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Arthur Tatnall
Anthony Jones
(Eds.)

Education and Technology for a Better World

9th IFIP TC 3 World Conference on Computers in Education, WCCE 2009
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Volume Editors

Arthur Tatnall
Victoria University
PO Box 14428, Melbourne 8001, Australia
E-mail: arthur.tatnall@vu.edu.au

Anthony Jones
The University of Melbourne
Melbourne 3010, Australia
E-mail: a.jones@unimelb.edu.au

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Preface

Education and Technology for a Better World was the main theme for WCCE 2009. The conference highlights and explores different perspectives of this theme, covering all levels of formal education as well as informal learning and societal aspects of education. The conference was open to everyone involved in education and training. Additionally players from technological, societal, business and political fields outside education were invited to make relevant contributions within the theme: Education and Technology for a Better World.

For several years the WCCE (World Conference on Computers in Education) has brought benefits to the fields of computer science and computers and education as well as to their communities. The contributions at WCCE include research projects and good practice presented in different formats from full papers to posters, demonstrations, panels, workshops and symposiums. The focus is not only on presentations of accepted contributions but also on discussions and input from all participants.

The main goal of these conferences is to provide a forum for the discussion of ideas in all areas of computer science and human learning. They create a unique environment in which researchers and practitioners in the fields of computer science and human learning can interact, exchanging theories, experiments, techniques, applications and evaluations of initiatives supporting new developments that are potentially relevant for the development of these fields. They intend to serve as reference guidelines for the research community.

Proposals were invited on a wide range of topics relevant to the theme and included, but were not limited to these streams (based on the Stellenbosch declaration, WCCE 2005):

- Digital solidarity
- Learners and lifelong learning
- Teachers – teaching and role of teachers
- Decision making strategies/policy
- Networking and collaboration
- Innovation and creativity in schools
- IT security in Academia
- Informatics, programming and problem solving

Perspectives:

- societal perspective
- learning and teaching
- technology and infrastructure
- research

It is usual for the conference to reflect new trends, presenting the more relevant research in the area. Among the hot topics that have often been discussed there, we can cite those in the areas of innovation and creativity in schools, informatics, digital solidarity, learners and life long learning, networking and collaboration and teaching and the role of teachers.

Along with traditional paper sessions the conference had several symposia and expert panels for professional in-depth discussions and reflections. A special stream was dedicated to Lifelong Learning under the IFIP AGORA umbrella. The Workshops also complement the main conference by providing a more focused target audience for discussion of current topics of interest. These activities are not reported in this book or the CD proceedings but were aimed at initiating or continuing activities and events throughout the world after the conference.

All this has been the tradition since the First World Conference on Computers in Education (WCCE) that was held in Amsterdam, The Netherlands in 1970, and these conferences have since then been organized every fourth to sixth year in: Marseille (France), Lausanne (Switzerland), Norfolk (USA), Sydney (Australia), Birmingham (UK), Copenhagen (Denmark) and Cape Town/Stellenbosch (South Africa) before finally arriving in Bento Gonçalves, Brazil this year – the first time in South America.

The main goal of the **WCCE 2009** proceedings is to offer a venue for the presentation of a sample of the best papers submitted to the WCCE 2009 Research Track. In particular, this special issue is of relevance to anybody interested in current research in computers and education and the development and use of relevant applications and tools. This keeps with the spirit of the event, which aims at stimulating contact between participants in order to exchange experiences on applications, methodologies and management of educational hardware and software.

We would like to thank all the scientists who contributed to this WCCE 2009 edition. We received 289 contributions to the conference, whereof 146 were accepted as full papers, and finally 48 of these were selected as the best papers to be published in this book. All conference papers were peer reviewed by at least three reviewers, and those published in this book were subjected to additional peer review before acceptance.

We also thank the members of the International Program Committee who did a very good job and worked hard given the total number of contributions we received. Moreover, we want to express our gratitude to the editors Arthur Tatnall and Anthony Jones for making this book a reality.

Finally, we are also grateful to the WCCE 2009 organizing team, our sponsors and in particular to the participants. WCCE 2009 was an IFIP event hosted by the Computer Society of Brazil and organized by UFRGS (Universidade Federal do Rio Grande do Sul) UFSC Universidade Federal de Santa Catarina, and IDESTI (Instituto de Capacitação, Pesquisa e Desenvolvimento Institucional em Gestão Social de Tecnologia de Informação).

May 2009

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Part I

Invited Papers from Brazil

Scientific and Technological Education in Brazil: Advancements and Challenges for the 21st Century

Claudio André, Norma Teresinha Oliveira Reis, and Demerval Guillarducci Bruzzi

Ministério da Educação, MEC, Brazil
claudio.andre@mec.gov.br, normareis@mec.gov.br,
demervalbruzzi@mec.gov.br

Abstract. There is a complexity of challenges related to scientific and technological education in Brazil, including literacy in basic concepts and principles by students; better pre- and in-service teacher training; sufficient supply of computers, internet and other technological resources to all Brazilian public schools; provision of teacher training on how to effectively use such tools; and promotion of public awareness of science and technology and their vital role socioeconomic development and sovereignty. Recognizing the importance of fostering usage of technologies in education and the urgency of promoting and encouraging synergic efforts in the development, implementation, monitoring and evaluation of policies/programs/projects for science and technology in pre-college education, it was created in 2008, the Coordination of Educational Technologies, in the structure of the Brazilian Ministry of Education. This paper aims to: a) provide a general panorama of Brazilian education; b) discuss some current Brazilian efforts targeted to the advancement of scientific and technological education in pre-college education. As an illustration, we present the so-called "Guide of Educational Technologies," a publication that allows educational managers to select resources that contribute to the enhancement of education in their school systems. This publication offers a wide range of educational technologies, such as in-service courses for teachers, web resources, software and programs targeted to several educational areas and demands.

Keywords: Science education, educational technologies, quality in education.

1 Introduction

Education is a fundamental pillar for the construction of a project of society committed to the promotion of sustainable development and social welfare. Any sovereign nation based on principles of democracy, social equality, and ethics is sustained by an inclusive education. For this reason, the Brazilian Ministry of Education has been working towards amplifying access and enhancing quality of education offered in both public and private educational systems. For the Brazilian government, education represents an investment and priority for present and future. It is also a legitimate right of every Brazilian citizen.

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In order to better contextualize Brazilian education, we present some aspects of our State. The Brazilian State is a Federative Republic composed of 5.564[1] municipalities, distributed in 26 states and a Federal District and constitutes a legal democratic state, founded on principles of sovereignty, citizenship, dignity of the human person, social values of labor and of free enterprise and political pluralism, according to its Federal Constitution of 1988. A considerable fraction of public policies, such as the educational one is executed in collaborative regime with states, municipalities and the Union. This regime is foreseen in the federative pact, as a constitutional principle.

The Brazilian national territory extends over 8.514.876.599 km^2,[2] and is divided in five geographical regions that present, despite a linguistic unity, extremely heterogeneous cultural and socioeconomic patterns. As a consequence of differentiated levels of industrialization and socioeconomic development, states and municipalities in different regions present unequal levels of investment and management potential, mainly in societal areas. Such inequalities also lead to disparities in the educational sector, in regard to both economic-financial and qualitative aspects.

The Brazilian educational system is divided in two levels: basic and higher education. The basic level comprises early childhood education (kindergarten and preschool), devoted to children from 0 to 5[3] years old; elementary and middle education, which sum up nine years of compulsory education, from 6 to 14 years old; secondary education, ranging from 15 to 17 years old, which has been integrated to vocational education, preparing youth for the labor market and to continuation of studies. It also comprises modalities such as youth and adult education, devoted to those did not have access or continuation of studies at regular age, and special education, responsible for assisting impaired students, preferably in regular educational systems.[4]

As mentioned previously, public educational policies in Brazil are carried out in an intergovernmental collaborative regime. States, the Federal District and Municipalities are autonomous in the management of their respective education systems. The Ministry of Education, by constitutional principle, exerts normative, re-distributive and supplementary functions, coordinating and proposing educational actions at national level.

The Brazilian educational system is composed of public and private institutions, which follow curricular guidelines elaborated by the National Council of Education (CNE), normative organ associated to the Ministry of Education. In the division of responsibilities regarding the offer of education in the public sector, the Union is responsible for offering higher education. Primary and secondary education should be offered by both state and municipalities. A considerable parcel of secondary education is under the responsibility of states and a certain contingent is managed by federal sphere. Municipalities are responsible for offering early childhood and elementary education with priority.

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[1] Brazilian Institute of Geography and Statistics – IBGE, Brazil in Numbers, v. 14, 2006.

[2] Ibid.

[3] Law number 11.274, February 6, 2006, determines that all six-year-old children be enrolled in fundamental education, which will be nine years long instead of eight, as it used to be.

[4] Impaired students used to attend specific classes/schools. Currently, they are being integrated to regular classes always that possible, as an inclusive action. The purpose is that these students realize they are also capable to learn and interact with the “normal” ones.

The Brazilian Ministry of Education (MEC) has been strengthening partnerships with public and private educational systems (municipal and State levels) and intensifying the dialogue with different societal groups for a collective elaboration, implementation, monitoring and evaluation of policies, programs and projects targeted to strengthen and improve educational services offered.

In an effort to better improve the education offered, the Ministry became concerned with paying closer attention to the need to strengthen scientific and technological education offered in the country. As a response to that the Coordination of Educational Technologies was created in 2008, responsible for conceiving and implementing public policies for the advancement of scientific and technological education in pre-college level, and for integrating and coordinating public, private, and societal efforts to foster education in such fields – so strategic to assure national development, as we will discuss in the coming sections.

2 Panorama of Brazilian Education and Public Policies of the Ministry of Education

Brazilian education is guided by a systemic vision[5] [1], that is, the understanding that the success of each educational stage/level contributes to the success of the next. For instance, higher education has to be prioritized if one wants well-prepared teachers. Based on lessons learned from prior public policies that used to prioritize one educational level in detriment to others, and after several societal debates, it has been decided to assure equal priority and financing to all educational levels. The Brazilian Ministry of Education, guided by this *vision*, has been conducting policies aiming to assist and invest equally in all education levels and learning modalities. Actions cover the following areas: a) Basic Education; b) Higher Education; c) Vocational and Technical Education; and d) Literacy and Continuing Education. Programs and projects implemented in each area harmonize and complement themselves and are designed to make it possible for students to have access to all education levels.

In cognizance of the constitutional collaborative regime with educational systems, the Ministry, by means of its Secretariat of Basic Education,[6] has been making efforts to promote social quality in education. This quality has an inclusive dimension, committed to providing an efficacy that could be translated into effective learning, knowledge democratization, and social inclusiveness. Brazil has been gathering substantial progress in the expansion of educational scholar assistance in all levels and modalities[7]. Actually, enrolments enjoyed a quantitative evolution with the inclusion of 97.3%[8] of children from 7 to 14 years old in school. Currently, Brazil is in course of universalizing access also for students in early childhood education and high school, by means of equitable state financing of each phase of basic education.

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5 Term coined by the current Brazilian minister of education, Dr. Fernando Haddad.

6 Includes early childhood, primary and secondary education.

7 Presently, we have two modalities: a) regular education and b) youth and adult education. Thanks to a recent policy, impaired students are being progressively included in regular classes; they used to represent a separate education modality in the past.

8 Brazilian Institute of Geography and Statistics – IBGE, National Research by Domicile Sample – PNAD, 2005.

Access, though, is far from being the unique challenge. As a matter of fact, results of our *National System of Basic Education Evaluation* – SAEB, reveal that it is mandatory to pay closer attention to education quality – which involves knowledge construction and development of abilities, attitudes and values expected by the end of the school year. Retention, drop out, age-grade distortion demonstrate the urgency of investing and qualifying even more the education offered, as well as of assuring access to all stages and modalities in basic level.

For this purpose, in 2007 the *Brazilian Education Quality Index* – IDEB was launched, in provision of incentives at sub-national level. This index is based on systematic evaluation of how schools are achieving their goals. This indicator is established in a scale ranging from 0 to 10. Using this tool, the Ministry established biannual performance goals for each school and systems until 2022. Currently, IDEB average for elementary level is 4.0 in public schools; while in private institutions the number is similar to industrialized countries, reaching, 6,0. The new index used in its first measurement data from 2005. Two years later, in 2007, it was proved that the joint effort of government and society working for the betterment of education could generate tangible results, as shown in Table 1. Based upon analyses of IDEB numbers, the Ministry offered technical/financial support to municipalities with insufficient indexes. The amount of resources has been defined from adhesion to the so-called *Commitment All for Education* and the elaboration of the *Plan of Articulated Action* (PAR).

