a multidisciplinary team at NUPPEAD (Distance Learning Research Group) and, in brief, looks to provide a set of guiding principles for groups dealing with the problem of implementing distance learning courses in diversified implementation scenarios.

2 The integrated pedagogical approach concept and principles

The integrated pedagogical approach concept represents a reference term integrating the various project planning dimensions and its implementation dynamics such as the curriculum model, the learning management approach, the tutoring system, the technological infrastructure, the logistics and the assessment and evaluation methods and procedures (Figure 1). Each one of these dimensions has to be in accordance with the defined institutional pedagogical principles, and beyond that has to overcome the distance learning specific limitations.

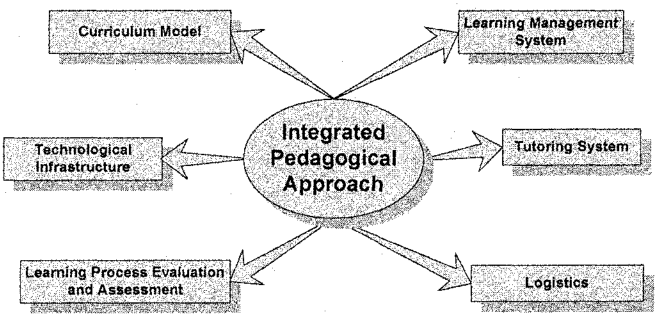

Figure 8. Integrated Pedagogical Approach

In brief, the integrated approach proposed is based on a set of general basic principles such as: collaborative work, interdisciplinary methods, autonomous learning, and meaningful learning [2,3,4].

3 Curriculum model - learning core units, thematic matrixes, flow and module

The curriculum model proposed for the integrated pedagogical approach is structured in various articulated units focusing on providing the target course profile. The units are "Learning Core Units", "Thematic Matrix", "Flow" and "Module" (Figure 2) and, in brief, they try to guarantee the interdisciplinary methods and collaborative work.

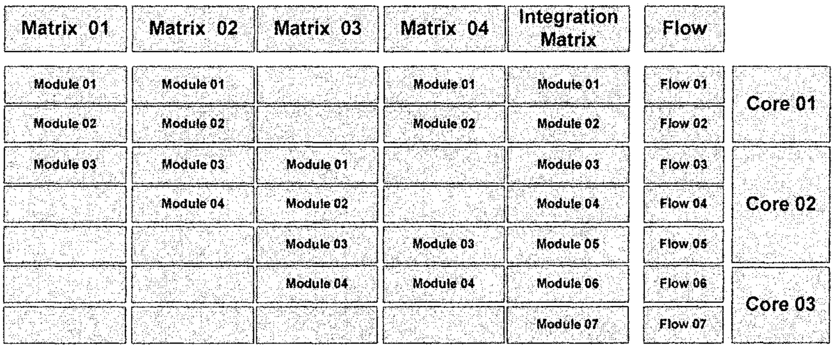

Figure 2. Curriculum Model – Core, Matrix, Flow and Modules

The learning core units correspond to the units defining competences and skills to be developed through the different steps of the professional formation. Each defined learning core unit is a curricular unit equivalent to course main areas which represent specific moments of the course and steps in the professional formation process. The learning core units are composed of either part of or entire "matrix units" and define skills and competences which are to be stimulated and developed in all moments of the educational process. The core has its own objectives and proposes interdisciplinary methods both in horizontal (time frame/ flow) and vertical (curricular completion) planes.

Thematic matrices are curricular units expressed vertically and composed of sets of disciplines which define specific curriculum thematic fields. Matrices articulate disciplines and related contents to knowledge areas. Each matrix has its own interdisciplinary objective and content that effectively articulates its disciplines and objectives. Distance learning curricula are composed of matrices whose number and time duration are defined according to the specificities and duration of the distance learning course.

The integrating matrix (Figure 2) is an important element of the pedagogical approach and is present for the entire course execution period. Its function, as suggested by the name, is to integrate through project development student learning experiences throughout the various flows previewed for the course.

Flows are temporal units in the context of distance learning courses but have no relation to the traditional temporal units adopted by face-to-face courses (periods, semesters, others). Flows in this integrated pedagogical approach correspond to the offering of thematic modules in pre-defined time frames. Flow duration is defined according the complexity of their discipline contents and, typically, provide a realizable execution time frame.

Modules are the basic components of the matrices and are composed of the set of course contents and corresponding disciplines they congregate. In the curriculum model adopted in the integrated pedagogical approach each module integrates a set of course contents which in classical face-to-face curricula would be dispersed in independent disciplines.

In brief, the proposed pedagogical approach is composed of curricular units which operate in an integrated fashion in order to promote the articulation between course contents, competences and skills.

4 ICT options and course management

The information and communications technology (ICT) options to be adopted in the proposed pedagogical approach follow the basic principle of using multiple technological resources either isolated or in conjunction. The effective choices are made according to course objectives, audience profile and local infrastructure facilities available. In addition, the course logistics are adapted to the socio-economics of the target public and region and, as such, the technological infrastructure available has to be taken into account [3,4].

Course management is a fundamental aspect of the integrated pedagogical approach, which proposes a new management model structure with a Course Coordination and Mediation element, a Technical Coordination element and a Matrix Coordination element (Figure 3).

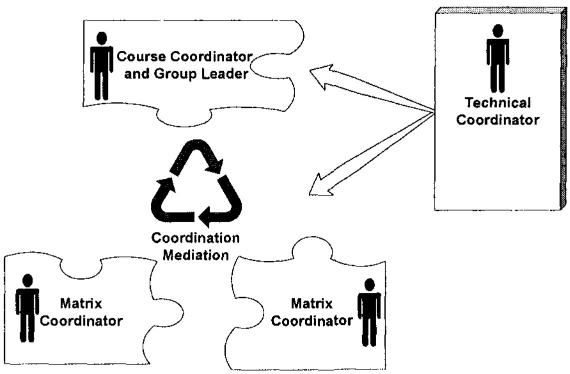

Figure 3. Course Management Actors

The course coordinator, as the name suggests, is the mainelement responsible for the general coordination of the educational process and, beyond that, acts collaboratively in a more general structure where other specific coordination activities are present. In this structure the technical coordinator is a distance learning specialist whose main responsibility is to promote the interchange of expertise among the various courses implemented according the integrated pedagogical approach. The matrix coordinators are responsible for the multidisciplinary course content integration under course coordinator supervision and mediation. Each matrix has its own matrix coordinator working, typically, part time or, optionally, two thematic matrixes are conducted by a single matrix coordinator working, typically, full time.

5 The integrated pedagogical approach – experimental cases and conclusion

The integrated pedagogical approach has been applied to the following distance learning undergraduate courses at Salvador University: Pedagogy Course (2.900 hours) – undergraduate course – number of students: 3.000; Agricultural Business Management (1890 hours) – undergraduate course – number of students: 160; Retail Management (1890 hours) – undergraduate course – number of students: 160; Portuguese and English Language (2.940 hours) – undergraduate course – number of students: 500; Mathematics (2.900 hours) – undergraduate course – number of students: 700

The implemented courses had their curricula defined according to the basic institutional pedagogical principles (collaborative work, interdisciplinary methods, autonomous and meaningful learning). The different course dimensions (curriculum, tutoring, technological infrastructure, logistics, assessment) have been addressed in an integrated planning process, and the technological options have adopted multiple media and multiple communication resources principles.

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Is it Computer Literacy, IT, ICT or Informatics?

What is going on in Austria's Compulsory Schools in the Context of Educational Standards?

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Abstract. Schools in Austria providing compulsory education are accountable for imparting IT skills and informatics competencies to their pupils. The term and subject "informatics" encompasses almost every activity which has to do with computers at schools. In many cases "IT" would be more appropriate to describe the present situation at the lower secondary level. Therefore clarity of the terms "IT" and "Informatics" is necessary. This paper also addresses the issue of developing educational standards in that field, which are considered important to close the digital gap after compulsory education.

1 Introduction

Without doubt the information and knowledge society exerts an enormous influence on education at all levels of schools. This applies not only to vocational schools but also to schools imparting general education. The Austrian school system encompasses the elementary (grades 1 to 4), lower secondary (grades 5-8) and upper secondary levels (grades 9-12/13). This paper mainly deals with the approaches of establishing IT/informatics in secondary education in Austria with respect to the compulsory grades 5 to 9.

Beginning in the early nineties of the last century, the subject "informatics" has been implemented at the secondary lower level for pupils aged 10 to 14 years in various forms. Presently there are only a few lower secondary schools which offer the subject informatics continuously. Until now the lower secondary level in Austria

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must be seen as a patchwork with regard to an overall systematic supply of IT/informatics knowledge and skills.

2 IT/informatics as a part of general education

It is obvious that information technology has dramatically changed the world outside our schools and is changing the teaching and learning environment within them. The survey "Key data on ICT in schools in Europe" reveals that at the age of 15 a majority of European pupils claim to use computers at school regularly. But the PISA study [11] shows that the regularity of using the computer in school activities is still very heterogeneous across all investigated countries. While in some countries about two-thirds of the 15-year-old pupils use computers at schools once or several times a month, there are enormous differences between countries, between the schools within a country, and even between classes or groups within schools.

Mastering of the common language, applying mathematical modeling, being competent in at least one foreign language, the self regulation of acquisition of knowledge, and last but not least IT-competencies are regarded as basic cultural tools [1]. Thinking of a new and widely-accepted contemporary canon of education, we cannot ignore this. Informatics as the basic and referring science of ICT can therefore be considered indispensable in every educational process. Many countries today consider understanding ICT and mastering basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy [6].

Since 1985 when the subject informatics was implemented in all Austrian secondary academic schools in grade 9, this term has been frequently in use and a quasi placeholder for everything which has to do with computers. The artificial term "informatics", deduced from "information" and "automation/automatics" has its origin in Europe, but it is not in frequent use in other parts of the world.

A survey in [4] shows the trend for an integrated approach using ICT. In some countries, ICT is part of the compulsory minimum curriculum. Official recommendations regarding these approaches are fairly similar among the countries. Among the official aims of the curriculum, activities involving the use of software, information searches and communication networks for extending knowledge of various subjects are uniformly the most representative, irrespective of the level concerned in compulsory education. In many countries, the amount of time set aside for ICT is very flexible. Only in a few countries, and particularly in those of central and eastern Europe, is there a minimum annual number of hours to be marked for teaching ICT as a separate subject. Whereas ICT is the common term in most European countries, in Austria it is called "informatics".

ICT is one side of the coin, informatics the other. "Does ICT eat or feed informatics" was the topic of a noteworthy panel discussion held at the ISSEP conference in March 2005 in Klagenfurt (http://issep.uni-klu.ac.at), which as expected did not lead to a clear conclusion. The borders cannot be drawn exactly. They are fairly indistinct and floating. But Table 1 below should provide more clarification and moves informatics definitively towards general education with a certain degree of product independency and conceptual knowledge.

Table 5. A Comparison reflecting the Difference between IT and Informatics

IT	Informatics
specific education	general education
concrete, practical	abstract, theoretical
application oriented	fundamental, basal
instruction, training	education
technical schooling, courses	class, lessons
Certificates	school reports
product knowledge	conceptual knowledge
Just in time and short term learning	sustainability
instantly available knowledge	general knowledge
using software	modeling and developing software
applying software	reflecting the use of Informatics systems
competencies, skills	knowledge, comprehension
executing tasks	problem solving

This dichotomy, with the (job) training on the left side and the alleged (academic) "ivory tower" on the right side, still leaves one major concern: the distinction between "pure" informatics (or is it computer science?) and applied informatics (IT, ICT) also troubles secondary education. While other science, technology, engineering and math disciplines have improved their diversity of terms in the last years, ours has gotten significantly worse.