Table 1. IDEB 2005, 2007 and projections for Brazil

	Elementary school				**Secondary School**			
	Observed IDEB		**Goals**		**Observed IDEB**		**Goals**	
	2005	2007	2007	2021	2005	2007	2007	2021
Total	3,8	4,2	3,9	6,0	3,4	3,5	3,4	5,2
Public	3,6	4,0	3,6	5,8	3,1	3,2	3,1	4,9
Federal	6,4	6,2	6,4	7,8	5,6	5,7	5,6	7,0
States	3,9	4,3	4,0	6,1	3,0	3,2	3,1	4,9
Municipalities	3,4	4,0	3,5	5,7	2,9	3,2	3,0	4,8
Private	5,9	6,0	6,0	7,5	5,6	5,6	5,6	7,0

In order to enhance this index, the Federal Government proposed, in partnership with society, the so-called *Education Development Plan* – PDE [2], which comprises the Plan of Articulated Actions, and represents an effort involving government, educational systems, private initiative and other societal actors working in partnership to construct basic education with quality and for all. This pathway was chosen because such task is just too large and complex to be achieved individually, hence the entire society should be involved.

The *Plan* sets goals for quality in basic education, contributing for schools and secretariats of education to get organized in assisting students. It also establishes a basis on which families can have support to require education with quality. The *Plan* also foresees accompaniment and advisory to municipalities with low educational indicators. It also comprises investments for qualifying educational managers and other basic education professionals, evaluation of offered education; consolidation of mechanisms for social engagement in education, such as school councils; as well as actions to strengthen of scientific and technological education.

As a matter of fact, PDE represents advancement in Brazilian public policies for education, in the sense that in works with effective mechanisms of integrating societal efforts to construct collectively the desired education. This *Plan* makes it possible that the Ministry of Education work along with society to construct and consolidate education with quality and inclusive, in the scope of a systemic vision.

3 Scientific and Technological Education for Sustainable Development

Education for the 21st century presents novel and complex challenges for everyone. Teachers and students are faced with demands of living in a societal fabric characterized by globalization, social inequalities, changes in the traditional family structures, diversity, the influence of media – TV, internet, inclusiveness of impaired students, changes in the labor market, just to mention a few. Productive process has been acquiring high complexity, so that quality and permanent learning becomes mandatory [3].

Science and technology sectors are fundamental to sustainable development of nations (Waack and Amoroso, 2005). Since the Industrial Revolution, scientific and technological advancement has been contributing to generate different levels of development amongst nations [4].

In order to assure higher levels of development in science and technology, national governments have been adopting several strategies to maintain and enhance their level of autonomy and competitiveness in these sectors. One such strategy refers to the elevation of citizens' proficiency in science and technology, by strengthening science and technology taught in schools. In fact, scientific and technological education plays an important role in the preparation of citizens considering that society, mainly from the 20th century on, has been permeated by processes, products and services that require of all individuals a certain level of scientific/technological literacy for effective social inclusiveness (Reis *et al*, 2008). Preparation of professionals in such sectors constitutes also a high priority.

Education in science and technology hence plays a vital role in this panorama. Success of the teaching/learning process of science and technology challenges students, educators and policy-makers worldwide. The integrated understanding of sciences as part of everyone's life has not been achieving the expected results. This is partially demonstrated by national and international standardized evaluations applied to students, such as the Programme for International Student Assessment – PISA [5], which shows that many pre-college students worldwide have not been learning these subjects as they were expected to.

Certainly it is also correlated with both global literacy processes starting during or before elementary education, as well as with intra and extra-scholarly factors. As for the intra-scholarly factors, teaching methodologies sometimes go far beyond the typical manner that students learn. Education in science and technology also faces challenges correlated to pre-service and in-service teacher training. Moreover, schools do not always offer proper conditions/technologies to the quality of the development of pedagogical practices in these areas.

Knowledge changes extraordinarily fast these days. Science and technology evolves very rapidly. The internet has been revolutionizing the manner individuals interact with information and knowledge and teachers are not always sufficiently prepared to work with students born into a world much more changeable and dynamic than the world of just a couple of decades ago. Currently, students need to access, filter and organize a wide amount of data coming from several sources. Due to the expansion of technologies of information and communication – TICs, the production and distribution of information became more accessible to a larger amount of individuals. Nevertheless, information should be translated into knowledge. The process by which students used to learn in the near past (the paradigm of Industrial Society), linearly, cannot be used successfully in the knowledge society. Today, students should have abilities to navigate the cyberspace and work effectively with new TICs. This cybernetic environment, by its turn, is characterized by being non-linear and non-sequential [6].

It is necessary that schools evolve as students change their manner of interacting with the fast transformation in the world scenario. The pathway to assure success in this change must take into serious consideration constraints, interests and possibilities of all actors involved: students, teachers, educational managers, community, parents, and so forth, in a collective, democratic process of gradually substituting ancient paradigms, concepts, and methodologies for those required for the school of the 21st century.

4 Brazilian Policies for Scientific and Technological Education in Basic Level

Countries that acquired higher levels of socioeconomic development invested in educational programs focused on quality. Evaluation results of education quality have shown discrepancies amongst industrialized and developing countries, and meaningful differences between nations that faced the challenges of scientific and technological sectors and those that did not.

In Brazil, there are several initiatives that contribute to the betterment of scientific and technological education of pre-college students, some of them carried out by government, primarily the Ministry of Education in partnerships with educational systems, the Ministry of Science and Technology, and others by the private sector and other societal actors.

Nonetheless, scholarly education in Brazil should improve its approach in order to adequately meet current demands in this area. Apart from the problems related to initial and continued teacher formation and others intrinsic to curriculum, schools lack the basic structure to scientific teaching and practice. From the 143.631 schools that, in 2005, offered some of the primary school grades: 6% counted with science labs; 12% had computer labs; 15% had internet access; and nearly 23% had libraries. For the secondary schools, the situation is better, but still distant from the ideal conditions to make it possible scientific and technological education with social quality. From the 16.570 schools with secondary education in 2005, nearly 38% counted with science labs; 51% had computer labs; 58% had access to Internet; and 79% counted with libraries or reading rooms [7].

Aiming to change this panorama and enhance the quality of basic education, the Brazilian Ministry of Education is implementing the Program of Incentive and Valorization of Scientific and Technological Education in Basic Level. It is a set of articulated actions targeted to promote enhancement of conditions required to a scientific and technological education with quality and for all.

The program is national and counts with the involvement of public and private institutions devoted to teaching, research, and scientific outreach in all scientific and technological areas. The program includes the following actions/goals: a) incentive to pedagogical innovation programs; b) technical and financial support to educational systems to the enhancement of teaching conditions; c) constitution and consolidation of an evaluation system of scientific and technological education teaching; d) support to actions of initial and continued teacher formation; e) creation and maintenance of an educational portal on the Web; f) support to events and publications, and so forth. Some current actions of the Ministry of Education to the advancement of scientific and technological education include:

Science Prize: Financial support to innovative projects of incentive to the scientific and technological education in public schools, as guarantee of sustainability to initiatives that contribute to enhance didactic practices and of integration of school with their respective communities. Targeted to teachers and students of public schools, this initiative focuses on recognizing efforts of educators and students conducting relevant work in science and technology at pre-college level. The prize is not only monetary, but also in form of destination of equipments for schools and various incentives for students.

Science Olympiad: The so-called *"Brazilian Olympiad of Science in Public Schools - OBCEP"* intends to engage teachers and students at national level, in actions of teacher formation and students' research in order to prepare a national competition in science. The initiative is targeted to students, teachers and schools of primary and secondary levels, at state and municipal educational systems. It is similar to the *International Mathematical Olympiad*, and its essence is not purely competition, but cooperation and involvement in an environment of continued learning, in which students participate in exciting activities such as science fairs, science clubs, astronomy clubs, and so forth. The result is a national mobilization that reaches far beyond mere purposes of a competition of "questions and answers". The purpose is to create a scientific and technological culture among individuals by applying this strategy that has demonstrated effectiveness in different contexts worldwide.

National Program of Support to Science Fairs: Conceived to provide financial support to events such as science fairs and expositions, in order to expand and enhance scientific and technological education in basic education. The Ministry of Education encourages educators nationwide to organize science fairs in the scope of their institutions. The concept we adopt here for science fair is a technical-scientific-cultural activity targeted to establish interaction and experiences exchange amongst students and of them with the community they belong to, by the exposition of scientific and cultural productions realized in the educative context. To the community, they are an opportunity to appreciate and understand the phases of construction of the scientific knowledge. For students, events like those contribute to the strengthening of creativity, logical thinking, and research capacity, contributing to build up their intellective autonomy. It is recognized that such activities have a positive impact for a meaningful understanding of science and technology beyond the school walls.

Guide of Educational Technologies: A tool that education managers nationwide can use to select programs, software, didactic materials, courses for teachers, amongst others, to strengthen basic education. Educational managers use the Guide to select the technologies that best suit their scholarly community's requirements, and make a formal request to the Ministry, which by its turn should assist them with the requested technologies, by means of a process that will be detailed in the coming section.

This set of interconnected and integrated actions also contributes to promote scientific and technological culture. They need to be evaluated in order to identify gaps and to proceed to necessary adjustments. For this purpose, the Ministry evaluates such actions in a regular basis.

There are some other public initiatives of the area of Brazilian technology, carried out by the Secretariat of Distance Learning (SEED), which have been offering valuable contributions to basic education, such as:

Open University System – UAB (http://www.uab.capes.gov.br/): It prioritizes teacher formation for basic education, by means of wide articulation among Brazilian universities, states and municipalities in order to promote, through distance learning methodologies, access to higher education to populations without access to this level of education.

Teacher Portal (http://portaldoprofessor.mec.gov.br/): The Ministry aims to include teachers who live outside large urban centers in the environment of technologies. The portal content comprises classroom suggestions in accordance with each subject matter curriculum and resources such as videos, pictures, maps, audios and texts, which contributes to make studies more dynamic and engaging. In this *Portal*, teachers could prepare classes, obtain informed about in-service courses offered in their respective municipalities and in the federal area, and about specific legislation. Chats, blogs and online seminars stimulate communication and interaction among teachers, who will count with digital libraries and museums and be encouraged to create Web sites in schools. Initiatives of educators will be presented in the so-called *Teacher Journal*, with usage of journalistic texts and experimental videos.

4.1 The Guide of Educational Technologies – A Brazilian Innovation for the Enhancement of Quality in Education

For more than a decade, the Brazilian Ministry of Education has been conducting the largest program of distribution of didactic books in the world. Teachers receive a guide in which they select, in order of preference, books they would like to use in the coming scholar year, for the main scholar subjects. Those books are selected to compose a ministerial guide after a comprehensive evaluation of quality, adequacy, and other criteria such as inclusiveness, absence of prejudice and other parameters.

Similarly, a Guide has been launched for the selection of educational technologies capable of enhancing quality of education. The *Guide of Educational Technologies* is a publication that comprises descriptions of a set of technologies that will enable education managers to select those capable of better contributing to enhance pedagogical practices in their scholarly systems. It contains educational technologies: techniques, apparatus, tools and other resources with usage potential in the development and support to the accomplishment or enhancement of educational processes.

The Guide is divided in five areas, as follows: a) management of education; b) teaching-learning process; c) preparation of professionals of education; d) inclusive education; and e) educational portals (MEC, 2008). This set of technologies comprises commissions, programs, software, educational activities, projects, systems, techno kits, teacher formation programs, courses, portals, materials for impaired students, and more. Such technologies are targeted to scholarly community from early childhood education until high school.

Fig. 1. Guide of Educational Technologies – cover page

Aiming to select technologies to compose the Guide, the Ministry published guidelines and requirements that such technologies should present. Based on that, public and private institutions submit their proposals, which are then submitted to ministerial evaluation. Any individual can present a proposal.

A set of technologies is then selected to compose the mentioned Guide – they are pre-qualified. A technical-academic committee is responsible for evaluation of conditions for pre-qualification of the educational technology. It is taken into consideration the expected impact on quality indicators, technical and pedagogical quality, and experience of usage in the pedagogical practice, coherence between objectives and methodology and potential of dissemination. This process aims to:

- Pre-qualify educational technologies as referential of quality, for usage in schools and educational systems;
- Disseminate standards of quality for educational technologies capable or guiding the organization of work of professionals of basic education;
- Encourage specialists, researchers, universities and societal organizations to create educational technologies capable of contributing to elevate the quality of basic education;
- Strengthen a culture of production targeted to quality in the area of basic education and their concrete standards.

The Guide was sent to municipal systems and education managers chose technologies that would suit their educational systems better. Recently, the Ministry made available technologies for correction of the age-grade distortion problem. Three programs, including distribution of material and continued teacher formation, were made available by three distinct private institutes for municipalities presenting such situation in their scholarly public systems.

The Ministry sends a correspondence to each municipality containing a form and a manual with information about the three technologies. After reading the manual, the education manager fill in the form, choosing technologies in order of preference, from 1 to 3. This has been made in order to assure that at least one of their preferences would be provided, although the purpose is to provide their very first choice. They send the form back to the Ministry, which proceeds to transfer financial resources to those institutions that will offer the program.

The execution process thus involves decentralization of monetary resources to those private institutes and they are in charge of conducting their programs autonomously with municipalities. They will be accompanied during the process through monitoring and evaluation actions, conducted by universities in partnership with the Ministry of Education. After two years, pre-qualified technologies could be certified by the Ministry, whether after evaluation it is verified a positive impact on the evolution of the quality indicators for education, such as the IDEB, in those municipalities in which they were applied.

As a result, there will be a set of technologies proven to be successful and that could be continuously requested by educational systems in the coming years. New editions of the Guide will be launched annually so that not only the institutions selected previously could present their technologies for evaluation, but also new institutions, so that a wider range of new technologies should be pre-qualified and made available for the scholarly community choice.

5 Conclusions, Challenges and Perspectives

Advancement in scientific and technological fields contributes substantially to promote autonomy, competitiveness and sovereignty of nations. This scenario claims for the strengthening of scientific and technological education in basic level. By means of scientific and technological education it is possible to capture interest of young students towards scientific and technological careers. It requires investment and development of pedagogical strategies capable of turning the scientific and technological language and contents attractive to this audience. It is also necessary to invest in the preparation of teachers and in equipping schools with resources to facilitate scientific and technological literacy, and effective inclusion in current knowledge society.

A set of initiatives could contribute substantially to enhance scientific and technological education offered in schools in the coming years in Brazil. Some of them are: a) the enhancement of initial and in-service teacher formation; b) provision of computers and internet to public schools; c) monitoring, evaluation, and continuation of governmental and non-governmental initiatives targeted to the promotion of scientific and technological education; d) promotion/participation in events to debate the issue with national and international individuals, in order to access how they have been dealing with their own challenges.

It is also necessary to encourage a culture of science and technology among the Brazilian population. The creation of the Coordination of Educational Technology in the Ministry of Education is a giant leap towards achieving the necessary visibility to the effort of strengthening science and technology taught in schools. It is also necessary to invest more in outreach materials, marketing and other strategies to popularize science and technology.

Although there are several actions carried out by different actors to promote scientific and technology education in Brazil, we still need some extra coordination in order to increase their effectiveness. It is necessary to better identify our real population needs situated in individual's territoriality and diversity, and after that, there is the challenge of identifying public and private partners, in order to create synergy of efforts towards pre-established goals. Innovation should also be welcome, such as programs in space education, environmental sciences, and similar subjects that can raise students' interest to learn science and technology in a meaningful, integrated, and fascinating, manner.

In tune with requirements of knowledge society and Brazilian societal demands, the Ministry of Education, in partnership with educational systems, has been working towards constructing scientific and technological education with quality and for all.

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NASA Education and Educational Technologies Exemplified by the Space Weather Action Center Program

Norma Teresinha Oliveira Reis[1], Claudio André[1], Troy D. Cline[2], Timothy E. Eastman[3], Margaret J. Maher[4], Louis A. Mayo[2], and Elaine M. Lewis[2]

[1] Brazilian Ministry of Education – MEC, Brazil
normareis@mec.gov.br, claudio.andre@mec.gov.br
[2] Honeywell Technology Solutions Inc., USA
troy.d.cline@nasa.gov,
louis.a.mayo@nasa.gov, elaine.m.lewis@nasa.gov
[3] Wyle Information Systems, LLC, USA
timothy.e.eastman@nasa.gov
[4] NASA Goddard Space Flight Center, USA
margaret.j.maher@nasa.gov

Abstract. We explore here the Space Weather Action Center (SWAC) Program, as an example of NASA initiatives in education. Many human activities in space can be disrupted by space weather. The main objective of this program is to enable students to produce space weather forecasts by accessing current NASA data. Implementation of the SWAC Program requires: technological resources, online materials, and systematic work. Instructional guides, materials and methods are explained on the Space Weather Action Center Web site (http://sunearthday.nasa.gov/swac). Ultimately, students' forecasts can be presented through a variety of accessible media including inexpensive video editing software and/or already existing school-based broadcast studios. This cross-curricular program is targeted to middle and high school and can be applied in almost all educational contexts as the number of schools with computer and internet access increases worldwide. SWAC is a pioneer initiative that contributes to fostering student interest in STEM and promotes their intellectual autonomy. Through SWAC, they get to act like real scientists by accessing, analyzing, recording, and communicating space weather forecasts in a professional approach.

Keywords: STEM education, education technologies, space science education.

1 Introduction

Scientific and technological development generates socioeconomic benefits and sovereignty [1]. For this reason, among other strategies to foster advances in those sectors, governments have been concerned with the promotion of public policies to strengthen Science, Technology, Engineering and Mathematics (STEM) taught in

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schools, as a vehicle to encourage careers in those areas. Moreover, STEM education plays a vital role in promoting effective inclusiveness of citizens in a societal fabric permeated by processes/products/services requiring of individuals a certain level of STEM literacy [2]. Currently, a growing number of students have access to computer, internet, and other technologies. Nevertheless, the success of STEM education is well below that expected, as shown by both national and international examinations, such as the Programme for International Student Assessment – PISA [3]. Indeed, STEM education has been facing several challenges, such as: a) theoretical-methodological inadequacy; b) teacher pre- and in-service preparation; c) quality didactic books and technological equipment; d) fallacious pedagogical theories according to which students can learn spontaneously, without practical experience yet with overly-abstracted contact with theory; e) difficulties to work in an interdisciplinary approach; f) rapid changes in the world of knowledge [4]. This scenario claims for pedagogical approaches that adequately address STEM education concerns.

Space education is an alternative for effective STEM teaching. But what is space education anyway, and where can we find it? Space education stands for a wide range of pedagogical practices; didactic resources; subject matters; curricular and/or cross-curricular topics; formal and/or informal; systematic and/or sporadic programs/projects/activities, which take advantage of the amazement that space matters exert on students' imagination, thus capturing early interest in STEM subjects, elucidating scientific knowledge in a non-abstract approach, spreading the benefits of space programs, and ultimately encouraging STEM careers.

The National Aeronautics and Space Administration – NASA – has the largest and most complex space education program in the world. Education plays a unique role in the scope of the overall NASA mission. In this paper, we introduce NASA education and educational technologies, and present one of its state-of-the art programs, the Space Weather Action Center – SWAC.

2 NASA Education and Educational Technologies

Space education and outreach at NASA started as a concern towards offering societal contributions and disseminating the agency's activities. In fact, "Education and contributing to the public understanding of science have long been important components of NASA's mission." [5]. After the cold war period, space faring nations required socioeconomic benefits from their space programs, as political motivations weakened. In this framework, NASA's Office of Space Science hired education leaders and scientists to establish its own education and outreach programs (EPOs). In 1993, after getting advice from national education experts, Dr. Jeffrey Rosenthal set up an "ecosystem" for EPO. Instead of each scientist, institution, and mission pursuing EPO on its own, the new EPO programs would coordinate and amplify individual efforts so that the overall effect would be greater than the sum of its parts. The system was made of forums to coordinate EPO activities among like missions, and regional brokers/facilitators to link missions/scientists to school systems, museums, educational publishers, etc [6]. This complex structure increased scope and pedagogical impact of NASA education efforts.

NASA education goals are aligned with wider American objectives for education. The agency aims to strengthen STEM taught in schools and to ensure that an adequate supply of scientists and engineers will be available in the future to continue NASA's explorations. NASA education takes advantage of its unique personnel, rich online and printed resources, educational materials facilities, partnerships with scholarly communities, countrywide scope, international efforts, and more, to engage individuals in STEM [7].

The NASA public policies for education are implemented through a portfolio of investments, which comprises programs, projects, activities, processes, didactic resources and education technologies targeted to students, educators, families and communities. It aims to strengthen the NASA mission by means of the achievement of its main goals/outcomes: a) contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals; b) attract and retain students in STEM disciplines; c) build partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission [8].

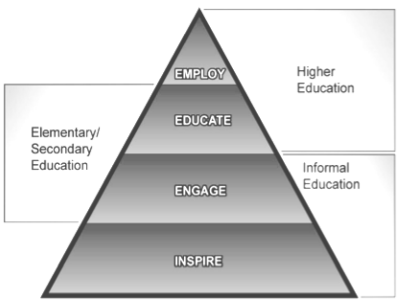

Fig. 1. Education levels of involvement of the NASA portfolio. Source: Figure 2 of the NASA Education Strategic Coordination Framework: A Portfolio Approach.

The agency's portfolio of investments covers five strategic areas: higher education; minority university research and education; elementary and secondary education; informal education; and education technology and products. Indeed, NASA supports elementary and secondary schools, universities, colleges, by providing exciting research and internship opportunities that will fuel the passion for a new culture of learning and achievement in STEM. Moreover, to strengthen STEM education, NASA will sustain professional development and research opportunities for pre-service and in-service teachers and university professors [9].

There are some criteria/principles guiding this portfolio, such as diversity, relevance, continuity, and partnerships/sustainability. Activities in the portfolio cover one or more categories of involvement:

1. Inspire: awareness of NASA's mission among the public.
2. Engage: interaction with NASA contents for a deeper understanding.
3. Educate: learning among targeted populations.
4. Employ: development of individuals who prepare for employment in disciplines needed to achieve NASA's mission and strategic goals.

Each of these categories should lead to the next. Students are inspired and engaged by means of informal and formal education activities. They could choose careers in STEM, eventually leading to employment at NASA [8].

NASA education activities are complex because there are offices of education in each of ten space centers. In addition, almost all missions have an education and outreach

(EPO) office with specific budget to conduct mission-related educational activities. Four mission directorates cover major areas of the agency's research and development: Aeronautics Research, Exploration Systems, Science, and Space Operations. Another important component of NASA education is partnerships with national and international entities, in order to generate synergy of efforts. Quality communication, monitoring and evaluation are essential to the effectiveness of such a complex enterprise.

The agency offers a wide range of resources to both educators and students, such as online and printed resources, in-service courses for teachers, guided visits to space centers, lectures with astronauts, interaction with members of the ISS, by means of the Amateur Radio on International Space Station – ARISS (http://www.nasa.gov/audience/foreducators/teachingfromspace/home/index.html) interactive tools such as the Digital Learning Network – DLN (http://dln.nasa.gov), the LEARN Project (http://www.cet.edu/?cat=cotf), podcasts, webcasts, and more. The main gateway to NASA educational products is the *NASA's Education Home Page* (http://education.nasa.gov/home/index.html), which offers curriculum support materials by grade level, type of material or subject. These materials include educator guides, classroom activities, lithographs, project brochures, video clips. Subjects include careers, earth sciences, life science, mathematics, physical science, space science, and technology [10]. Investments in educational technologies at NASA enable new learning environments using tools such as simulations, visualizations, online game playing, intelligent tutors, learner networking, e-Professional Development (e-PD), digitized building blocks of content, and so forth [8].