3 Global frameworks, definitions and approaches

The importance of IT/informatics education is not only restricted to Austria, Germany and the rest of Europe. Global initiatives to establish frameworks for IT/informatics curricula for all stages prove to be a worldwide concern and can be identified in the form of proposals from very prominent institutions such as UNESCO/ IFIP, ISTE and the ACM.

Ludger Humbert [3] stresses the importance of reinforced international networking in the field of informatics in schools. At the same time he complains that the acquisition of IT skills is primary and dominating too much at the expense of a deeper reflection and concepts of informatics.

It is remarkable but not surprising that the task force around Tom van Weert [10] decided to use the uniform denotation "ICT" instead of "computer science". Here ICT is used, applied and integrated in all activities of working and learning on the basis of conceptual understanding and methods of informatics. This framework is based on the definition "ICT by methods of informatics". In order to enrich the discussion about terminology regarding the buzzword "e-literacy", definitions for "computer literacy" [2], informatics literacy [3] or "ICT lieracy" [6] can be found.

Moreover, the UNESCO/IFIP paper [10] defines "informatics" as the science dealing with the design, realization, evaluation, use, and maintenance of information processing systems, including hardware, software, organizational and human aspects, and the industrial, commercial, governmental and political implications of these".

4 About curricula, the ECDL and educational standards

In Austria and also Germany a remarkable debate on curricula is going on. Obviously, curricula do not have the expected impact on the outcomes of the pupils. The emerging buzzword in this context is "educational standards". Obviously, these standards aim at the crucial part of the curriculum, namely the definition of its objectives which are often expressed in terms of learning outcomes.

The recent PISA-study of 2003 [11] revealed some obvious deficits of Austrian pupils in the area of math and problem solving, so that the Ministry of Education immediately reacted to that situation in establishing the shift from input orientation to output measurement in the form of educational standards.

Due to Austria's rather disappointing ranking in the recent PISA-study 2003, educational standards are developed for the subjects German, English and maths. Independent of these activities, since 1998 a remarkable development in the Austrian educational system with regard to IT education has taken place. Under the patronage of the Ministry of Education, the European Computer Driving License [12] plays a prominent role in the Austrian school system. The ECDL certificate is offered at all stages of secondary education, and some schools even adopt the ECDL core syllabus as the basis of the subject "informatics". This is unique in Europe. The syllabus of the ECDL consists of seven modules and matches exactly with the proposed framework in [10] except for modules on ethical issues and jobs and/with ICT.

When speaking of basic IT-skills, one cannot ignore the ECDL. The ECDL with its global extension ICDL (International Computer Driving License) is available in about 140 countries worldwide. At the moment it is the world's leading and largest vendor-neutral end-user computer skills certification program with presently almost 6 million participants. Although the Austrian model of the ECDL in schools can doubtlessly be considered successful, there is concern that it is not an appropriate educational standard for general education. Therefore the Austrian ministry for education is at the point of developing educational standards also in the field of informatics. This initiative aims at a more comprehensive understanding of informatics beyond mere IT product training. Even if these ambitious educational standards should be established, there would be a long road to acceptance.

However, the prospects of realizing these educational standards seem to be promising because the development of ICT literacy as a new assessment domain of PISA has been considered relevant [5]. The development of widely-accepted and output-oriented educational standards could help bridge the obvious gap between IT and informatics and may address the demands from policy makers and the informatics community as well. As a consequence, within their autonomy Austrian schools would have to take appropriate measures to establish an increasing number of informatics classes and/or provide better integration of informatics into other subjects. At present e-learning activities in Austria's schools are noticeable and increase the need for IT competencies grounded in a profound informatics education.

5 Conclusion

We still experience an annoyingly diffuse use of terminology such as "computer literacy", "IT", "ICT", "computer science" or the preferable middle/eastern

European term “informatics”, which in Austria holds for almost every activity with computers. Standardizing the terminology would be a worthwhile global task.

Lower secondary education can still be regarded as at an important stage with respect to IT/Informatics education. Due to the fact that not all pupils in Austrian schools experience the first systematic instruction in IT/informatics, the digital gap is still undesirably wide at this level. Standardizing the learning objectives in the form of educational standards as extended curricula with the focus on output measurement could improve this situation. The certificate ECDL/ICDL, which is offered and accepted at lower secondary schools in Austria, is not compulsory and due to autonomy it does not reach the majority of pupils.

Educational standards for informatics in addition to the quasi-standard ECDL/ICDL are presently developed by formal and informal working groups [13]. In the view of many informatics teachers this is regarded as a necessary process. The result in the form of obligatory learning objectives and appropriate assignments should guarantee that a vast majority of pupils aged 15 will not only dispose of basic IT skills and ephemeral software handling. A deeper understanding of informatics, accompanied by more creativity, problem solving and reflection would be very much appreciated also at the lower secondary level.

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M-learning Standardization: Concepts and New Ideas about Learner Profile

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Abstract. The Learning Technology (LT) standardization process is a hot topic today within the e-learning scientific community. This paper introduces the main LT specifications, and, specifically, presents several concepts about Learner Information standards, discussing some complements to them related to mobile learning.

1 Introduction

Standards can be defined as "documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose" (ISO, 2002).

Concerning E-learning n particular, the process of standardization for the purposes of ensuring interoperability, portability and reusability, includes architectures and reference models, educational metadata, course structures, student assessment, content packaging and encapsulation, student management, runtime environments, and other specifications [1].

E-learning is a concept which comprises almost anything related to learning in combination with information and communication technology (ICT) [2]. We can define it as follows: "E-learning is the acquisition and use of knowledge distributed and facilitated primarily by electronic means."

In particular, E-learning is the use of internet technology for the creation, management, making available, security, selection and use of educational content to store information about those who learn and to monitor those who learn, and to make communication and cooperation possible.

M-learning, or Mobile E-learning, is fundamentally E-learning delivered through mobile computational devices (Palms, Windows CE machines, digital cell phones,

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MP3 players, etc.) [3]. So, mobile learning can provide online learners with capabilities to get instant notification by e-mail, access learning sites, report data from the field, and collaborate with learning colleagues.

But M-learning is much more than simply E-learning through mobile devices. As mobile devices evolve and people discover new ways in which the functionality of these devices can be applied to learning, mobile E-learning will become increasingly different from conventional E-learning and will create a new learning environment; an environment where learners have access to contents, teachers and other learners anywhere and anytime, where the contents they are accessing are dynamic and dependent on their location in space and time, and finally where learners can record any learning content for later use.

2 LT standardization

As we remark above, learning technology standardization is essential for use in systems design and implementation for the purposes of ensuring interoperability, portability and reusability; and there are many institutions and organizations involved in the standardization of E-learning technologies. The more significant domains of work of these bodies are:

• Metadata. Metadata is information about data or other information. Metadata describes how, when and by whom a particular set of data was collected, and how the data is formatted. Metadata standards have been developed to facilitate the management, discovery and retrieval of resources on the World Wide Web [4].

• Educational Modelling Languages. An Educational Modelling Language (EML) is a semantic notation to create units of learning to support the reuse of pedagogical entities such as learning designs, learning objectives, learning activities, etc. An EML describes not just the content of a unit of study (texts, tasks, tests, assignments) but also the roles, relations, interactions and activities of students and teachers [5].

• Learner Information. Learner Information specifications are dedicated to support the exchange of learner information between different systems. They provide data models, including the syntax and the semantics, to describe both the characteristics of a learner and his or her knowledge/abilities.

• Runtime. The basic tasks of runtime environments are content delivery to the student, support of the interaction between the content and the Learning Management System, and deciding the content to be delivered next depending on the static and dynamic course structure and previous student actions [6].

• Accessibility. Accessible design grants a wider range of learners more options and greater flexibility in learning. Presenting educational material in a variety of formats will also provide benefits to those with disabilities and/or with differing learning styles (visual, auditory, tactile) and will allow people to learn in their preferred learning style [7].

• Digital Repositories. Digital repositories store a collection of resources that can be retrieved through the network without knowledge of the collection structure.

• Content Aggregation. The need for educational resource sharing among learning systems and authoring tools motivated the development of common formats and procedures for encapsulating learning resources [8]. These encapsulated learning resources form a package including information about structural hierarchy and behaviors of its resources.

• Architectures and Interfaces. The purpose of developing system architectures is to discover high-level frameworks for understanding certain kinds of systems, their subsystems, and their interactions with related systems [9].

3 Learner information

Learner Information is a collection of information about a learner. The objective of these specifications is to allow the import data into and extraction of data from different systems. They provide data models, including the syntax and the semantics, to describe both the characteristics of a learner and his or her knowledge/abilities [10].

The information is associated with learners and used by Learner Information servers that may exchange data with Learner Delivery systems or with other servers. It is the responsibility of the Learner Information server to allow the owner of the learner information to define the information to be stored and shared.

Basically, information about a learner comes from three different sources: personal information, preferences, and academic information. In the following section we present various contributions to complete some standards and specifications about learner information, especially those related to learner's preferences, because it is in these preferences where specific characteristics of learning through mobile devices are reflected.

3.1 Learner profile and device profile

Inside the Learner Profile, a new type of structure, called Device Profile, will be created. The Device Profile addresses the characteristics of the device used by the learner for learning tasks. More specifically, the Device Profile stores a set of preferences about managing the device related to its particular characteristics. These preferences will be processed as "default preferences", which, if it is possible, will be finally used. To consider those cases in which these preferences can't be satisfied, some ranges of variation about them are defined. Obviously, these ranges must be supported by the considered device.

Ultimately, for facilitating the task of fully supporting the experience of learning according to conditions solicited from the learner, a set of values will be included that indicate the maximum capabilities supported by the device related to its characteristics (e.g., related to speed and types of connection, display capacity, etc.), and always carrying out the user's preferences. Furthermore, a learner can be in possession of several devices for use in learning; because of this, the learner must be able to complete his/her learning through all of them. Depending on his/her situation at the moment, he/she can select, from among all his/her devices, the one that is more convenient at that moment to achieve the learning tasks that he/she wants to complete. In such a case there will be not one Device Profile, but as many Device Profiles as the learner has "learning devices" to be used at his/her convenience.

Therefore, three possible forms to implement the above exist:

- To include all the Device Profiles inside the same Learner Profile, which implies the system must be able to interact with each of the different Device Profiles within a single Learner Profile.
- To permit only one Device Profile per Learner Profile, which implies the existence of several Learner Profiles (at least one per Device Profile) with which the system must be able to interact.
- To permit both previous schemas, i.e., to permit several Learner Profiles (or only one), which can include one or more Device Profiles.

All of this implies the need for researching a set of services to manage all gathered information related to mobile devices. These services must be complete with a series of behavioural models that define how the data will be managed.

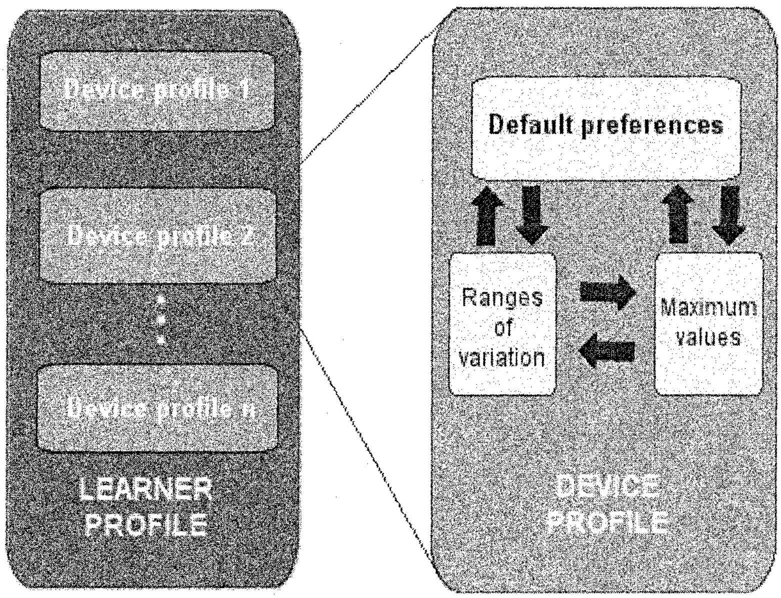

Figure 1. Learner Profile: A possible type of implementation.

The fact of having perfectly defined the different characteristics and capacities of each device that a learner can use for learning facilitates forming groups of learners who have devices with the same or compatible characteristics. To have a number of students with compatible devices in a group makes possible an easier and more effective process for them to interact with each other, and provides a better exploitation of resources as well. Furthermore, the fact that the students know about the existence of other students who use similar devices within their same group stimulates more feedback and sharing among them. Of course, feedback and sharing among learners having different devices must be possible and facilitated too.

4 Conclusions

Throughout this paper we have presented several concepts such as “standardization”, “E-learning” and “M-learning”, and we have introduced the main LT specifications. Finally, we have addressed Learner Profile characteristics and we have proposed a set of upgrades for current Learner Profile standards that consider the special requirements and needs of M-learning and its associated mobile devices.

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Teaching IT to Managers or Teaching Management to Engineers? None of the Above

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Abstract. Information Technology (IT) has been the greatest wealth generator of the last two decades and there is an increasing number of managers who see IT as a strategic weapon and want to harvest their profits. MBA programs are starting to incorporate IT but many times this component gets relegated to one or two irrelevant courses that nobody likes. The opposite direction of adding one or two courses of management to a typical IT program will not produce the future CEO that is needed. We present here our experience with a new program that takes the best of the two worlds. A balanced curriculum (50-50) can be made strong enough in management and in technology. The mixed background of students produces a rich environment where students with business backgrounds benefit from students with IT backgrounds and vice-versa. The preliminary evaluation of this experience is very positive.

1 Introduction

Information Technology (IT) is considered a strategic element for companies and organizations. This has resulted in MBA programs incorporating this subject into their curricula. Since many managers graduate from these programs it is critical that these programs provide sound education in IT. For these students to wholly understand how to take advantage of the new opportunities generated by IT and to face its risks and limitations, contents and methodology must be carefully designed. The challenge is keeping motivation high even when the material is rather technical for this audience.

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Most of the modern management trends are based on technology: CRM, reengineering, e-commerce, e-business and globalization among others. The dotcom revolution increased the visibility of IT by showing the common people that technology could generate impressive valuations. IT went from being a "nerds" topic to being discussed in the highest boards of directors.

Many MBA programs have incorporated IT in their curricula, most of the time as a single course which covers diverse aspects, from hardware and software fundamentals to data mining and electronic commerce. One problem with these courses is that they usually fail to become popular core courses [3] and, even worse, they do not achieve the goal of producing a change in the future manager's *"palette"* of options in such a way that he or she may make the most of the opportunities generated by the technology.

We are exploring a somewhat different approach. Last year we started a new program, called Masters of Information Technology and Management (MTIG)[13], in which both information technology and management are first class citizens. The curriculum includes 50% of courses that are similar to the ones in a typical MBA program, and 50% of courses with information technology contents. Furthermore, we achieved a tight integration of these two fields through the following strategies:

- the mix of students (50% have business degrees, 50% have engineering degrees)
- IT instructors teach with the business perspective in mind (real life examples rather than textbook)
- Instructors of management courses incorporate as much technology as possible

The graduates from this program are, therefore, business people who learn about the new possibilities that IT brings, and also engineers or computer science graduates who learn how this wonderful technology can be used to generate value or to make the organization more efficient. In either case, this is a person who is very well equipped to become the CIO, or even the CEO, of a company where technology plays a crucial role.

2 The MTIG program

We describe here only the most distinctive characteristics of the program.

2.1 Short courses

We realized quite early that the typical semester-long (10 credit hour) courses were inappropriate for our purposes. We needed to cover many different subjects in a short period of time. The solution was to design half-semester courses (5 credit hours), so a student could do 20 or 24 courses in one year instead of just 10 or 12. This solution still allows us to accommodate an unusually large course by cutting it into two courses that must be taken in two consecutive periods.

[13] MTIG corresponds to the Spanish (Magister en Tecnologías de Información y Gestión)

2.2 Non-exclusive dedication

Although the program could be perfectly offered in a full-time dedication format, we decided to start with an evening-only class format.. The decision was based on information we have collected about the potential market for this program: there was a lot of interest among working engineers and managers but nobody would quit his job to enroll in a graduate program. Since we were specially interested in providing these new skills to people who were already in management positions, the best option was to create a part-time program with classes after the regular working hours.

2.3 Duration of studies

The students take only three courses simultaneously (12 courses in one year). The program comprises a total of 24 courses, so it will take about two years for a student to complete the program. During the last semester, the student must also do an individual capstone project. In most cases this project is carried out for the company where the student works. We knew from past experience that this academic load (three courses) is the maximum that a person with a full-time job (especially IT jobs!) can handle without risk of massive failure.

2.4 Methodology

The first problem we had to face is how to teach the hard IT courses to a group that was heterogeneous (many of them already knew a lot of IT) and not necessarily technology motivated (at least half of the group).

Although about 60% of the MBA programs include an IT course [2], students usually are dissatisfied with it and this course, which should be a key course in their formation, simply becomes a barrier to overcome. Frequently this is due to an excessive technical approach which is dissociated from what the student is really interested in: in what way will IT make a better manager of him and how can he take advantage of the new opportunities opened by IT. According to Bacon and Fitzgerald [3], "They tend to expect practice-related, insightful, integrated themes, with useful models that they can take away and use".

We believe that learning by doing is a great way to increase motivation among non-technically-oriented students. For example, instead of giving a power point presentation about the internet, we help them to put together an e-commerce site of their choice. All our IT courses have lab sessions whose purpose is not to teach some specific skills or how to use some software tool, but to keep the students interested in the technology.

A big challenge is how to design the lab sessions such that people with little or no previous technical skills can complete the job, but at the same time the students with the knowledge do not get bored. We solved this dilemma by building every lab experience as a series of small steps. Everybody must do the first 3 or 4 steps. The more experienced students are encouraged to do 5 or 6 steps and receive detailed feedback of their work as a reward. When time is up everybody is tired but quite happy and proud of what has been accomplished.

For instance, the internet course started with a lab experience in which students interact directly with a web server through a simple terminal emulator. The first steps were simple GET requests and then it got more and more involved including specific headers, etc. It was easy to talk about the HTTP protocol after this.

2.5 The capstone project

As we said before, during their last semester in the program, the students must develop a short IT project. This project, in most cases, is developed for the company the student works for, which provides also a sponsor who also serves on the student committee. After a six-month period the student must make a public presentation of her work in front of the members of a committee.

The project itself can go from "how to generate business value through business intelligence tools" to "design of a dimensional model for management control" to "feasibility of biometric authentication techniques in small to medium organizations", etc. The goal is to show that she is capable integrating the new knowledge to solve real problems or situations.

3 The experience

A month after we announced the program and with almost no advertising at all we got many phone calls asking for more details. Our web site got hundreds of visits and many prospective students left their contact information. Even though we had detected the demand before, it was a pleasant surprise to confirm our suspicions. Many of the respondents said they felt this program responded to their needs much better than a Masters in IT or an MBA program. We got a full enrolment (35 students) for the first year only one month after the program was announced. Many of the students said this was just the program they were looking for.

It is still too early to perform a full evaluation, but so far we feel that the students are quite happy. The feedback information is collected through opinion polls that the students complete after each course and also through meetings with a group of students with very different backgrounds. More than 80% say they are happy or very happy with the program. Students with a business background said that only some courses were really hard but nevertheless they enjoyed them and learnt a lot of new things. More important yet, they said that the technological courses were the most interesting and that the new stuff they had learnt changed their view of IT.

Computer science or IT students found the management courses the most interesting (no surprise), but they still enjoyed the technically-oriented courses because there was new stuff that they never learnt before.

What students appreciated most was the heterogeneous composition of the group. The engineers could listen to questions and comments that would never have arisen in an all-IT group. Conversely, businessmen were exposed to the language and views of the IT people.

The instructors worked very hard. There are too many challenges here:

- heterogeneous group with very different backgrounds
- teaching hard technical stuff to people who are not very interested in it

- combining lectures with labs to produce a more constructivist approach
- polishing the contents of most courses because they were all new courses

In spite of all that, students are quite happy with the experience so far. They have all confirmed their participation for a new period and most of them are planning to make a few adjustments according to what they learnt from the first experience. Some teachers who were initially quite skeptical changed their minds completely.

4 Conclusion

An increasing number of managers see IT as a strategic weapon and want to harvest their profits. IT has been the greatest wealth generator for the last two decades. This can be expressed in several ways, for instance: in the U.S., during the 1995-1999 period, 60% of productivity improvements and 40% of growth were explained by information technology [4].

Since many future managers come from MBA programs, it is reasonable to include the IT component in those programs. Until now not many successful experiences have been reported; often times, the technological component gets reduced to one or two electives and they are sought by students only as a barrier that needs to be passed. From the other side, graduate IT-only programs are weak on management and fail to attract the desired audience of decision-making people.

We have described our experience with a program that provides an alternative approach for producing the leaders that 21st century companies require. The curriculum includes management and technology courses in equal proportion. The group of students includes businessmen and engineers. The methodology favors a constructive approach that allows keeping the non-techies interested and motivated. Although it is still too early to celebrate, the results so far are promising. There is a huge interest in the program and both the participating students and the instructors are quite happy. We will have to wait to have a more definitive answer.

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Implementing Use of ICT in Teacher Education

How to add quality to teaching and learning with the help of a Learning Resource Centre

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Abstract. Teachers in Sweden are still in need of digital literacies to master the pedagogical use of ICT in schools. Teacher education has a key role in adding the use of ICT to the abilities of their students and teachers. At Stockholm Institute of Education the Learning Resource Centre has an important role in providing appropriate technology, supported learning environments and competence development for teachers and students. Competence development programs focus on digital literacies. Continuous self evaluation by participants points to good results. The problems which arise for teachers are mainly dependant on lack of time for training and maintaining digital work patterns.

1 Introduction

Even if computers have been used in schools for many years, teachers in Sweden are still struggling to make pedagogical use of ICT, often also lacking proper digital competence. Children's own use of new media and ICT for communication, playing, etc. is a trigger for change in schools. Teacher education has to meet these challenges and introduce adequate ways of teaching and learning with ICT.

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Olsson, L., 2006, in International Federation for Information Processing, Volume 210, Education for the 21st Century-Impact of ICT and Digital Resources, eds. D. Kumar, and Turner J., (Boston: Springer), pp. 387–391.