We will explore in this paper a program of NASA's Science Mission Directorate (SMD), devoted to space science studies by Earth-orbit and deep space observatories, spacecraft to visit other planetary bodies and robotic landers, rovers and sample return missions. This directorate develops research on Earth, heliophysics, planets and astrophysics [10]. As an example of NASA's state-of-the-art education programs, we present here the Space Weather Action Center – SWAC, a heliophysics education program, which aims to engage students into the understanding of the Earth-Sun system in a highly innovative, awe-inspiring, and content-rich pedagogical approach.

3 Scientific Background – The Earth-Sun System and Space Weather

The SWAC Program aims to provide an understanding of space weather. In order to contextualize space weather, some concepts related to the Earth-Sun system must be introduced. One of them is *Heliophysics,* the study of the Sun's activity and its effects on the interplanetary environment, the planets and other solar system bodies, and the interstellar medium. It also comprises the study of plasmas, magnetic and electric fields, and small- and large-scale electrical currents [11] Plasma is the fourth state of matter, distinct from neutral gas, liquids and solids. They are constituted by an interactive mix of charged and neutral particles, magnetic and electric fields, which exhibits collective effects and can sustain electrical currents. We live in a "Plasma Universe[1]." The space between the planets, moons, asteroids and comets, although

[1] Term coined by plasma physicist Dr. Anthony Perratt.

apparently empty, is actually filled with plasmas, which despite being very tenuous, can have huge effects across these enormous distances [12].

Space weather is a result of the behavior of the Sun, the nature of Earth's magnetic field and space environment, and our location in the solar system. Through complex couplings, the Sun, the solar wind, and the magnetosphere, ionosphere, and thermosphere can influence the performance and reliability of spaceborne and ground-based technological systems [11]. In other words, space weather refers to the interaction of plasmas coming from the Sun (via the solar wind) with Earth's space environment. During periods of intense solar activity (solar storms) the Sun liberates excessive amounts of plasma energy. Magnetic fields near the Sun help to accelerate energetic plasmas, especially near sunspots, and the resulting outflow through the solar wind (either in the form of coronal mass ejections or solar flares) can impact Earth‘s space environment. Within one to four days, plasma coming from the Sun compresses Earth's magnetosphere on the dayside while the side opposite to the Sun is stretched farther out into space. Our magnetosphere tries to re-establish its original shape. Some of this plasma is filtered through the outer magnetospheric boundaries and follows Earth's magnetic field towards the northern and southern polar regions where plasma particles (especially electrons) collide with the upper atmosphere to generate magnificent auroras [12].

Some space weather effects are not so beautiful though, and can generate storms. During such storms, energetic particles and photons can threaten human activities both on Earth and in space, posing a radiation hazard for astronauts in spacewalk, and crews and passengers of aircraft. Severe geomagnetic storms can interfere with communications and navigation systems, reduce the useful lifetime of telecommunications and observation satellites. It can also disturb spacecraft orbits due to increased drag, and provoke power blackouts. Humans venturing into space need to monitor the Sun and have access to space weather forecasts to protect both themselves and their spacecraft systems. Scientists studying space weather, like meteorologists studying weather patterns in Earth's atmosphere, seek to better predict when and where space storms will happen. Predictions depend on research on the complex nature of the Sun, its heliospheric plasma environment, and the response of the Earth's magnetosphere [12].

4 The Space Weather Action Center – SWAC

The Space Weather Action Center – SWAC – is a nationwide education program aimed to capture students' interest for space sciences. The SWAC system focuses on leading students to master an enhanced understanding of the Earth-Sun system – specifically the interaction between solar plasmas and Earth's magnetic field and plasma environment (magnetosphere), and other ways in which the Sun affects the Earth system, by monitoring the progress of solar storms. Students assess current conditions in geospace, create a space weather report, and share their reports with peers around the world via the Web. Activities take just a few minutes per day, and combine science, technology, arts and plenty of creativity.

Its target audience is composed primarily of middle and high school students. However, SWAC data resources have also been largely used at the university level, and the program has proposed for additional resources and educational activities for students at the elementary level. Many of those resources are already available with the Sun-Earth Day program[2]. SWAC is a featured activity in that program, managed by the Sun-Earth Connection Education Forum (SECEF) at NASA Goddard. Also, SWAC materials are being downloaded from a variety of countries around the world including Brazil, Germany, Canada, India, etc.

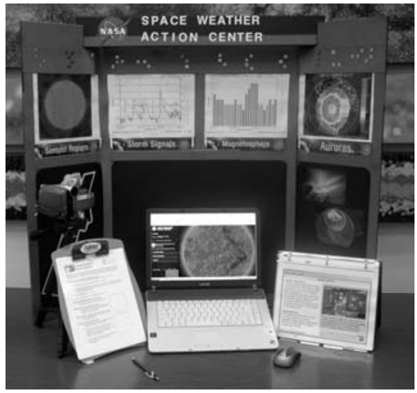

Fig. 2. SWAC Display Board constructed by students

Some basic technological devices are needed to establish a SWAC, such as a computer and internet access. In developing countries, many schools do not have such "basic" resources, but the number of schools with such resources is steadily increasing as a result of a worldwide concern towards fostering digital literacy in the scope of technological inclusiveness. Hence, the SWAC Program can be applied in all developed and many developing countries.

In order to begin, the first step is the assembly of SWACs. In the second cross-disciplinary phase of the program, students access, analyze, and record NASA satellite and observatory data in real time in order to produce professional-looking space weather journal data, reports, and multimedia broadcasts. To facilitate the execution of this task, a sample script is provided on the program's Web site. In other words, the idea is to enable students to monitor space weather, and generate space weather reports analogous to terrestrial weather reports we watch on TV.

The program is based on well-defined protocols. The principle is to enable everyone to achieve roughly similar results by following the same procedures. Instructions and resources are available on the NASA SWAC Web site (http://sunearthday.nasa.gov/swac/). Basically, the Instructional Guide and the Flip Chart Guide present full explanations on how to plan and execute tasks. The Instructional Guide is a starting point to plan and construct the SWACs, also presenting background information about the Sun, along with a glossary of space weather terms and other resources. In its turn, the Flip Chart Guide includes data collection sheets, space weather data, tips, questions from the student data collection sheet, etc. At a first glance, it may seem difficult to access and analyze NASA data, but as teachers and students become familiar with those materials, it gets unexpectedly easy. There is a single link on SWAC Web site for space weather data (http://sunearth.gsfc.nasa.gov/spaceweather/), along with detailed tutorials that make it easy, simple and fast for students to collect, analyze data and prepare their reports.

SWAC is unique in that it provides step-by-step instructions and tutorials on how to access and analyze new information. The intention is to have students carrying out research, accessing data in a professional manner, and communicating results using Web and broadcast resources. During this pedagogical process, students need educators'

[2] For more information, visit http://sunearthday.nasa.gov/2009/index.php

supervision and guidance, but simultaneously they should be encouraged to increase their intellectual autonomy, high level thinking, teamwork and communication skills because they would be asked to broadcast their results in a meaningful, objective, clear manner to the entire class. Although the focus here is space weather, the SWAC systems and architecture may be adapted to almost any other educational topic, such as environment conservation, violence in large cities, global climate change, agriculture management, and other subjects of interest to each educational community. With access to the proper data resources, student reports can be generated on any subject.

4.1 Structure and Resources

4.1.1 Physical Structure

Each SWAC should contain the following elements:

- Computer with Internet access;
- Display Board (Assembly Required);
- Instructional Flip Charts (Assembly Required);
- Data Collection Clipboards or Notebooks (Assembly Required).

At least one internet connection is needed to access data from the SWAC Web site. However, students not having computer and internet connection can take advantage of the supporting activities: how to build and/or use a sunspotter, understanding magnetism, and more. Schools with limited internet connectivity can still participate. If technology is limited and dedicated access to a computer is only via a teacher's computer, the teachers can access and share specific sets of data with the class on a daily basis. Students can then simply copy the data to their notebooks or maintain a classroom data folder.

It is recommended that a secure area of a classroom or a separate room be established exclusively for the SWACs. They should be placed in easily accessible spots, offering students a separate space to visit topics of interest and/or to reinforce selected skills. Having a specific place for them assures that it will not interfere in other ongoing routine classroom activities. A list of material required for the display board assembly is available on SWAC Instructional Guide.

4.1.2 Obtaining and Analyzing Data

A set of online didactic materials is used to orient students on how to obtain and analyze data:

a) **Student Flip Charts:** provide a snapshot of the four major space weather areas. Each section contains a brief overview, helpful tips and questions from the student Data Collection Sheets. Each set of flip chart cards also includes 'easy to follow' <u>Instruction Cards</u>, containing steps necessary to obtain, analyze and record online data, along with <u>Information Cards</u>, containing a variety of sample images and helpful tips on how to interpret and analyze data.
b) **Data Collection Sheets:** provide the necessary questions and refreshers on how to interpret necessary space weather data. A comprehension question at the bottom of each data sheet provides an opportunity for students to summarize the data and make a prediction for verification over the next several days.

c) **Space Weather Media Viewer:** this observation tool is a single Web page containing live or 'near-real' time space weather data, and tutorials with step-by-step instructions on how to interpret data. Once opened, it can be kept in a separate browser tab or window for faster data access when needed.

Resources are divided into four 'color-coded' categories: sunspot regions (orange), storm signals (green), magnetosphere (blue) and aurora (purple). This color code scheme is used in all SWAC materials.

After students have collected and analyzed the data in each center, they will be ready to explore data from other links and resources readily available in the Space Weather Resources 'Additional Data' section of the Web site.

4.1.3 Recording and Organizing Data

A variety of tools is available to keep recorded data organized for quick review:

a) **SWAC Clipboards:** provide a stable writing surface that students use while collecting data. A clipboard, pencil, and a copy of the corresponding data collection sheet should accompany the station.
b) **SWAC Notebooks:** to eliminate the need for multiple copies of data collection sheets, download and print one set. Glue each data collection sheet to the inside cover of a separate notebook. When completed, there will be four separate data collection notebooks, one for each SWAC station.

It is recommended to keep a set of data collection sheets and/or clipboards nearby to allow students collect information required to complete their space weather news report.

4.2 Getting the Job Done – Lights, Camera, Action!

The first step to get started is to have students construct their SWAC display boards, containing drawings, pictures, and words related to space weather topic(s). It encourages an artistic approach and a sense of student ownership. Four areas should be contemplated, corresponding to major space weather topics: sunspot regions, storm signals, magnetosphere, and auroras. There are three assembly options: a) <u>Single Classroom Display Board</u>: includes components from all four areas of SWAC; b) <u>Four Separate Display Boards</u>: one display board for each section of SWAC; c) <u>Classroom Bulletin Board Display</u>: a large bulletin board display featuring the dynamic Sun and solar storms affecting the Earth's magnetosphere. The bulletin can be divided into four sections, corresponding to the four sections of SWAC.

Students use action centers to access imagery and data from NASA databases and analyze them by following instructions established on the previously mentioned materials. Then, students elaborate their own forecasts. To produce reports, students must be able to predict which sunspots may be a source of solar storms, discover when solar storms occur and predict which ones will affect Earth, measure disturbances to Earth's magnetic field and predict auroras, know when to watch for auroras, and share the news as professional space weather alerts. They can use video/audio equipment or email information to colleagues.

Data collection is performed weekly. Teams use SWAC clipboards or notebooks to document space weather data at their action centers. Daily data collection is recommended if the curriculum time allows a minimum of 2-3 times a week. If journaling is not done on a daily basis, students need to review the space weather data from previous days to stay current.

Students should circulate through each section by rotating groups on a weekly basis, because this allows them to learn about each section, continue to collect and analyze data, make first-hand observations about how the data changes over time, and gain experience in broadcasting. By sharing and graphing the data over a month-long period, they can look for patterns or trends in the data and develop a deeper understanding of targeted concepts. Small groups of 2-4 students can rotate and share data collection responsibilities. However, the entire group can take part in the optional reporting out and/or broadcasting component.

4.2.1 The Lesson

The lesson is divided in phases that follow a logical sequence of pedagogical procedures.