2 The Learning Resource Centre and its task

At Stockholm Institute of Education (SIE) a Learning Resource Centre (LRC) was set up in 2002 as a means of introducing and supporting the use of ICT in education and research and thus strengthening the competencies of future teachers. This decision was motivated by a number of factors which further underlined the need for digital competencies. Such factors were life-long learning issues, Swedish legislation for higher education which demanded information and media literacies for the students, and not least the competition for the recruiting of students by using new e-learning and distance education possibilities. The task of the LRC, which is named Lärum, is

- to use new pedagogical models, ICT, new media and new library models to generate creative environments for information handling, teaching and learning.
- to have an initiating, coordinating and developing role concerning ICT and its use in education and research.
- to provide, develop and synchronize flexible learning environments, to create a virtual university setting and develop support for distance education in cooperation with other responsible departments.

Two existing departments merged into the new LRC: The University Library with information services, collections, student work stations, user education and new physical learning environments, and the Media Production Department with services for film and video-production, computer- and video-conferencing. An ICT support and project development unit was added to the organization with the goal to build collaborative projects with teachers, students and distance education, and responsibility for net course administration. The staff consists of professional librarians, media producers, teachers, technicians, web designers and project leaders from various disciplines. With this mix of staff know-how, organizational background and professionalism it is possible to develop a unique base for the delivery of training and supporting of key competencies.

The essential idea of Lärum is to provide competence development with ICT and learning environments on a broad basis to a majority of students and teachers and encourage them to develop their teaching and learning abilities by pointing to best practice (rather than perform our own projects of excellence). During 2002-2003 learning environments and basic support functions and web were created. Resources were inadequate and the goals were difficult to attain. 2004 brought about better funding and a formal demand for competence development with ICT.

3 Strategies, leaning environments and digital literacies

The task of Lärum is performed by 1) developing an academic standard which encompasses and integrates key skills of using information, media and technology in teaching and learning; 2) by creating flexible learning opportunities with usable tools; 3) by supporting e-learning as active and experimental learning, and tutor-led environments; and 4) by supporting learner autonomy, the independent learner.

At Lärum we have recognized the following key skills and competencies as the most important ones to help develop and support: 1) *Information literacy* is the ability to understand processes for, and to be able to, access, acquire, organize, and evaluate information and information sources and form valid opinions based on the results as well as use information for problem solving [1]; 2) *Technology Literacy is* the ability to use new media such as the Internet to access and communicate information effectively [2]; and 3) *Media literacy and creativity* is the ability to access, analyse and evaluate images, sounds and words in various media and to produce, communicate and distribute content to audiences of all sizes.

To achieve our goals and intentions we try to inspire and support students and teachers in their actual work situations, e.g., by offering supported physical and virtual learning environments with hands-on oriented tools for use such as the library, a media laboratory, smart boards or groupware. Support is provided by professional staff for such thing as film production. We also try to provide appropriate technology, wireless working areas, video streaming, supported communication platforms, learning platform (i.e., Fronter) or net meeting options (i.e., Marratech).

The continuous use of learning environments guarantees more solid ICT competence. We found that users who have made long term use of communication platforms are more willing to adapt to new ICT tools. Our intentions are to support good habits and best practice. The use of learning environments is to a great extent performed as learning by doing which helps develop technology literacy as well as media creativity. The ratio between student and teacher use for communication platforms, net meeting and video streaming is teachers 70%, students 30%, and for media laboratory, library and groupware is 20% teachers, 80% students. Evaluation of the learning environments is indicated by use which has increased by 150% since the LRC opened. Assessment is also performed by web enquiries with a few questions which indicate a high level of satisfaction.

4 Competence development programs for teachers

Another main strategy to reach our aims is to provide various programs for competence development. These programs are performed according to the principle of integrating learning with task performance. Development programs are directed towards all teachers and all students. All teachers at Stockholm Institute of Education have been offered competence development focussing on the use of ICT. Their active participation in various programs totals 20-40 working hrs. Sustained individual learning is guaranteed by the fact that their own learning goes on during their own teaching, which is why we try to develop IT support and tools which can be used continuously. 300 teachers out of 600 attended standard and advanced Office package workshops. Before the program started a web enquiry was sent out to all teachers. The response rate was 80%, and 60% of the teachers were of the opinion that they needed training in the use of standard programs. The immediate evaluation of the workshops was very positive. However, a more in-depth enquiry of the competence development program was carried out in February, 2006.

So far 120 teachers have participated in a net-based course, which means they have to act as students on the net. The course certifies them as net teachers. It involves their using and learning the communication and learning platforms; making homepages; using web evaluation; using smart boards; making power point presentations; producing web based learning materials; searching, using and evaluating information sources on the internet; adapting and using programs for physically impaired, and training in acting as a distance education tutor. Evaluation is performed after the course is finished. The course gets an overall positive assessment, particularly those parts which focus on information literacy and technology literacy. This distance certification course gives the participants a good opportunity to develop all necessary literacies. Fifty teachers can be considered to be very experienced distance educators, and for those teachers we provide just in time support.

A qualitative evaluation of the competence development program for teachers will be carried out by in-depth interviews with sampled teachers and students and video recording of information searching and producing. Selected courses have been evaluated by teachers through the use of e-portfolios and discussion forums on student work and learning patterns. Every 3rd year a large enquiry on student work and life, i.e. ICT literacies, is performed; the latest was presented in February, 2006.

5 Competence development for students

For students there is comprehensive competence development concerning information literacy, including *Basic Information Search*, *In-depth Information Search* as well as *Individual tutoring*. *Basic Information Search* is a good example of how these courses are carried out. The purpose is that students achieve knowledge and skills in order to be able to search and review scientific information in databases and use web tools for searching as well as being able to critically assess internet sources. The course is designed as a 2 x 45-minute workshop.

I*n-depth information search* classes prepare students for degree projects and theses. The class is designed as a 3 x 45-minute workshop, covering relevant referential and full-text databases, information sources, and individual search practice search methods, search engines, source handling, referential matters, and the question of "what makes an article scientific?". After the workshop, participants should be able to choose relevant databases and information sources, to search for information, and to critically analyze information. During the fall term 2005 509 students participated in the classes and 234 responded to the evaluation. For the basic class 84 responses indicated that 60% were content with the pedagogy and 70% were affirmative that they would benefit from their new knowledge in their future studies and work. The assessment of in-depth information search showed that 150 responded, and 74% were positive that their new knowledge would help them in future studies and work.

6 Conclusion and coming projects

Starting spring 2006 students' formal learning of digital literacies (information literacy, media creativity and technology literacy) will be integrated in the teacher education programme. All new students will have to take a diagnostic interactive web test which tells them their level of proficiency using standard programs and web tools. Throughout the program the learning of digital literacies is attached to the developing of 1) communicative abilities, 2) information understanding, analytic abilities and scientific work patterns, and 3) abilities to perform, analyze and present an investigation. In this way these abilities as well as the literacies are trained in progression. It also means a close cooperation between teachers and staff from the LRC, which already during the planning stage has meant creative development.

Ongoing projects at Lärum are e-publishing, the provision of a school of the future test site and the development and organization of learning objects.

The reason that Lärum so far seems to have had a beneficial influence on teacher education is to a great extent due to the mix of professional skills of the staff at Lärum, which makes creative development and support of a broad spectre of digital competencies possible. Still there is need for competence development of the staff as well. During fall 2005 a net course for all staff started, *Learning in Networks.* The course is operated as a project between Lärum and Åbo and Vaasa universities [4].

To decide future development of Lärum, an external evaluation of the organization was performed in March 2006.

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edu.LMC and Other LMC Simulation Approaches: Contributions to Computer Architecture Education Using the LMC Paradigm

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Abstract. The LMC paradigm is not a recent approach to teaching computer architecture: it has been presented, tested and used since 1965, first by its authors, Madnick and Donovan, and their MIT students, and since then in many other universities around the world. The main purpose of the LMC paradigm is to explain, using a very simple model, the main components of a real computer system, and to learn how to program using a simple decimal-encoded instruction set. Using new LMC simulators (based on the LMC paradigm) developed since then, students can nowadays take advantage of simulation processes (e.g., to simulate a program's step-by-step execution). We evaluated six different LMC simulators, picked the "best practices" associated with each one, and developed a new simulator especially focused on management and informatics undergraduate student requirements. This new simulator, edu.LMC, has been tested in a computer architecture course.

1 Introduction

A large collection of simulators for computer architecture students is available nowadays. Web pages [4] and [5] configure repositories of many of those educational resources. However, most of the referenced simulators are not pedagogically adequate, considering the learning context of management and

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informatics (M&I) undergraduate students. These students have no more than basic skills in computer architecture. One of the simulators that can be interesting in an M&I learning context is the Little Man Computer, LMC, based on the LMC Paradigm, introduced in 1965 by Stuart Madnick and John Donnovan. LMC simulators are "simple instruction level" simulators and "very simple single accumulator based architecture with a small number of instructions, suitable for a first course in computer science" [6]. The LMC paradigm introduces, through a very simple approach, a model to represent the components of a real computer system, very similar to von Neumann's model. Students can write their own programs using a simple instruction set, and the programs can be tested using an LMC simulator.

In computer architecture courses with M&I undergraduate students at ISCAC[14], we have used the LMC paradigm and an LMC simulator to test LMC programs. LMC simulators allow "students to learn the fundamentals of computer organization/architecture by visually observing and interacting with animated data flow within a particular or real machine" and by "using animated resources" [6].

Several LMC simulators were tested: *Son-of-LMC* and three other directly derived simulators – *FoSoLMC*, *AoFoSoLMC* and *LMC Clone*, Interactive Web-based Simulation and LMC Editor/Assembler/Simulator v1.2.

1.1 The LMC paradigm

As a conceptual approach, the LMC paradigm represents easily understood concepts and features providing a very simple way of understanding the functional areas of a real computer system: ALU (Arithmetic and Logical Unit), Control Unit, Memory, Program Counter and Input/Output Areas. The LMC main area is a mailroom whose fundamental components are: *100 mailboxes* numbered with 2 digits from 00 to 99 (that represent memory in a real system and they are used to store decimal coded numbers corresponding to program instruction, values input by user and operation results), *a calculator* (representing an ALU to store, temporarily, input values or output results and do simple arithmetic additions and subtractions), an *instruction location counter* (program counter, which identifies the instruction being executed at a specific moment), *input* and *output baskets* (I/O, recipients to communicate with outside of the mailroom) and a *Little Man* (control unit, which memorizes instructions and mailbox data and supervises the program execution).

1.2 Methodology

We have tested six LMC simulators concerning their editor, assembler, execution and printing areas, manipulation on input/output and their adequacy in M&I undergraduate computer architecture courses. The decision of choosing those six simulators was based on the fact that they were described in many computer architecture education papers and also due to being effectively used in similar learning contexts. After concluding the LMC simulator analysis, we collected their "best practices" and joined them together in a new LMC simulator, edu.LMC, for special use with M&I undergraduate computer architecture students.

[14] ISCAC – Coimbra Institute of Accounting and Administration

2 LMC simulators

During our research we tested several LMC Simulators: Son-of-LMC (available on http://elearning.algonquincollege.com/coursemat/pincka/dat2343/lectures.f03/14LMC-Simulator.htm) and three other directly derived simulators – FoSoLMC, AoFoSoLMC and LMC Clone; Interactive Web-based Simulation (homepage at http://www.itk.ilstu.edu/faculty/javila/lmc/) and LMC Editor/Assembler/Simulator v1.2 (online at http://www.d.umn.edu/~gshute/cs3011/LMC.html). Table 1 represents a synthesis of that analysis especially considering the most interesting functionalities but also some points that could be improved to create an LMC simulator more focused on pedagogical issues for M&I students.

Table 6. Synthesis of the six LMC simulator analyses.

LMC Simulator	Description	Advantages	Disadvantages
Son of LMC [1]	The basis of other simulators: FoSoLMC, AoFoSoLMC e LMC Clone.	Follows strictly the concepts of the LMC paradigm.	3 digit decimal-encoded instructions; no mnemonics.
Interactive web-based LMC Simulator[1], [2]	This approach has been tested with computer architecture students.	3 areas: Source Program, Opcode, LMC and Program Status Field; mnemonics can be used; it supports 3 different addressing modes.	No example files; No help file.
LMC Editor/ Assembler/ Simulator v1.2	This approach seems to be very effective for M&I students.	Program example files; LMC application window divided into Editor, Assembler and Computer Areas.	Installing process not very friendly for students with no Java skills.

3 edu.LMC Simulator

Collecting all the test results done, we developed a new LMC simulator – edu.LMC, which is available for download at www.iscac.pt/~ipedrosa/LMC/edu_lmc.htm. It consists of a Win32 application, created specifically for students with very basic skills in computer architecture, mostly not majors in computer science or computer engineering. This is a special purpose simulator, with a clear pedagogical focus, tested and used during computer architecture classes for our M&I course. edu.LMC uses instruction mnemonics based on the LMC paradigm, allows instruction commentaries and verifies each instruction before the simulation starts. Students can create, run, debug, print and save programs. This simulator includes example files and a help area describing each instruction. It was our purpose to create a simulator that represents a close approach to the LMC paradigm, including all functionalities and features that are difficult to find together in other simulators. Additionally, edu.LMC is simple to use as our main target users are M&I undergraduate students.

3.1 The application

The application window, shown in Figure 1, is divided into 4 main areas:

- **Editor**: program writing using mnemonics. It's possible to write directly instructions or to open program text files (if they respect the defined structure shown in Figure 2) with a .lmc extension. Programs are verified syntactically as we write each instruction and the operation code (opcode) is generated. The *Load* operation puts *Opcodes* in *Mailboxes*. edu.LMC saves programs, presents the current program name, creates new programs, prints the program and all comments and verifies all syntax errors or inputs that can not be supported.

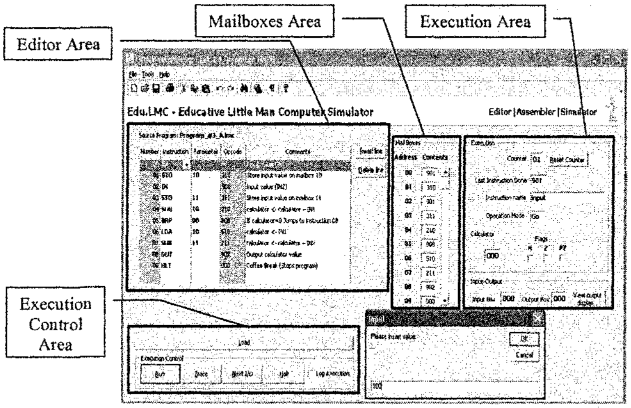

Figure 1. The edu.LMC application window

00 IN; input value (IN1)
01 STO 10; Store input value on mailbox 10

Figure 2. The edu.LMC input text files.

- **Mailboxes**: mailboxes and its three decimal coded contents. The first are taken for program instructions, the last ones for values stored by programs.
- **Execution**: other functional LMC component contents such as calculator, counter (for instruction location counter), last instruction done (important if there are jumps), instruction name, operation mode, flags, I/O boxes and an option to *view output display* (if output sequence are important).
- **Execution Control**: four modes for executing LMC programs - Run (direct execute from 00 instruction until HALT), Trace (Step by Step), Next I/O (execution stops only for I/O values) and Halt (stops the programs anytime).

Edu.LMC aggregates many functionalities: create, open, comment, save, verify, execute and print programs. Besides that, it includes examples classified by level of difficulty, a complete help area with executable examples of each instruction. Users can also view the saved "Execution Log" file, receive detailed information about program tracing and check or change the Mnemonics Conversion Table.

3.2 edu.LMC core functionalities

- **Execution Log**: Usually students find it difficult to understand the way variable values change. It's possible to activate the "Log Execution" option and generate a text file with information about program execution.
- **Program Tracing Information**: This is another way of tracing program execution. If the execution mode is Trace, a dialog box with information about each instruction is presented, as well as the next one to be executed.
- **Mnemonic Conversion Table**: A significant number of LMC simulators use different instruction codes. This table gives a user the chance to configure those codes or to restore default values.
- **Print Report**: The user can save his programs and/or print them. The Print Report content is very similar to the Editor Window.

4 Conclusions and future work

We have tested six LMC simulators in order to find an adequate simulator for our undergraduate M&I students. Our conclusion was that those simulators included numerous features that are difficult to find together in one simulator. Therefore, we decided to design edu.LMC, a new LMC simulator, simple and user-friendly, and especially focused toward our target students. edu.LMC can be improved by adding functionalities concerning address modes, more examples, a feature to implement array concepts and also an efficient way to represent the fetch-execute cycle.

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Information Technology Literacy: Examples from Academia in Chile and Hawaii

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Abstract. This research describes the challenging task of identifying new required competencies and responding with new ITL programs in two different regions. The first one, in Chile, is part of an Ibero-American initiative, ALFIN (ALFabetizacion en INformacion). The second one, in Hawaii, is part of a nationwide program in the United States, advocated by the American Library Association, the Association of College and Research Libraries, and the American Association of School Libraries, among other agencies. Research findings include the target audience of IT programs; copyright issues; necessary cooperation among domain instructors, education specialists, librarians and technology specialists; tools and systems being considered; and distance education

1 Introduction

ACRL[1] defines information literacy (IL) as the ability to 1) recognize an information need, 2) access information, 3) evaluate information and 4) synthesize information. Computer literacy (CL), on the other hand, is defined as the "level of expertise and familiarity someone has with computers. Computer literacy generally refers to the ability to use applications rather than to program." (http://www.webopedia.com). The term Information Technology Literacy (ITL) is becoming the preferred term as it implies a close relationship between IL and CL.

Research methods and procedures include analysis of documents, action research, focus groups, evaluation of ITL programs and workshops as well as interviews with IL, ITL, and CL program managers, researchers and instructors. The data gathered provided descriptions of the goals, programs, plans, and implementations of both initiatives in Hawaii and Chile. The main purpose of the

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analysis was to identify good practices, challenges, and work necessary to have information literate citizens.

2 Background / Motivation for this study: Information Technology Literacy (ITL)

ITL is a theme that has become a new strategic element in the development of the Information Society. Associated with new educational models, ITL is based on the interaction of teaching, research, and information services. The goal is to have a citizen who is able to critically evaluate information and contribute their own values to the new culture. Quiroga's [2] research on the educational needs for building digital libraries in Latin America showed the importance of having information technology literacy. Different agencies such as government, private, non-profit, and academic institutions made large investments digitizing valuable collections that were not used as expected by instructors and students. A possible reason is related to the lack of ITL competences necessary to integrate digital collections in their teaching and learning.

3 Information literacy in Hawaii and Chile

Hawaii adheres to a set of national standards. The Association of College and Research Libraries ACRL [1] developed the "information literacy competency standards for higher education." The American Association of School Librarians AASL [3] developed IL standards for the K12 community. The standards for student learning include information literacy, independent learning and social responsibility.

In Ibero-America, Spain has made the greatest contribution of Spanish publications that include models, research, proposals, standards, and experiences on "Alfabetizacion en Informacion", ALFIN. There is a commission on ALFIN that is coordinated by the University of Havana in Cuba, with several regional focus points, as part of EDIBCIC (Association of IberoAmerica and the Caribbean teachers and researchers in Archives, Library, Documentation and Information and Science).

In Chile, the University of Playa Ancha, as part of its participation in ALFIN, is leading an initiative aimed at developing regional standards. The recommended national standards developed by the United States are part of the work being studied by the ALFIN group in their search for models that could be adapted and used in the Ibero-American region. The Library Science Program at the University of Playa Ancha created a research line in IL. Several projects financed by the General Direction office allowed the development of models, programs, diagnosis, and evaluation tools as well as a constant reflection and discussion on IL in conferences and seminars. A recent proposal for the creation of a national network to collaboratively work on IL is a step toward collaborative work at the national level. Other initiatives have emerged from the school libraries section of the Ministry of Education. The goal is to provide teachers in middle and high schools with information competences and skills. Other projects aimed at providing IL to the citizens are headed by the Chilean Library of Congress. There is an awareness of the importance of IL, and a clear interest in developing these competences and skills to the Chilean population.

4 Information Technology Literacy (ITL) issues identified in Chile and Hawaii

In Chile, and as part of a recent research project developed within the framework of ALFIN, Loyola [4] and Matus [5] and a group of students at Playa Ancha University participated in research aimed at identifying their needs regarding ITL competences and skills. Data was gathered using action research, focus groups, interviews, and evaluation of ITL programs and workshops.

In Hawaii, data was gathered by interviewing IL, ITL, and CL program managers, researchers, and instructors in two universities and one community college. They provided descriptions of the goals, programs, plans, good practices, and the challenges they are facing.

4.1 Target audience

In Chile and Hawaii, the emphasis is on educating the students. ITL for instructors is provided indirectly by involving them in the student ITL program. Young students consider themselves competent in computers, information technologies, word processing, and internet searching and browsing mechanisms. From their point of view, that is all that is necessary to be information literate. It was found, however, that they fail at discriminating and assessing the validity and credibility of information. Many of them are unaware of other resources offered in libraries such as online specialized databases and electronic resources. One ITL program, being used in an academic library in Hawaii, invites students to take a pre-test on ITL. Librarians found that taking this pre-test helped students realize their weaknesses and motivate them to enroll in an ITL program.

Some instructors consider themselves to be competent doing research and distinguishing bias, different points of view, and the validity of claims and information. However, many of them have been more concerned with the content of their studies and teaching, leaving aside the ITL skills needed to incorporate digital content in their instruction. Some of them need computer literacy rather than information literacy. In the information technology literacy course offered to graduate students by the Library and Information Science program in Hawaii, students reported a good experience from an activity designed to coach faculty in a personalized, one-to-one fashion. This kind of training seems to be more accepted by faculty than workshops as their information technology competencies and needs vary. These examples point to the need for various kinds of ITL programs that are targeted to different needs and demographics where age is an important element. A significant proportion of university students are returning to prepare for second careers. They are mature persons who might have a different ITL need when compared to their teenage classmates, who were born using technology and who face the rapid changing technologies naturally.

4.2 Copyright

Being competent in the understanding of copyright was mentioned as one of the abilities needed by instructors, especially those working in distance education. Librarians interviewed mentioned that the notion of fair use was more clearly understood in the world of print and analog media. Currently, these librarians perceive that even they need a better understanding of digital copyright laws before trying to educate instructors on these issues. Special collections, such as those in arts, films, and photography, for example, are some of the disciplines where copyright infringement can have serious consequences for instructors and librarians.

4.3 Necessary cooperation

Efforts to foster cooperation among domain instructors, education specialists, librarians and technology specialists were represented in the data that was collected for this paper. Instructional modules must be designed in cooperation with educational specialists in order to produce valid teaching and learning methods and procedures. Librarians contribute their knowledge of sources and information retrieval systems and their ability to identify users' information needs to the design of the instructional modules. In both regions there are programs in Information Technology Services to facilitate instructional design and computer literacy. However, at one Hawaiian university, the library and the instructional design support program are part the same unit. This has made it easier to collaborate, and plans are being made to integrate computer literacy and information literacy.