1. Engage (30 minutes): The teacher conducts discussions with students to access their prior knowledge about the Sun, connecting it to topics to be learned, aiming to motivate students to activities to come.
2. Explore (45 minutes): Students are divided in four teams, corresponding to the four SWAC areas, to explore material and content.
3. Explain (45 minutes): Teams share with the entire class their expertise about the Sun and space weather acquired from the previous phases, and produce a report on their specific area.
4. Elaborate 90 minutes (Initial Startup Assemble): Students design, assemble and use an action center. Completed display boards are often used as backdrop for the learning center and are placed behind computers used to access SWAC data. In this phase, students apply concepts they have learned, establish connections with related concepts, and apply their understandings to the world around.
5. Evaluate (20 minutes): There is a link provided at the SWAC Web site containing several suggestions on how to promote the continuous assessment of student learning.

4.2.2 Preparing Reports

With their new action centers assembled, students should be assigned to one of the following five subject area groups: a) Sunspot Regions (1-5 students); b) Storm Signals (1-5 students); c) Magnetosphere (1-5 students); d) Auroras (1-5 students); e) Broadcasting (1-5 students)

Teams can have four students working as data miners, while one student from each group acts as data analyst. Data miners collect and record all information needed on the data collection sheet specific to their assigned subject area. The data analyst in each group monitors student data sheets, summarize information and fill in the required information on the space weather script. In each group, students can share or rotate data collection responsibilities for their specific subject area.

A sample script is provided, so that students fill in the missing pieces based on data collected in their student journals. Updates for each section of the script can be taken from data collection sheets. Students should include images when possible. After all groups have filled in the required information on the script template, it can be given to the broadcast team who develop and present the information as a comprehensive space weather news report.

Students should dedicate some 15 minutes per day to collect data for their station and some 15 minutes per week to produce a space weather report. They should be encouraged to present reports as space weather broadcasts. These brief reports can be presented through various accessible media, including inexpensive video editing software and/or already existing school-based broadcast studios.

4.2.3 Real-Time Broadcasting

Students are encouraged to transform their SWAC reports into regularly scheduled news reports, which can be presented through accessible media including inexpensive video editing software. Materials required:

- One (1) additional Internet capable computer and desk;
- One (1) Webcam or camcorder;
- One (1) wall area for use of a 5 by 6 foot green screen or backdrop;
- Audio/Video Recording Software: There is a variety of software options available, including SONY Vegas Movie Studio, Adobe's Visual Communicator 3 (VC3), CCTV, iMovie, Audacity, Garage Band, etc.

The SWAC Web site includes sample scripts, video clips, sample reports, teacher guides, downloadable graphics, etc. These additions are needed to use video broadcasting or movie editing software. A sample Space Weather video report can be viewed on the SWAC Web site.

5 Conclusions

Space education at NASA is a complex enterprise that has been offering many benefits for STEM education. The "portfolio" of investments in different programs, technologies, didactic resources, Web-based material, courses and more maintains a focus on the agency's efforts while offering the educational community a variety of products to fit their specific needs and interests. NASA online resources benefit both national and international educational communities. Currently, however, STEM education in the U.S. overemphasizes national assessment. National evaluations tend to focus on some content such as mathematics and language, somehow discouraging teachers from investing more time in teaching STEM content more fully. Additionally, as the number of school hours devoted to STEM education reduces, teachers need to become more selective about which contents to teach and, again, space education loses "space." In this panorama, debates between NASA and the Department of Education should be encouraged in the sense that proper space-related content and practices could benefit STEM curricula at a national level.

In this paper we explore the Space Weather Action Center (SWAC) Program, which presents a pedagogical approach that takes advantage of motivating tools such as video and broadcasting to capture students' emotion to subjects explored. When students are emotionally engaged in a task, they perform better [13]. Activities contemplate important aspects of STEM education, such as high-level thinking, teamwork, communication, and more. SWAC also encourages students to act like professional scientists, and students feel responsible for the accuracy and communication quality of their work, as they will be "on the screen!" We here suggest some tools that could enhance the program. For example, conceptual maps [14] could help access students' understanding of space weather concepts before, during and after activities are over. Teacher could gradually accompany how students are retaining and correctly linking concepts, in hierarchical levels.

There is controversy between pedagogical theories targeted to STEM education. Some of them encourage students to construct their knowledge autonomously, and others state that proper guidance is fundamental to achieve learning, especially if students still do not have substantial prior knowledge in a given field [15]. The SWAC Program covers both aspects, as there are moments in which students receive full guidance to conduct their activities, and there are other moments in which they should work autonomously in collecting, analyzing and reporting data. Actually, we see guidance and autonomous work as complementary to each other, and SWAC provides both dimensions in a balanced manner. Considering the great potential of the SWAC architecture, both its structure and content could be applied to many other topics and translated to other languages.

As society becomes increasingly complex and dynamic, education should accompany such transformations in order to be effective. Space education at NASA offers singular contributions to STEM education and we need to be more emphatic in our efforts to make of it a curricular, systematic practice, as well. However, educators must be closely involved in the process. While curricular negotiations evolve between agencies and stakeholders at all levels, we should focus on student needs along with pre- and in-service courses for teachers in space education topics. These courses should consider the level of understanding of teachers in areas to be covered. In other words, we need to speak their language. Interdisciplinary teams of scientists and educators are fundamental in this enterprise. For example, this year, as we celebrate the International Year of Astronomy (IYA), we need to engage students and educators to view both the Earth and the Universe in new ways. In summary, we all need to keep strengthening our educational efforts, and simultaneously seek more "space" for space education, as this area offers singular pedagogical benefits for STEM education.

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Evaluation of Distance Course Effectiveness – Exploring the Quality of Interactive Processes

Francisco Villa Ulhôa Botelho[1] and Rosa Maria Vicari[2]

[1] Universidade Católica de Brasília, UCB, Brazil
fbotelho@ucb.br
[2] Universidade Federal do Rio Grande do Sul, UFRGS, Brazil
rosa@inf.ufrgs.br

Abstract. Understanding the dynamics of learning processes implies an understanding of their components: individuals, environment or context and mediation. It is known that distance learning (DL) has a distinctive characteristic in relation to the mediation component. Due to the need of overcoming the barriers of distance and time, DL intensively uses information and communication technologies (ICT) to perform interactive processes. Construction of effective learning environments depends on human relationships. It also depends on the emotionality placed on such relationships. Therefore, knowing how to act in virtual environments in the sense of creating the required ambiance for animation of learning processes has a unique importance. This is the theme of this study. Its general objectives were achieved and can be summarized as follows: analyze indexes that are significant for evaluations of distance course effectiveness; investigate to which extent effectiveness of DL courses is correlated with quality of interactive processes; search characteristics of the conversations by individuals interacting in study groups that are formed in virtual environments, which may contribute to effectiveness of distance courses.

Keywords: DL quality, evaluation of DL effectiveness, interactive processes in DL, evaluation of DL interactivity.

1 Theoretical Background for an Evaluation of Distance Course Effectiveness

Distance learning is an education modality, and education is basically learning. Thus, learning and interactive processes are the most comprehensive themes when thinking about theoretical references that may consolidate our research path.

Two approaches that could complement each other when guiding studies on effectiveness of interactive processes in virtual learning environments are Vygotsky's history and cultural theory [1] and the foundations of complex thinking. The rationale for choosing these theoretical approaches is the understanding that learning should be evaluated without being reduced to the result of a formal teaching action, in which the individual is passive and the phenomenon can be isolated from its context. Learning, on the other hand, should be treated as the action of people interacting with other

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people and with their environment in the process of production, conservation and change in their lives. In such case, the phenomenon comprehends several interacting elements, conforming a complex reality.

Vygotsky's history and cultural approach [1, 2, 3] was used as an attempt to understand the importance of interactive processes for human learning: how people learn and develop themselves. Complex thinking served to provide the orientation that learning does not obey a linear cause-effect logic, but is a dynamic process, as a result and factor of multiple interactions, as part of the self-organization process of people and society.

Both approaches provided a definition of learning and understanding of its process. Theoretical references were used to aid the process of effectiveness evaluation in DL courses. Therefore, these approaches provided teachings that not only indicate components of the human learning system to be evaluated, but also their interconnections and movements, their self-organization.

The phenomenon of human interactions focused on formal educational processes represents a complex system, which establishes relationships with their social and historic context. Education is, before any thing, a dynamic process in which many elements – student, teacher, mediation instruments and signs, environment – are interacting so that results are not necessarily predictable, do not obey a simple cause/effect process.

We are convinced that the learning phenomenon and its effects in students' practices cannot be reduced to a product or result of educational actions. Treating such a rich phenomenon as a result of a mere sum of actions is closing the door to an understanding of its totality. Without discarding the necessary educational planning, one should be open to aspects of an emerging nature that every educational process has.

2 Description of a Possible Path for Evaluation of Distance Course Effectiveness

2.1 Characteristics of the Study Case

One of the main difficulties of studies on evaluation of effectiveness of courses or educational programs is the follow-up of all stages, that is, action onset, process, end and subsequent step, in which results are analyzed. DL actions usually have some components that make evaluation even harder, such as space comprehensiveness of the action, quantity and heterogeneity of the target audience. Such difficulties indicate a possible justification for the lack of studies on DL effectiveness.

As an attempt to overcome the challenges of studying DL effectiveness, an ongoing DL experience was chosen as the object of this study. It is a course that, since it was implemented, has been planned having an evaluation project as a component. Such course, as well as data collection instruments, were developed by the team of Universidade Católica de Brasília Virtual (UCB VIRTUAL).

It is a formation process for higher education teachers with the aim of improving the quality of teaching-learning practices. This course is developed at a virtual environment with some in-person meetings. Its didactic material is structured in

Autonomous Study Units (ASU). Each ASU is comprised of contents as hypertexts, case studies and exercises, references and website, conventional digitized texts for complementary reading.

The entire follow-up of the learning process is performed by teachers through a tutoring system composed of two in-person meetings and interactive processes performed at a virtual environment. The most widely used interactive tools are chats and discussion forums.

2.2 Indexes of Results/Impact of Distance Courses

The main sources of research information are apprentices (higher education teachers), their colleagues, coordinators of the areas in which apprentices act, and students belonging to classes of courses taught in their respective institutions.

Information is collected by electronic questionnaires using close-ended and open-ended questions. Data collection process is performed according to the model described in Figure 1.

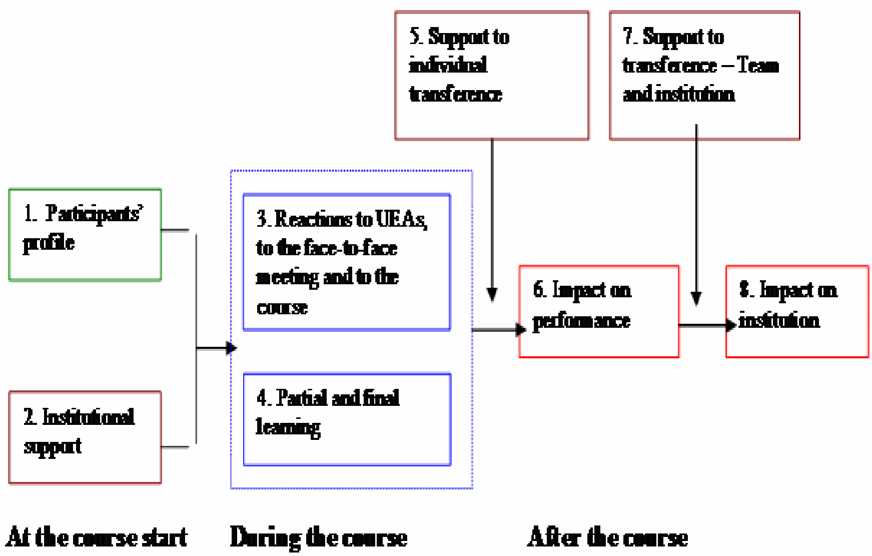

Fig. 1. Evaluation model (based on the model of five stages developed by Abbad (2000))

This model is an evolution of the traditional approach by Kirkpatrick (1976) and Hamblin (1978), both cited in [4]. Such a model enables collection of information for studies at the level of students' reaction to formation, learning, students' behavior at work or formation impact, organizational change, and final value measured to improve the quality of products and services within organizations (the last three levels are performed in formations offered based on a given institutional demand).

Although the analysis process uses nearly all information collected according to the described model, indexes focused by his study are those relative to results. Such indexes are comprised of the information described in item 6 of Figure 1 above, namely, change in professional performance as a consequence of the course (changes in aspects regarding course objectives or deep impact).