4.4 Tools and systems

A large variety of ITL tools and systems ranging from complete courses (usually aimed at incoming students), web tutorials, and the use of proprietary collaboration software such as WebCT were used. An interactive system, successfully used by students and instructors affiliated with the University of Hawaii, is the Library Information Literacy Online (LILO) http://www.hawaii.edu/lilo/. This system is modeled after the North Carolina State University system for Library Online Basic Instruction. LILO was designed by library faculty in collaboration with instructional design specialists. LILO guides the students in all steps of research. This process includes finding a topic, constructing a thesis, developing search strategies, as well as learning how to cite sources, and avoid plagiarism. In addition, they learned to evaluate information critically for reliability, accuracy, and relevance. A useful feature of LILO allows students to maintain a journal of their research process. This information can be accessed by faculty who want to track students' progress.

In Chile, they primarily use open source software. At the University of Playa Ancha, several web based virtual classrooms have been devised that include ITL modules. In addition, open source blogs are used both to train library staff in ITL and to design ITL instruction.

4.5 ITL and online education

Programs to teach ITL online are being conducted in Chile and Hawaii. LILO is an example previously described in section 4.4. However, it was recognized that little has been done to integrate ITL as part of the curricula for distance education programs. Another element to consider is the need to provide ITL to instructors to increase their participation in distance education. Several studies have explored the relationship between faculty use of information technologies and their participation in distance education delivery. They found faculty more likely to participate in distance education when they think their technology skills are adequate.

5 Information technology literacy challenges in the digital age

ITL is perceived as one of the main roles for librarians in this digital era. To be information technology literate implies the ability to search for relevant information and to organize and maintain our personal digital libraries and collections. It also means we need to be able to use social networking systems such as blogs and wikis to gain the benefit of being active participants in a community of practices; i.e., groups of people with common interests.

A partnership between educators, librarians, IT experts, and domain specialists, among others, with support of government and private organizations, is needed to account for the resources necessary to study and implement the most relevant practices in ITL. A research area of interest includes an analysis of programs and challenges in developing partnerships and linkages aimed at computer literacy, information literacy, and information technology literacy programs.

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A Staff Development Program for Promoting Change in Higher Education Teaching and Learning Practices

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Abstract: This paper presents and discusses a faculty development program being carried out at the University of Aveiro, aiming at providing academics with essential skills in areas such as teaching best practices, student-centered curriculum design, collaborative learning and the adoption of ICT/Internet technologies.

1 Background

Founded in 1973, the University of Aveiro is one of the youngest Portuguese Universities, with a staff of more than 900 in 2006, including senior and junior members. The traditional model of teaching has been centred on the teacher with the predominance of information-passing style in lectures. However, new technological innovations, the globalisation of our society and culture, and new lifestyles will bring a demand for a different type of education. The role of the teacher as well as the student has been changing in the past years due to the new demands of the information society. Faculty cannot be focused only on the delivery of knowledge but also on how that knowledge is acquired by students and the resources they use to make the information more accessible [1].

From that early stage in 1998 up to today, the adoption of the Internet has soared. At the present the university owns a Blackboard Academic Suite™, which includes an LMS and a Content Manager. More than 90 per cent of the 12.000 students and over than 80 per cent of more than 800 staff members use Internet-based ICT to support their daily teaching and learning activities.

Continuous professional development (CPD) programs for faculty members at universities have never been a priority in Portuguese higher education institutions. Neither the rules for academic career progression nor the institutional authorities stimulate the personal and institutional investment in the development of

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pedagogical and didactic skills, except for a minor part of self-stimulated staff members or educational experts.

However, our own and others' experience is providing evidence that the use of Internet-based ICT promotes a set of benefits not only to students but also to teachers, providing means to enrich student-centred learning experiences. Many arguments may be used to explain this effect, but a relevant one is that the use of Internet-based ICT may lead a teacher to organize learning as a set of activities that will engage learners in pre-established tasks that require their own effort to be accomplished. This leads to a direct involvement of learners, improving the chances of meaningful learning experiences, thus resulting in the acquisition of new knowledge.

Taking advantage of the reorganization of higher education in Europe towards the creation of a common higher education space, as defined by the Bologna declaration, the University of Aveiro has decided to organize a CPD program running in 2005 and 2006. This initiative aims to help faculty members to get a better understanding of the power of Internet-based ICT in the promotion of their teaching and learning skills.

2 The staff development program

Technologies are tools to help build solutions. So is the case in education: technologies, namely Internet-based ICT, are tools to help build and deploy learning solutions. But technologies are not the solution by themselves. Technologies can even be a problem if not properly used. For example, if they are not used as a way to achieve a required result, but just as an easy way to create funny gadgets.

That is why the initial of the three modules that compose the staff development program covers the basic concepts and strategies relating to pedagogy and curriculum design in higher education. The second module provides an in-depth view of the power of Internet-based ICT in education, and addresses the most relevant issues concerning the current status of standardization and available products for the creation and management of learning solutions using Internet-based ICT. Finally, the third module addresses the practical issues related to building and managing distributed learning communities.

The next section provides a description of the general organisation of the program and a short syllabus of each of the three modules.

2.1 General organization

Each module of the staff development program runs for 2 months with a 50-hour workload and is organised on a blended-learning approach, thus comprising face-to-face (f2f) and Internet-supported distance activities.

In each module there are three one-day f2f moments. The first happens at the end of the first week of the module. During the first days of this week some distance activities are proposed, namely a couple of ice breaking social activities and some initial readings. This first f2f activity is very important because it enables students to build a common understanding of the learning outcomes to be achieved and of the work strategies to be used during the following weeks. It is, also, the moment for each person to get acquainted with the other participants and to understand the possible scientific, professional and personal bridges that students may be interested in establishing with each other, namely for the work to be carried out throughout the module.

The second f2f session is held at the end of the fourth week, and is used to share the work that each group has developed after the first f2f meeting and to (re) organise the work for the last part of the module. Each module ends with the third f2f session comprising final presentations and discussions. The completion of an online portfolio of the reports highlights the work carried out throughout the module. This final activity is strongly recommended since it will stimulate the reuse and dissemination of the knowledge acquired by the participants.

2.2 The pedagogy and curriculum development module

Today, we acknowledge a growing concern of the faculty members about the issues of pedagogy and academic success. It is clearly a turning point in the traditional conception of teaching and learning in higher education [2].

Bearing in mind the continuous transformation of higher education (HE) systems all over Europe, we believe that more than ever, academics need to reflect upon issues such as university pedagogy and curriculum development. Furthermore, continuous professional development of university teachers will create more qualified teachers in the area of didactics and educational sciences.

In order to achieve this purpose, this module is build on three premises: i) the acquired knowledge of pedagogy and curriculum design in HE, ii) best teaching practices, and iii) professional experience of the participants. The activities developed throughout the module comprise f2f or on-line debates about a specific issue of the program. These debates will lead to a set of written reports that will culminate in a final portfolio.

At the end of the module, participants should be able to achieve a number of competences, such as i) critical analyses of the challenges of HE in the context of the Bologna declaration, ii) critical thought, with a strong theoretical emphasis, regarding the curriculum design and the process of teaching and learning in HE, and iii) ability to monitor their practices as a way of modifying and improving their daily teaching activities.

2.3 The ICT module

The main objectives of the ICT module are to familiarize academics with the current status of the power of Internet-based ICT in education and to provide a comprehensive view of the status of standardisation.

Learners are encouraged to read reference texts covering the main areas of application of technologies: content delivery, individual and group interaction through asynchronous and synchronous communication, and assessment, among others. Furthermore, the need and advantages of using a comprehensive management environment is discussed, leading to the familiarisation with the typical functionalities currently available in Learning Management Systems (LMS), Learning Content Management Systems (LCMS) and Learning Activities Management Systems (LAMS).

As far as standardization is concerned, learners are introduced to the most relevant standardization organizations (e.g. ADL, IMS, IEEE) and an overview of current standard specifications is provided. Special attention is given to the SCORM model and to the IMS Learning Design specification, and discussions are carried out concerning concepts such as re-usability, content granularity and its interdependence.

During the first f2f session of this module, a general presentation of the main topics is provided. However, most of the time is reserved for practical exercises concerning the creation and organisation of work areas in an LMS and the creation of SCORM-compliant learning objects and their integration under the LMS. For this last purpose the eXe™ authoring tool is used, which provides a very easy and user-friendly tool. For the organisation of the learning objects content the use of the IMS Learning Design concepts and paradigm is encouraged, leading the way for an activity oriented learning strategy.

The work plan adopted in this module provides a complete and comprehensive view of the steps regarding the creation and maintenance of learning contents in LMS/LCMS/LAMS and, also, of the main technological paradigms and options that faculty members have to face when designing a course.

2.4 The collaborative teaching and learning module

Collaborative teaching and learning in higher education is certainly the secret for the academic success of students, academic staff, curriculum and institutions [3]. But the big question is how to effectively mobilize the actors of the process for contributing to the new teaching and learning paradigm. In fact, recent trends and meta-trends in educational theory and practice in higher education emphasise collaborative teaching and learning for students and academic staff construction or co-construction of knowledge and pedagogical and technological innovations in teacher education systems [4]. This point is very important for different actors, mainly to the students and academic staff. One important issue that we should focus our attention on deals with the following question: how do lecturers and students manage the different problems these learning situations pose and what do they actually do and must they do in the future? In this context, the learning communities assume a relevant importance. Recently, there is a growing attention to the development of on-line learning environments, which easily allow "partnerships between academics across faculties and disciplines; partnerships across multiple campuses; and partnerships online regardless of location" [5].

Thus, the aim of this module is to promote the development of learning partnerships inside the University of Aveiro and in the near future across countries. Following this main purpose it is our objective:

To identify new forms of learning and their implications for the future of teaching and learning in higher education.

To describe learning partnerships in the context of lifelong learning.

To describe on-line learning environments and to explain the advantages of some e-learning platforms such as Blackboard.

To reflect about best teaching practices and new forms of teacher training.

The tasks are planned to engage actively the participants of the module with the broader objective to establish learning partnerships inside the work group. Furthermore, some of theses activities will imply the discussion of some topics in the f2f sections as well as in the discussion forums using the ICT teaching-learning tool: Blackboard.

3 Conclusions

The main project aims targeted the development of specific intervention strategies for academics to improve their knowledge of topics such as curriculum design and collaborative learning by using an ICT teaching-learning tool (Blackboard).

Faculty members acknowledge this staff development program with a lot of interest, and all the available places (more than 150 for the three modules) were filled.

The courses are currently being run, and preliminary evaluation based on informal questionnaires and case studies developed by trainees show that the program helped academics develop their methodological and technological skills and also their perception about the adequate role of ICT as an enhancement factor to improve higher education teaching and learning practices.

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Intelligent Learning Objects: An Agent Approach to Create Interoperable Learning Objects

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Abstract. Reusing learning material is very important to design learning environments for real-life learning. The reusability of learning objects results from the product of three main features: modularity, discoverability and interoperability. We proposed learning objects built based on agent architectures, called Intelligent Learning Objects (ILO). This paper discusses how the ILO approach can be used to improve the interoperability among learning objects, learning menagement systems (LMS) and pedagogical agents.