Evaluation questionnaires contain questions relating to impact, to try and capture changes in participants' performance – in their teaching activity – in relation to course objectives. The items included in the questionnaire completed by course participants have a correspondence in the questions completed by their students, regularly enrolled in one of the courses taught in their institution.

2.3 Indexes of Interactive Process Quality

Human learning has multiple dimensions: from psychosocial to historic. Such dimensions turn it into a complex phenomenon. To study it from the complex thinking perspective, it was necessary to have a methodology that could guide analysis of interactive processes in a virtual environment. The Meta Learning model proposed by Losada[5] was chosen.

The Meta Learning model proposes a view on the learning process of people interacting in a group. It is an explanatory model of the functioning dynamics of teams and of the interaction between people that compose such teams. It is focused on the understanding of factors contributing to creation and maintenance of high performance group dynamics.

After testing and analyzing a set of variables representative of "speeches" of people in conversation processes, Losada's study reached three bipolar variables that can be extremely significant to explain interaction dynamics. Depending on such dynamics, groups have a performance marked by creativity and innovation or by common sense and repetition. They are descriptive variables of people's postures in interactive processes. They indicate the quality of people's attitudes toward the "speeches" of others in relation to the characteristics of positivity or negativity, questioning or proposition, being focused on oneself or on the other (Table 1).

Table 1. Matrix of team performance [6]

Performance	**Dynamics**	**Connectivity**	**Bipolar Variables**		
			Questioning/ Proposition	**The other/ Oneself**	**Positivity/ Negativity (Emotional Space)**
High	Complexor	High	Balanced	Balanced	Expansive P>>N
Medium	Limit cycle	Medium	Tendency to unbalance in the direction of proposition	Unbalanced oriented to oneself	Restrictive P>N
Low	Fixed point	Low	Unbalanced in the direction of proposition	Entirely unbalanced oriented to oneself	Highly restrictive N>P

Among bipolar variables, positivity/negativity is crucial for interactive processes. It operates as a powerful feedback system to generate different emotional spaces. Such spaces are represented in the Meta Learning model (Figure 2) by P/N ratio (total number of positive interventions divided by total number of negative interactions). When this ratio is within an adequate range, people are creating expansive emotional spaces that increase connectivity and cause better group performance. Outside this range means that actions are resulting in restrictive emotional spaces that discourage performance.

P/N ratio is calculated and set within a reference range called *Losada Line*, in which positivity ranges between 2.9013 or more (not higher than 11.6153) to 1 of negativity. This means that, for each negative intervention in team interactions there must be at least about three positive interventions.

Reference in history and cultural approach and in complex thinking is clearly manifested in two expressions: dynamics of interactive processes or conversational dynamics. Analysis of interactive processes as a way to understand the quality of DL courses is supported by Vygotsky's concept of learning. The theoretical references mentioned above also change the focus to dynamics of interactive processes, as they see the phenomenon of human learning as an open system that establishes relationships with their social and historic context.

Therefore, when quality of interactive processes is sought, the answer to the following question is being built: What type of intervention and how interventions are combined in group contexts to generate a positive conversational dynamic for learning and for effectiveness of courses (such dynamic was called "complexor" by Losada)? This is a crucial issue in the development of indexes and to create an analysis able to describe such dynamics and its attractors.

In any type of communication between people it is known that, when certain "speeches" are said, conversation could be terminated or reduced to repetitions, or generate an animation that might ensure that people are open to continuing the conversation or satisfactorily resuming it in another opportunity. This takes place in conversations held by a family group, a group of friends or in a classroom. Teachers know when a class acquires a dynamic of strong participation and interest or when it seems they are talking to the walls. What are the interventions that lead to each of these dynamics?

In the study of discussion forums, two pairs of bipolar variables presented in the Meta Learning model by Losada & Heaphy [6] were adopted. Such adaptation was performed by suppressing one of the three pairs of variables from the model and rewriting the description of two other pairs.

The need for eliminating one pair of variables is justified by the fact that Losada's study was performed by observation of people/teams during in-person conservations, so that body manifestation of participants in conversations (the body talks) was also observed and information was added to capture of variables. In our case, variables were captured from records in discussion forums; therefore, a written verbal communication, which prevents observation of participants' body aspects.

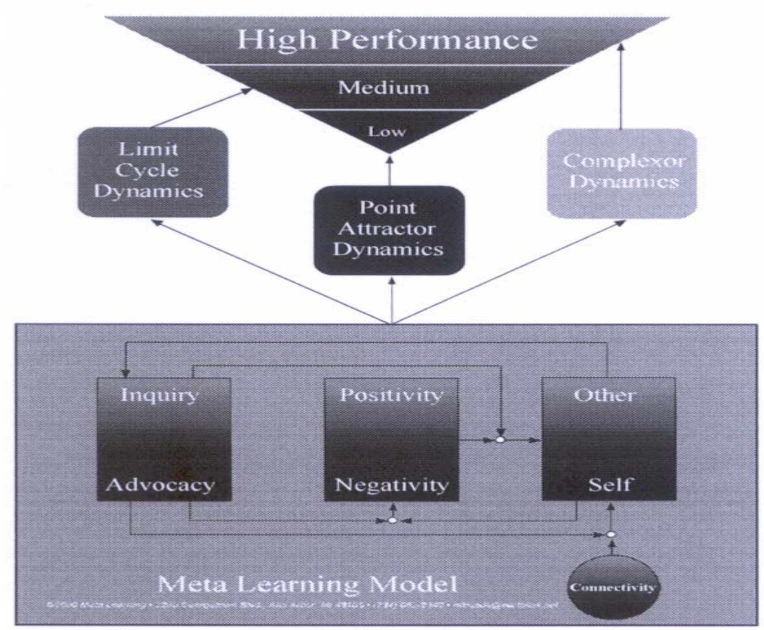

Fig. 2. Losada's Meta Learning model [6]

Table 2. Definition of variables to analyze interactive processes

VARIABLES (classification of forum interventions)	**DEFINITIONS**
QUESTIONING	• (investigation) • Questioning on the theme • Question to qualify or deepen the interaction • Question to start the interaction • Expression of curiosity
PERSUASION	• (argumentation) • Standpoint defense and resource of polemic/debate, which may include: • Question as a resource for defense or contraposition of ideas • Experience report as a defense resource of thesis contestation • Introduction of a new thesis
APPROVAL	• (agreement/acceptance/confirmation) • Being in favor (acceptance of another person's thesis or standpoint) • Affirmation by repeating the thesis or proposition of others (confirmation)
DISAPPROVAL	• (disagreement/rejection/denial) • Contrary standpoint (rejection of another person's thesis or standpoint) • What is opposed to a proposition (opposition)

As can be seen in Table 2, the variables questioning/proposition and positivity/negativity were redefined in the Meta Learning model. The former was replaced by questioning/persuasion, and the latter by approval/disapproval.

2.4 Procedures for Analysis of the Correlation between Impact Results and Characteristics of Interactive Processes

The procedure for analysis preparation consisted of comparing the results of two analytic processes, structured based on the five-stage model and on the adapted Meta Learning model.

From the five-stage model (see Figure 1) basically the results of impact evaluation were used. The Meta Learning model was used to develop an adaptation for a better codification of written verbal communication: forums were codified and analyzed based on the bipolar variables questioning/persuasion and agreement/disagreement (see Table 2). Such variables use those applied in the Meta Learning model as reference; however, their content was redefined for a better standardization of text codification in forums, as shown in Figure 3.

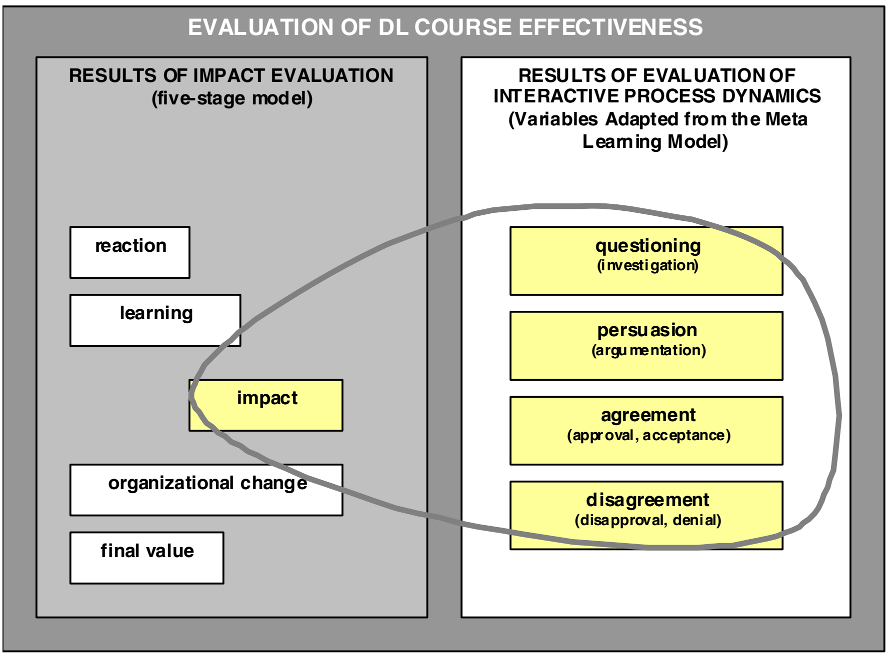

Fig. 3. Model of effectiveness evaluation applied in this study

Analysis of forums, with results expressing incidence of each variable in students' and tutors' "speeches" or interventions, was compared with mean scores of impact evaluation obtained by students. Thus, it was possible to obtain the characteristics of actors' "speeches" in forums according to groups with larger concentration of high or low impact evaluations.

For the same groups, classified according to quality in impact evaluation, forum dynamics was observed by analysis of the evolution of "speech" configurations from the first to the last forums throughout the course.

In summary, the script for the process of information analysis went through the following steps:

a) Searching, using impact indexes, people with the highest or lowest evaluations;
b) Verifying in which groups/classes such people are and whether there is a hegemony in relation to impact evaluation, i.e., relative to existence or not of groups with concentration of people with high or low impact evaluation.

In case groups of high or low impact were observed:

a) Identifying distinctive conversation characteristics in discussion forums using two bipolar variables in the adapted Meta Learning model, as well as distinctive characteristics associated with the quantitative of interventions;
b) Verifying the evolution (dynamics) of such conversational characteristics, comparing results between the first and last forums.

The following resources of descriptive statistics were used to analyze information and summarize results:

a) Descriptive graphs and tables;
b) Parametric description, in which the values of certain parameters were estimated to facilitate description of the data set: measures of central tendency and measures of statistical dispersion;
c) Correlations between variables.

Understanding that statistical results are only a support for the understanding of phenomena guided the analysis. Although correlations between many variables have been entirely explored, only those that contained significant information for an understanding of research questions were used.

3 Summary of Results

Understanding the dynamics of learning processes implies an understanding of its components: individuals, environment or context and mediation. It is known that distance learning (DL) has a distinctive characteristic in relation to the mediation component. Due to the need of overcoming the barriers of distance and time, DL intensively uses information and communication technologies (ICT) to perform interactive processes.

Construction of effective learning environments depends on human relationships. It also depends on the emotionality placed on such relationships. Therefore, knowing how to act in virtual environments in the sense of creating the required ambiance for animation of learning processes has a unique importance.

The general objectives of this study were reached: analyze indexes that are significant for evaluations of distance course effectiveness; investigate to which extent effectiveness of DL courses is correlated with quality of interactive processes; search characteristics of the conversations of individuals interacting in study groups that are formed in virtual environments, which may contribute to effectiveness of distance courses.