1 Introduction

This paper addresses the improvement of interoperability among learning objects in agent-based learning environments by integrating learning object technology and the multi-agent systems approach. According to Downes [3], Mohan & Brooks [10], and Sosteric & Hesemeier [11], a learning object is a piece of learning content that can be used several times in different courses or in different situations. According to Downes [3], the cost of developing learning materials for e-learning can be large, but if related courses are taught, the subject matter is similar and the cost of developing learning material can be shared. The learning object approach promises to reduce significantly the time and the cost required to develop e-learning courses. The use of reusable learning objects to create learning environments improves speed, flexibility and economy.

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A learning object must be modular, discoverable and interoperable in order to be reused [5]. To achieve these features and improve the efficiency, efficacy and reusability of learning objects, many people have dedicated a great effort. The main focus has been on standardization. Organizations such as the IMS Global Learning Consortium [7], IEEE [6], ARIADNE [1], and CanCore [2], have contributed significantly by defining indexing standards called metadata (data about data). Metadata contain the information to explain what the learning object is about, how to search, access, and identify it, and how to retrieve educational content according to a specific demand.

Mohan & Brooks [10] point out some limitations of current learning objects. According to them an instructional designer must carefully examine a large amount of learning object. The task of finding the right object may be quite time consuming and the learning object metadata are not very useful in supporting pedagogical decisions.

On the other hand, the state of the art in intelligent learning environments (ILE) points to the use of architectures based on the multiagent paradigm [8]. Using the multiagent approach can result in faster, more versatile and lower cost systems. We proposed the intelligent learning object (ILO) approach as a useful way of enabling the reusability of agents making up pedagogical systems.

2 Intelligent learning objects

An intelligent learning object (ILO) is an agent that promotes learning experiences to students in the same way as learning objects used to do. For this reason, an ILO can be seen as a learning object built through the agent paradigm. The technological basis of this approach is combination of the technologies for learning objects and for multi-agent systems.

As a learning object, an intelligent learning object must be reusable. The *reusability* is given as a result of three features: **interoperability**, **discoverability** and **modularity** [5]. In a learning object approach, metadata is used to give discoverability by describing the pedagogical content of the learning object. To enable the **discoverability** feature in ILO, we have adopted the IEEE *1484.12.1 Standard for Learning Object Metadata* [6]. The **modularity** of learning objects can be reached with a good pedagogical project. The design of the pedagogical task of an ILO must be made according to the expertise of some object matter specialists and pedagogical experts. Some **interoperability** can be reached by the use of well-known standards. For this reason, we adopted two learning object standards: a) the IEEE *1484.12.1 Standard for Learning Object Metadata* [6]; and, b) *IEEE 1484.11.1 Standard for Learning Technology – Data Model for Content Object Communication*. The 1484.11.1 standard is defined for communication of learning objects with *Learning Management Systems* (LMS). We use this standard in interactions among ILOs.

To assure interoperability among agents we have adopted the concepts defined by FIPA [4]. FIPA is an organization which defines standards to enable interoperability for multiagent systems. The main concern of FIPA is the definition of standards to enable the communication between agents. A well-defined communication framework is vital for interoperability among agents. We have used this reference model to define a communication framework for ILOs. The ILOs must use this framework in order to communicate with each other.

3 The ILO multi-agent architecture

The ILO architecture [12] encompasses three types of agents. The ***Intelligent Learning Object Agents*** are responsible for playing the role of learning objects. They generate learning experiences for the students in the same sense of learning objects. The ***LMS Agents*** are abstractions of learning management systems. They are responsible for dealing with the administrative and pedagogical tasks involving a learning environment as a whole, providing access to the ILOs for the students and storing information about the students.. The ***ILOR Agents*** are abstractions of learning object repository systems. They are responsible for storing data to permit a user or an agent to find ILOs. Figure 1 illustrates the proposed agent society.

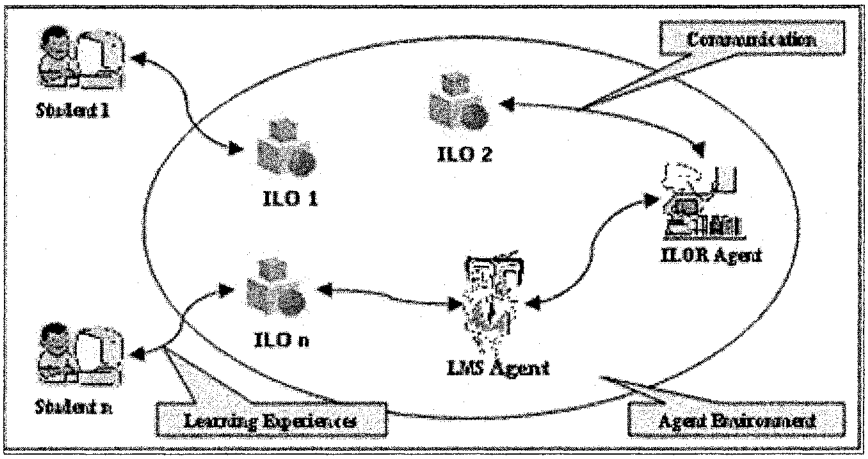

Figure 1. Proposed agent society

The students interact with the LMS agent in order to have learning experiences. The LMS agent asks the ILOR agent to search the appropriate ILO. The ILO is then responsible for generating learning experiences for the students. All these communications are performed by message exchanging using FIPA-ACL [4].

4 Case study

We developed an extended FIPA framework composed of a set of Java classes designed to build ILOs as easily as possible and applied this framework to the agent-based learning environment described by Lucas [9]. Such a system is composed of an ILO playing the role of a special calculator and an animated pedagogical agent (see Figure 2) playing the role of an animated tutor to help primary school students to learn some fundamental mathematical properties of multiplication.

Figure 2. The APA giving an instruction.

The animated pedagogical agent works like an LMS and the calculator pedagogical agent is a typical ILO. The communication between the two agents is performed using the FIPA communication framework.

5 Conclusions

Intelligent learning objects are able to improve the adaptability, interoperability and interactivity of learning environments built with these kinds of components by the interaction among the learning objects and between learning objects and other agents. This concept of communication is more robust than a single method invocation as the object-oriented paradigm used to be.

The test bed application showed that the proposed approach of agent-based learning objects promises to be useful to improve the interoperability of learning objects, pedagogical agents and agent-based learning environments. The pedagogical agents are capable of providing suitable messages to the student and interact with the learning objects in a powerful way. This interaction provides more reality to the environment, and the student feels that he/she and the agents are active characters in the learning process.

While the development of educational content is converging to the use of standards towards reusability, we are still developing *ad-hoc* pedagogical-agent-based learning environments. This is the issue that this paper addressed. We should start to think about reusability when developing pedagogical agents. We need to go towards the use of reusable and interoperable pedagogical agents. The convergence between learning object and agent technologies seems to be promising.

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Software Engineering 2004 – A Jewel in the ACM/IEEE-CS Curricula Effort

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Abstract. We outline the ACM/IEEE-CS sponsored Computing Curricula project, and then discuss the context and development of its Software Engineering Volume (SE2004).. We then discuss evaluation of the volume, internationalization, the relationship with other disciplines, and the importance of the document's future evolution.

1 Introduction

The last five years have seen a major international achievement in computing education. This has been the production of a set of curriculum volumes for undergraduate programs by the Association for Computing Machinery (ACM) and the IEEE Computer Society (IEEE-CS). These volumes address the broad field of computing including Computer Science, Software Engineering, Computer Engineering and Information Systems.

The work commenced in 1998 with an analysis of the existing Computing Curricula 1991 (CC'91) [1], which was also sponsored by the ACM and IEEE-CS. A survey of educators was conducted as part of the analysis. This early work resulted in the decision to divide the curricula into several volumes, each focusing on a particular computing discipline. So far, five discipline volumes have been produced plus an overview report. The Computer Science volume (CS2001) was published in December 2001, followed in 2002 by the Information Systems volume (IS2002). The Software Engineering volume (SE2004) and the Computer Engineering volume (CE2004) were both published in 2004. The latest version of

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the Overview volume, currently known as Computing Curricula 2005 (CC2005), and the Information Technology volume were available in draft form in September and October 2005 respectively. All the volumes can currently be accessed via the education web-site of the ACM [2]. The Computer Science volume, the first in the series, contains not only the material relevant to computer science but also some details of the overall project. Updated information on the latter appears in the Overview volume.

It is our opinion that the volume on Software Engineering (SE2004) [2] along with supporting material in the Overview volume, will have a particularly large impact. We believe that SE2004 will act as a catalyst for the development of more and more software engineering programs and should ensure that there are standards and consistency not just within individual programs but also among programs at different educational institutions, across countries, and around the world. We have no doubt that the production of this volume will be recognised in the future as a watershed both in software engineering education and in the maturity of the software engineering discipline. In Sections 2 and 3 of this short paper we provide outline details of the development and content of SE2004. Then in Section 4 we discuss such issues as how SE2004 was evaluated, its international scope, and our view of how it should evolve.

2 The development of SE2004

The project to produce SE2004 has been supported by four main groups of volunteers: a Steering Committee, an Advisory Board, an Education Knowledge Area Group responsible for defining and documenting a body of knowledge known as the Software Engineering Education Knowledge (SEEK), and a Pedagogy Focus Group responsible for using the SEEK in the development of appropriate undergraduate curricula and the definition of undergraduate software engineering courses/programs. The effort was ably led by Rich Leblanc (for the ACM) and Ann Sobel (for IEEE-CS). Further details of all volunteers involved can be found on the project web site [3]. The guiding principles adopted for the volume [2] emphasised that to be successful, the process of creating SE2004 must include participation by as many interested parties as possible, including not only educators but also business and government professionals. It was also of the highest importance to ensure that there was a fully transparent process open to scrutiny by the community. In the end, well over 100 volunteers participated both as contributors and reviewers. In addition, the development involved:

- Public reviews by the software engineering community
- Invited reviews by recognised experts in the field.
- Presentations at conferences to keep the community informed, and to seek input.
- A major invited workshop in Chicago to support definition of the SEEK.
- Articles in community publications, such as FASE and ACM SIGSOFT Software Engineering Notes, to inform the community (e.g., [4] and [5]).
- Open meetings and workshops at major conferences to provide information, carry out activities, and provide feedback. Many of these have been formally reported in detail (e.g. [6]).

3 An overview of the content of SE2004

The body of SE2004 [2] consists of eight chapters: 1: Introduction, 2: The Software Engineering Discipline, 3: Guiding Principles, 4: Overview of Software Engineering Education Knowledge, 5: Guidelines for SE Curriculum Design and Delivery, 6: Courses and Course Sequences, 7: Adaptation to Alternative Environments, and 8: Program Implementation and Assessment. These are followed by an extensive bibliography and two appendices that provide detailed descriptions of proposed courses (A), and lists of contributors and reviewers (B).

Essentially the volume consists of four logical parts. The first, comprising chapters 1 to 3, provides contextual information. This includes background on the SE2004 effort itself, expositions on aspects of software engineering (the discipline, its role as an engineering discipline, and the importance of professional practice), and the principles that underpinned the project.

Chapter 4, presenting the Software Engineering Education Knowledge (SEEK), forms the second logical part. The SEEK is divided into 10 *Knowledge Areas* (KAs) that are appropriate to undergraduate education. Each KA is subdivided into *units* and further broken down into *topics*. For each unit, recommended contact hours are given and for each topic a Bloom taxonomy level is given. The KAs are: Computing Essentials, Mathematical and Engineering Fundamentals, Professional Practice, Software Modeling and Analysis, Software Design, Software Verification & Validation, Software Evolution, Software Process, Software Quality and Software Management. It should be noted that these KAs differ from those defined within SWEBOK [7]. The reason is that the latter addresses knowledge appropriate to four years of professional practice whereas SEEK's target is the knowledge required by a new graduate. In the volume SEEK's relationship to SWEBOK is made quite clear.

The third logical part is Chapter 5. This contains a series of 18 guidelines to be considered both by those developing an undergraduate SE curriculum, and those teaching individual courses. The guidelines are grouped under four main headings: 1) Guidelines Regarding those Developing and Teaching the Curriculum; 2) Guidelines for Constructing the Curriculum; 3) Attributes and Attitudes that should Pervade the Curriculum and its Delivery, and 4) General Strategies for Software Engineering Pedagogy. Each of the guidelines is expanded to provide further advice on its application and warnings regarding possible problems that could occur.

The final logical part of the SE2004 document comprises Chapters 6 to 8. These are devoted to the practical aspects of developing software engineering programs. Chapter 6 presents courses and course sequences. A set of example curricula are presented which can be used to teach the knowledge described in the SEEK according to the guidelines described in Chapter 5. Patterns for introductory courses, core software engineering courses, and other courses are discussed in turn. Further details of the courses are given in Appendix A along with mappings to the SEEK. Chapter 7 is devoted to considerations relating to adaptations to alternative environments such as three-year colleges. Finally, Chapter 8 covers issues associated with program implementation and assessment, and in particular issues associated with: curriculum resources and infrastructure, assessment and accreditation issues, and software engineering in other computing-related disciplines.

4 Discussion

The project to produce the SE2004 volume was large and complex, making it appear slow. The time required was both due to the extensive use of volunteers with concurrent responsibilities, and the care taken to ensure that there was a full and transparent development and review process as outlined at the end of Section 2. It is of particular interest to note that all comments received were considered in depth by the relevant steering committee members. Both the comments and feedback on actions taken in response to the comments were permanently recorded on the project website. The standard set for acquiring and responding to public comments, and especially the use made of on-line tools in this process, was formally recognised by the Chair of the ACM Education Board in his annual report following the publication of the volume. He said it set a new benchmark standard for future ACM-sponsored curriculum guidelines [8].

The project is also notable for the efforts made to address the internationalisation issue. A guiding principle for the software engineering volume was that it must strive to be international in scope. Also, the members of the steering committee were very mindful of the adverse reactions to the computer science volume (CS2001) that occurred during sessions devoted to it at the World Conference on Computers in Education (WCCE2001) in Copenhagen in August 2001 [9]. At those sessions charges of a clear US bias were made. In the software engineering effort, not only were reviewers recruited from around the world, but also the steering committee and the Knowledge Area and the Pedagogy Area focus groups had international leadership and membership. Once again, the success in this area was highlighted by the Chair of the ACM Education Board as setting a benchmark standard [8].

One area that often causes consternation is the relationships between software engineering, computer science, and the broader disciplines of engineering. The chairs for the SE2004 volume worked hard to ensure that a balanced perspective always prevailed. They had to be particularly sensitive to the situation in the US where there are still relatively few software engineering programs at the undergraduate level, and where strong computer science and engineering professional communities jostle for influence. However, the work that has been undertaken has resulted in the relationships among the disciplines being more clearly defined. This has been reflected in the overview volume [2] where significant consideration is given to addressing the "spaces" in which of the sub-disciplines lie.

One question remains: what will happen in the future? Some of us believe that the publication of the software engineering volume will act as a watershed that will lead to the development of increasing numbers of software engineering programs producing the type of graduate that industry so obviously needs. These new software engineers will perhaps start to change the world of software, and poor quality will become a thing of the past. Nevertheless, one thing is clear and that is that the software engineering volume cannot be allowed to stagnate. There need to be mechanisms in place that will monitor its use, track the developments that flow from it, and, at appropriate points in time, ensure that it is examined and updated to reflect the ever-changing faces of education and computing.

Acknowledgements and supporting information

Parts of this paper draw from reports and materials that have been produced by members of the steering committee to promote dissemination of information about the volume. We would also like to acknowledge the contributions made by everyone involved in the development of the SE2004 curricula. In addition, it should be noted that during its developmental stages the project was known as CCSE (Computer Curriculum Software Engineering) and that references to this still appear, for example, in the name of the project web site [3].

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Abstracts for Posters

Incorporating Security Concepts into the First Course in Computer Science

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Abstract. Poorly written programs and applications are still the main source of security vulnerabilities and failures. In this poster presentation we discuss the need and importance of teaching and incorporating security principles from the very beginning in the computer science curriculum and present six security-related projects that can seamlessly be incorporated into the first programming course in computer science.

University Network in Research and Education on Experimental Mathematics

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Abstract. An inter-academic network within Universidad Tecnológica Nacional, Argentina, is organized in order to develop a new program on research and education on calculus through the conception of experimental mathematics. The aim of this

consortium is to change the conventional way to learn mathematics into a modern one by means of available software tool applications.

The central focus is the experimentation accounted for through the development of the Mathematical Exploratory Learning Systems (MELS), where students experiment and solve problems. Many scientific and common life problems are proposed for discussion. MATHEMATICA© Notebooks about Calculus (Functions, Derivation, Integration) have been developed. A MELS library is envisaged in order to help professors and students in their work. They may choose the ones suitable for their subject matters.

We treat mathematics like physics, an empirical discipline, a place where things are discovered because they are seen. Computers provide students with a "laboratory" in which they perform experiments, analyze examples, test ideas, gain insight and intuition, and discover relationships, similar to the experimentation in physics and biology.

WebQuests and Blogs in Teachers' Education: Postgraduate Students' Reactions

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Abstract. This paper reports Portuguese postgraduate teachers' reactions to the creation of a Blog and to the development of an educational website. During the semester students write on their Blogs their opinions, criticize papers,and indicate sites or events they were interested in. The Blog was used as an e-portfolio, and the teacher always commented their posts in the Blog.

Students also had to develop an educational web site and all but one group chose to create a WebQuest. Their difficulties in conceiving a WebQuest and their opinions about the implication of the WebQuest in learning are described. Students reported to have enjoyed the design of a WebQuest and the creation of their own Blogs as well as the posting. In their reflection at the end of the semester about the contribution of the course outline to their professional life, they mentioned feeling prepared to use the internet in their classes.

Integrated Teaching of Programming Foundations and Software Testing

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Abstract. The importance of software testing is widely recognized, but usually only a small portion of the computer science (CS) curriculum is allocated for teaching it. Some experiences have suggested that the teaching of software testing should begin as early as possible so an adequate culture of testing could be created. One way to achieve this is dealing with testing practices in conjunction with programming concepts in introductory CS courses. In this poster we explore this idea, working on the integration between the teaching of software testing along with the teaching of programming foundations. We discuss the development of an educational module and its related learning materials for integrating such knowledge domains. Besides that, we propose – PROGTEST – a web-based environment for the submission and automatic evaluation of practical programming assignments based on testing activities, aiming at providing an adequate feedback to evaluate the learners' performance concerning programming and testing.

Remote Support for Lab Activities in Educational Institutions

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Abstract. RAP (Remote Assistant for Programmers), is a web and multi-agent based system to support remote students and programmers during common projects or activities based on the use of the Java programming language. To be able to support their users, personal agents build and maintain a profile of them. One of the most interesting features is that RAP is not a closed system, but based on a dynamic network of RAP platforms (i.e., some platforms can be disconnected, the platforms can be grouped on a set of disconnected systems) managing groups of geographically localized users and documents. In fact, the application is aimed at helping students and researchers in the context of the @lis-TechNet project, and it leverages the worldwide network of agent-based platforms deployed during the project.

MultiMedia Culture: Transcending Boundaries Through the Lens of a Camera

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Abstract. The project MMK is an actual blend of multicultural and multimedia aspects at an Austrian school. Due to Austria's history multicultural belongings do not have a long tradition. We use the attraction of multimedia equipment and the matter of our visually adjusted society to focus on the boundaries of heritage, education and experiences of the children. We seek these boundaries to then transcend them. It is a third, a fourth or already a fifth world that the children at our school dive into, a world of art and confusion. The Socratic principle is an aid for the children and teacher to achieve their goals. Several videos will be presented.

Using On-Line Museum Exhibits in Education

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Abstract. How well do virtual museums (i.e., those with web-based exhibits and web-accessible databases), support educational uses at varying levels of knowledge acquisition? Teachers' and students' responses to utility surveys will be used to address this question, and to make useful recommendations to the museum web-development community.

Computer Science Curricula Design for Peruvian Universities: San Pablo Catholic University Case Study

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Abstract. This paper gives the basis, strategies and principles for computer science curricula development for Peruvian universities. This work is based on Computing Curricula 2001, the latest curricular recommendation of ACM and IEEE-CS. As a case of study this poster proposes guidelines for computer science curricula development at San Pablo Catholic University (Arequipa, Peru).

Discovering Mathematical Concepts with Dynamic Software: A Demonstration

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Abstract: This presentation demonstrates the implementation of dynamic software in secondary mathematics classrooms (grades 7-12). It illustrates successful activities for infusing *The Geometer's Sketchpad*, version 4.06 (Key Curriculum Press) and *Winplot* (available free over the internet) into the teaching and learning of geometry, algebra, trigonometry and introductory calculus. Unlike traditional instruction, which follows the lecture→example→assignment sequence, this software offers modalities for learning that appeal to students with a variety of learning styles. Moreover, it mirrors the recommendations of NCTM and prominent learning theorists. Specifically, NCTM (2000) advocates mathematics instruction that is inquiry-based, collaborative, and involves open-ended investigations. The *Geometer's Sketchpad* and *Winplot* provide learning environments that accommodate these activities. Specific applications of this software within an NSF-funded ($11.6 million) project are included. The project, titled "Mathematics, Science and Technology Partnership" (2003-2008), is conducted at Hofstra University on Long Island, New York.

Workshop on Informatics Education: Bridging the University/Industry Gap

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Summary. The theme for the workshop is "Bridging the University/Industry Gap. It will provide a forum for an examination of the many types of interaction that can occur between universities and industry within the field of informatics (e.g. undergraduate projects with industry, staff exchanges) and the generation of categorizations. It will also allow an opportunity to exchange opinions and views on the key issues that relate to each type of interaction. The overall purpose of the workshop is to provide inputs into the development of a formalised framework that could be used to support not only the documentation of university/industry interactions but also future evaluations of such interactions and the industry practices that they have highlighted.

The workshop represents the third participative input into an international project that is supporting the work of IFIP Working Group 3.4 (Professional and Vocational Education) and which is being funded through the United Kingdom's National Teaching Fellowship Scheme (NTFS). A major aim for the overall NTFS project is to develop guidelines and recommendations regarding the identification of proven industry-related best practices and the incorporation of the treatment of these into both undergraduate and post-graduate computing curricula (including curricula that relate to maintenance of competence for existing professionals).

It is intended that the workshop will have a highly interactive format that will involve the active participation of all attendees. Any formal presentations that are made by the attendees in support of their viewpoints will be relatively short – the emphasis during the day will be in active participation with the goal of producing useful deliverables. Also it is intended that extensive use will be made of activities within small groups which will then report back to the main group. The workshop will close with a "brain storming" session for all participants. This will discuss progress made, identify future goals and strategies, and obtain opinions on current industry best practices that should prove useful within the subsequent stages of the project.

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