The main results of the analysis corroborate such statements, and can be summarized as follows:

a) There was a positive evaluation of the course by participants;
b) Final evaluation scores of course participants and their self-evaluations after ending the course were not good indexes of course effectiveness; results indicated inexistence of a correlation between final score and self-evaluation and impact evaluation;
c) Context proved to be important for course effectiveness;
d) Group and interaction dynamics between its components were considered as important for course effectiveness;
e) Teacher's activity was also considered as relevant for course effectiveness; his presence, with constant interventions throughout the entire course (initial and final forums), is significant for group impact; quality and balance (bipolar variables) of the teacher's interventions throughout the course are significant for group impact;
f) As to characteristics of interventions in the internal conversation of learning groups, persuasion stood out as a marked characteristic in conversations of both groups (high and low impact); there was an unbalance in the direction of persuasion in the bipolar variable questioning/persuasion in both groups; only high-impact groups had a compatibility between approval/disapproval variables and Losada Line (high-impact group – in forum 1 P/N = 7.9 and in forum 2 P/N = 3.9; low-impact group – in forum 1 P/N = 12.5 and in forum 2 P/N = 13.3); therefore, the study confirmed the Meta Learning model, indicating the importance of expansive emotional space (Losada Line range) for positive group dynamics.
g) Non-correlation between final evaluation score of course participants and impact on participants' performance, and importance of context for impact also corroborate some results found in previous studies on Organizational Psychology about the impact of training in in-person modality (Abadd, 2000).

In summary, the importance of the variables context, teacher and group were identified for course effectiveness. Relevance of certain characteristics of students' and teachers' "speeches" was also confirmed to generate conversational dynamics that result in higher course effectiveness.

It is also worth stressing some aspects of these results. First, the influence of context. In DL the student is spatially distant and has a more flexible time to study; however, institutional support for such process is decisive. Such support should be manifested in many aspects, for example: when the course is corporate – encouraging coordinators and colleagues, application of learnt content valued by the institution, support materials and technology, etc.; when the course is focused on a general audience – support infrastructure in places where students live; hence the importance of DL poles.

A second element to be stressed is the teacher's importance as a mediator of learning processes. This issue has a strong impact in DL models that are being practiced in Brazil and worldwide. In general, there are three major trends in structuring the teacher's role in the main DL systems:

a) The teacher as a course coordinator, guiding a group of tutors to interact with students; in this case, tutors (usually recently graduated students or undergraduate students) are responsible for establishing a direct relationship with students;

b) The teacher-tutor, who coordinates and directly interacts with their students (similar to the situation of in-person courses; this model was adopted in the course under investigation);

c) Course without interactions with teachers or tutors; such courses have a strong self-institutional component, with no human interaction, in which students are guided by didactic materials.

DL is always facing the challenge of combining what is particular and universal in formation. It is known that, to a certain extent, this is a dilemma in general education. A universal curriculum needs to be related to varied particular forms of knowledge, constituents of different identities. Particularly in DL there are specificities: on one hand, heterogeneity of the audience to be served – DL is usually a modality used in extensive geographical areas and large populations; on the other hand, the needs of a certain standardization of learning instruments to make system management feasible. This makes the educational system even more complex and reinforces the challenge.

Such issue can be faced by flexibility of the course design, to match curricular content with students' previous culture and knowledge. In this sense, a secret to achieve effectiveness in this process lies in the teacher's activity, as shown in this study.

This study represents the first steps in the development of a possible path to evaluate effectiveness of distance courses using the Meta Learning model adapted to the virtual learning environment. A methodology that aims to reflect dynamics – which are not linear – of interactive processes was proposed, a methodology that sees learning as a non-deterministic process (cause-effect), but as a complex phenomenon.

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Part II

Innovation and Creativity in Schools

The Impact of the Multi-sensory Program Alfabeto on the Development of Literacy Skills of Third Stage Pre-school Children

Betina von Staa[1], Loureni Reis[1], and Matilde Conceição Lescano Scandola[2]

[1] Positivo Informática, Brazil
betina@educacional.com.br, loureni@positivo.com.br
[2] Secretaria de Educação da Cidade de São Paulo, Brazil
mcscandola@prefeitura.sp.gov.br

Abstract. Here we present the results of the pilot-project undertaken in ten Pre-Schools with third stage (5 year-old) children who used ALFABETO Multi-sensory Program. The study shows that the project rendered meaningful results as to the development of writing hypotheses among the children who had access to the program. We also observed the opinions of the teachers involved in the project, who mentioned that ALFABETO motivated students to develop their reading, writing and oral skills, and promoted socialization and interaction among students.

Keywords: ALFABETO, Pre-School, Reading and Writing Skills, Interaction, Motivation.

1 Introduction

Alfabeto Multi-sensory Program (ALFABETO) combines educational software and hardware in a collaborative environment. It fosters the development of reading, writing and oral skills among students.

With this program, a group of students, mediated by their teacher, can participate in multi-sensorial activities that involve the manipulation of blocks that work together with a multimedia educational software. ALFABETO'S software is organized into themes, modules and environments. It contains activities at different levels, which involve the use of concrete materials and emphasize collaborative knowledge construction and interaction. The software allows the teachers to create their own activities by inserting pictures, sounds, and content to individualize students' learning. The software also supports students' learning with its intelligent multimedia feedback, which provides cues, written text and/or sounds while students progress through the program. If necessary, the software will display the correct answer to the exercise to encourage students to progress and avoid frustration.

The picture below shows a group of six students working together on ALFABETO. In their computer screen there is a picture of the heart that was drawn by the students and their teacher inserted it into the software through the configurator tool that comes

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with the Alfabeto software. The teacher also added the well-known Brazil song "Batatinha quando nasce" and the students recorded their voices reading/singing the lyrics. Through this collaborative work, the students are able to learn with familiar content that is motivating and meaningful for them. The picture illustrates students working on this customized activity and spelling the word "coração". They are working together to complete the lyrics by spelling with the blocks the selected words that appear on the screen in written form.

Fig. 1. Students cheering after having received positive feedback from ALFABETO

ALFABETO's multi-sensory panel recognizes the blocks through optic sensors, and the software, through PG (Patrulheiro das Galáxias), the speaking animated character in the program, who provides intelligent feedback to the children, rewarding them when they are right and guiding them when they need suggestions. The intuitive and manipulative nature of the interface makes it universally accessible. Students with limited previous exposure to Portuguese and to technology can all benefit from learning with Alfabeto.

ALFABETO's software offers activities that stimulate students' auditory, visual and kinesthetic learning styles. Age-appropriate sounds, animations, images, texts, words and letters motivate students to enhance their reading and writing skills. Teachers may include their own texts, sounds and animations into the software by means of the configurator to personalize students' learning. Thus, the teachers may adjust the content included in the program to their students' reading and writing skills and modify it through their learning process.

In 2008, the City of São Paulo Education Board requested a pilot-project to observe ALFABETO's impact in its own context, which is defined by teachers, parents, third stage students (5-year-old children) as well as by the physical location and space of the city's pre-schools, among other variables. During the pilot-project, we were supposed to observe ALFABETO's impact on third level pre-school children's reading and writing skills, as well as the teachers' attitudes towards the program.

No one expected the 5-year-old students to be neither completely literate by the end of the pilot-project nor to achieve first-grade-level skills. After all, according to *Toda Força ao 1.º ano* [1], it is in the first grade that children should consolidate reading and writing skills. The task of the pre-school is to offer children meaningful contact with language in social context. Like the Education Board of the City of São Paulo states [2], we understand that "language is a discourse system that is organized during and for its written and spoken use, always in context." We also agree that "the knowledge about the writing system and the written language can and should be taught simultaneously." Like São Paulo [1] we understand that "the development of reading and writing skills is not a process that comes to an end when the student knows how to deal with the writing system, but it lasts for the whole life, enabling each person to take part in more situations that involve written language and to read and produce more texts of different genres, from literary to analytical works".

Here we present the results of ALFABETO's pilot-project undertaken in the City of São Paulo.

2 Method

We have performed a quasi-experimental study. Children of the focus group as well as the control group underwent pre- and post- writing tests. We relate these results to our field data, in order to understand, describe and justify them.

Third Stage students and their teachers in 10 different pre-schools in the city of São Paulo used ALFABETO for two months The project was undertaken in five schools in the Itaquera region and five the region of Campo Limpo. It involved 2,600 students, 75 teachers and 30 Alfabeto units.

It is important to mention that, in these regions, only 44% of the mothers and even fewer fathers have a High-School degree. The rest of the parents have had even less schooling. In this context, schools are responsible for assisting students in developing skills that most of their parents do not possess.

Each class had 35 students and one teacher. Children remained at school for 4 hours a day. During the time they stayed at school they received either breakfast, lunch or dinner.

All the teachers involved in this pilot-project, were invited to participate in an 8-hour training session and received daily visits from assistants during the pilot-project. They also received suggested lesson plans developed by Positivo Informática based on the City of São Paulo curriculum. The equipment was installed in the different schools according to their own request, taking into consideration the space they had available and the way each school organized its daily routine in classrooms and laboratories.

The data we had available for this study was collected through

1. Pre- and post- writing-hypothesis test of focus group and control group.
2. Teacher's questionnaires gathering opinions on the project as a whole, on their work, on how they felt towards the technological innovation, as well as on how they evaluated the students' attitudes and development in relation do ALFABETO.

The writing-hypotheses assessments were undertaken before and after the students were introduced to Alfabeto. The study group included eight of the ten schools, all of which used ALFABETO. There were two control group-classes in two different schools which also received the pre-test as well as post-test. Students were supposed to answer five questions about their favorite friend, color, animal, toy/game and food by writing their answers. We evaluated whether they could write their own name, and whether they had a pre-syllabic, a syllabic, a syllabic-alphabetic or an alphabetic writing hypothesis[1].

3 Results

Here we present the overall figures collected from the use of ALFABETO, the results of the pre- and post-test, as well as the opinions of the teachers.

3.1 The Project in Numbers

Here are our project's accomplishments in numbers:

- There were 1,317 classes during the two months of the pilot-project in the ten participating schools;
- Each student used the equipment 1.1 times a week, on average;
- 62% of the classes were planned using the configurator tool;
- 82% of the classes were prepared with the help of the assistant.

The above figures indicate that ALFABETO was used intensively, and was therefore relevant for the education of the children during the pilot-project.

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[1] *Toda Força ao 1.º ano* [3] defines the children's writing hypotheses as follows:

Pre-syllabic:

The child writes using graphic symbols.
The child uses letters to write.
The child writes different texts using different letters.

Syllabic:

The child establishes a relation between spoken and written language (for each spoken syllable, there is a symbol) using different graphic symbols.
The child establishes a relation between spoken and written language, using letters, but without using their conventional sounds.
The child establishes a relation between spoken and written language using the conventional sounds of the letters.

Syllabic-alphabetic:

The child establishes a relation between written and spoken language, using one letter per syllable or more.

Alphabetic:

The child writes alphabetically, even without observing conventional spelling rules.
The child writes alphabetically, observing some conventional spelling rules.
The child writes alphabetically, always observing conventional spelling rules.

3.2 Results of the Hypothesis-Test

The Writing-hypothesis-test revealed a considerable increase in the number of students who knew how to write their own name, after they had access to ALFABETO. It also showed that many of these students developed the syllabic writing hypothesis. Some students also developed the syllabic-alphabetic hypothesis and some even showed to have an alphabetic hypothesis.

Below we present the results of the pre and post-test:

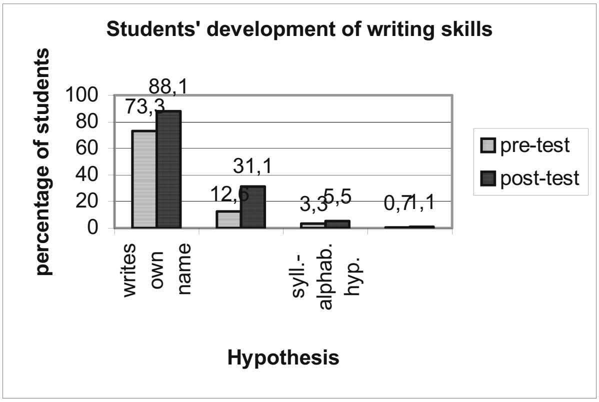

Fig. 2. Development of the writing hypotheses of focus group students between the pre-test and the post-test

From the eight schools that sent pre and post-test results, in seven of them students showed development. In one of the schools of the pilot-project as well as in the control group there was no difference between the pre and post-test numbers as to the skills of the students to write their own name or as to the development of any writing hypothesis.

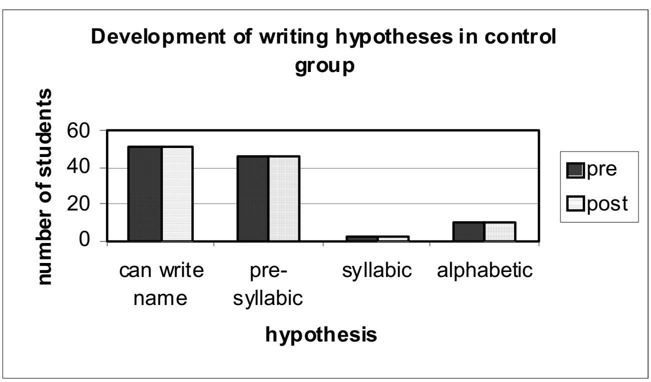

Fig. 3. Development of the writing hypotheses of control group students between the pre-test and the post-test

If we compare these results to the ones obtained from the control group, which was undertaken exactly in the same period as the focus group, we have to infer that our results are very meaningful. The students in the control group did not show any development of their writing hypotheses and name-writing, while the students who had access to ALFABETO showed to understand the writing system faster and more confidently than those who had no access to the program. It is important to consider that the teachers received training to learn how to use the equipment and the software; they had daily access to assistants and received suggested lesson plans to use with their students. The teachers in the schools that showed no development in their students' writing skills did not take part in the initial 8-hour training. They allegedly had no time for it.

3.3 The Teachers' Views

When we analyzed the opinions of the 75 teachers involved in the pilot-project as to the impact of ALFABETO on the development of their students' skills, we observed that they enhanced and confirmed the results obtained by the writing-hypothesis-assessment undertaken by the Board of Education of the City of São Paulo.

Here are our results:

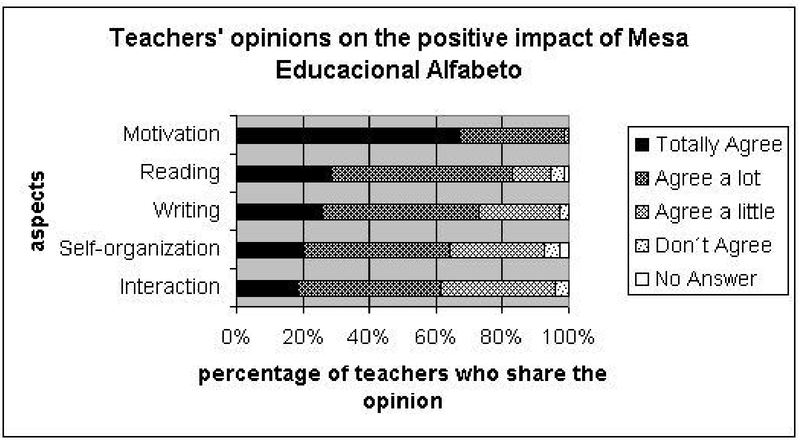

Fig. 4. Views of the teachers on the impact of Alfabeto Multi-sensory Program on their students' development. The questions that originated these results were: Motivation: ALFABETO motivated my students. Reading: My students felt more comfortable when reading at different moments in class.

Teachers have developed new ways of organizing their classes, with new activity structures for their lessons. They also noticed that the students took advantage from their time using ALFABETO because they were motivated and encouraged to develop their reading and writing skills, work on self-organization and work cooperatively. The graph above shows the degree of teachers' agreement that each different skill (reading, writing, self-organization, and interaction) is developed through the use of ALFABETO, as well as how much they believe the students are motivated by the program.

3.4 Analysis of Teachers' Open Answers

The open answers offered spontaneously by teachers who participated in the pilot-project also confirmed the quantitative data of this study. They reported that ALFABETO has contributed in many ways in the development of their students skills. ALFABETO is considered a rich, attractive and flexible program that stimulates participation, interest, attention and curiosity among students.

According to the teachers, ALFABETO develops students' reading, writing and oral skills, since it uses language with social functions, that are appropriate for preschool. Furthermore, teachers mentioned that ALFABETO also developed students' social skills, such as interaction, cooperation and sharing of knowledge. PG (Patrulheiro das Galáxias, the animated character that interacts with the students in the software) is referred to as playful and interactive.

Teachers reported that with ALFABETO, students developed their writing hypotheses, autonomy, self-organization and increased their comfort level with technology. The program is considered an ally for the teachers. They agreed that every aspect of ALFABETO contributed to children's literacy development.

They also noticed it was very important to work with ALFABETO in context and to take most advantage of it from the moment they had access to it.

They mentioned that in some cases, the students dealt with the equipment as if it were another toy, without understanding what it was for. At these moments, they considered it important to intervene and explain to the students what they were supposed to do with the program. Therefore, they concluded that the resource cannot be used by the children without teacher's surveillance. At the beginning, there seemed to be a belief on part of the teachers that students would be able to work by themselves on ALFABETO. In fact, this is not how the device is supposed to be used, and we are glad that the teachers noticed spontaneously that teachers' guidance was a necessary.

As to the teachers' difficulties to use ALFABETO, they considered the 8-hour training that was offered to them was too short to understand well how to use the equipment and they went through lots of trouble developing new ways to organize their classrooms and classes. Most of the teachers mentioned it was difficult to coordinate the students working with ALFABETO simultaneous with the other 30 students who were not working on the program.

Many teachers agreed that having an assistant help them prepare their classes, compensated for the brief training. After two months of effective use of ALFABETO, we noticed some teachers already knew how to use the configurator (which is the most sophisticated and complex teacher tool in the software) by themselves, but many others still had trouble using it. The teachers who did not take part in the initial 8-hour training had the most difficulties after two months.

The teachers mentioned that they would like to have more time to plan their classes, to work with fewer students in a classroom, and even to have less than six students per sensory panel. Many of them even worked ALFABETO regularly with four students per group.

It is important to mention that ALFABETO demanded the greatest effort from the teachers at the beginning of the pilot-project. Teachers say that it was difficult to integrate their syllabus to ALFABETO's content. However, teachers came to the important conclusion that planning was absolutely essential for the success of ALFABETO in their classrooms. In fact, teachers were very satisfied to discover that they could plan a wide range of activities and personalize the program according to students' needs, in the same space and at the same time, for different groups of students, taking into account their individual pace.

3.5 Solutions for Teachers' Difficulties

As mentioned above, there were some difficulties that the teachers had to overcome during the study. Most of their difficulties were related to classroom organization and coordinating different students working simultaneously on different activities. Positivo Informática supported the teachers by sending them lesson plans for the students waiting for their turn to use ALFABETO. Some of the schools that participated in the study organized special spaces or centers in their classrooms or laboratories for the other students to work on relevant activities, while the other groups used ALFABETO. Some teachers planned complementary activities related to the ones they would work on with ALFABETO, and even introduced special materials for their students to provide them with opportunities to practice further and to consolidate their newly-acquired skills, keeping in mind their learning expectations. In a short time, all classrooms started working harmoniously and teachers and students were more satisfied and less anxious about integrating ALFABETO in their programs.

4 Final Remarks

We observed that ALFABETO is a motivating multi-sensory program that promotes the development of reading, writing and oral skills, at the same time that it develops students' social skills, such as interaction, autonomy, and self-organization. The program was also considered a rich and flexible educational tool, which was effectively explored by the teachers involved in the pilot-project. This means that the results presented here have most probably been influenced by the use of the ALFABETO program.

As to teachers' practice, the professionals involved noticed how important planning was for the success of their work. The teachers' difficulties were concentrated on how to organize their classes, since they always had a situation in which they had some students using the resource and others doing something else.

Nevertheless, most of the teachers, with the help of their assistants and coordinators, developed strategies to deal with simultaneous activities or centers in their classrooms. This was very satisfactory for everyone involved in the pilot-project, since the quantitative results showed such a meaningful development, which is the aim of the teachers, coordinators, parents and students alike.

We can thus conclude that the combination of quality resources, motivating and flexible software, as well as teacher training and assistance, can render extremely satisfactory results in a short period of time for the development of students' skills and teachers' practice, even in contexts that are far from ideal, but just real.

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Personalized e-Learning Environments: Considering Students' Contexts*

Victoria Eyharabide[1], Isabela Gasparini[2,3], Silvia Schiaffino[1], Marcelo Pimenta[2], and Analía Amandi[1]

[1] ISISTAN – Fac. Cs. Exactas – UNICEN, Tandil, Argentina
Also CONICET, Consejo Nacional de Investigaciones Científicas y Técnicas
{veyharab,sschia,amandi}@exa.unicen.edu.ar
[2] Instituto de Informática, UFRGS – UFRGS, Porto Alegre, Brazil
{igasparini,mpimenta}@inf.ufrgs.br
[3] UDESC – Universidade do Estado de Santa Catarina, Joinville, Brazil

Abstract. Personalization in e-learning systems is vital since they are used by a wide variety of students with different characteristics. There are several approaches that aim at personalizing e-learning environments. However, they focus mainly on technological and/or networking aspects without caring of contextual aspects. They consider only a limited version of context while providing personalization. In our work, the objective is to improve e-learning environment personalization making use of a better understanding and modeling of the user's educational and technological context using ontologies. We show an example of the use of our proposal in the AdaptWeb system, in which content and navigation recommendations are provided depending on the student's context.

Keywords: Distance Learning, Computer Assisted Learning, Learning models, Personalization, Contextual and Cultural Profiles.

1 Introduction

Nowadays, personalization in e-learning environments demands more effective techniques to personalize student assistance in extremely dynamic and heterogeneous contexts. Context is vital to improve personalized access to and presentation facilities of learning resources. Context can be defined as a description of aspects of a situation [1]. If a piece of information can be used to characterize the situation of a participant in an interaction, then that information is context. For instance, the physical location of the student or the temperature of the student's surroundings are possible examples of context.

Research in adaptive educational hypermedia has proved that considering context leads to a better understanding and personalization [2]. Modeling the context leads to the design of systems that deliver more appropriate learning content and services to

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satisfy students' requirements and to be aware of situation changes by automatically adapting themselves to such changes [3]. An improvement in the user's contextual information leads to a better understanding of users' behavior in order to adapt i) the content, ii) the interface, and iii) the assistance offered to users.

Thus, a contextualized e-learning environment provides the student with exactly the material he needs, and appropriate to his knowledge level and that makes sense in a special learning situation. Thus, for each situation, an e-learning environment is dynamically adjusted depending on the context information available. However, while e-learning environments are inextricably linked to the notion of situation, this is only implicitly mentioned and not explicitly modeled. In order to support situation-aware adaptation, it is necessary to model and specify context and situation [3]. More accurately, there is a complex intermeshing and continuous transformation of situations in combination with fluctuating contexts, where meaning changes according to context and through preferences of different participants. In this sense, e-learning personalization is situation-dependent and cannot be managed in an independent form.

Ontologies are widely used to model context. In [4], we present an approach to model context using upper-level ontologies. An upper-level ontology provides the basic concepts upon which any domain-specific ontology is built. Based on our previous work, in this paper we use that upper-level model as a framework to describe context for e-learning. Thus, ontologies not only facilitate the specification of context but also the development of guidelines to use it.

We are working on strategies and techniques to model students' contextual information for e-learning environments. In addition, we investigate how to integrate the advantages of ontological models into personalized educational systems. Our aim is to increment even more the actual systems personalization capabilities making use of ontologies to model the user's context in different scenarios. As a result, in this paper we describe an approach to improve the personalization capabilities of an e-learning environment called AdaptWeb [5]. Particularly, we improved the models used in this e-learning environment in order to incorporate the notion of context and situation.

The article is organized as follows. First, section 2 discusses some related work. Then, section 3 presents our view about context modeling for e-learning, and our ontological-driven approach to model context within the concept of situation using upper-level ontologies. Section 4 argues about the context dimensions and section 5 explains e-learning personalization using the context information. Later, section 6 discusses how context is modeled in AdaptWeb drawing on our previous work. Finally, in section 7 we summarize our results and indicate future research.

2 Related Work

There are several ontology-based user profiling approaches to represent context ([1][6]). However, they are centered in using ontologies to describe the application domain and they usually do not consider the characteristics of contexts that are invariant during certain time intervals (situations). The ones that aim at describing the situation in which certain user information is captured consider only minimal contextual information, such as URL, date or time.

Dockhorn Costa et al. in [7] propose basic conceptual foundations for context modeling. Specifically, they suggest a separation of the concepts of *entity* and *context*. According to the authors, context is only meaningful with respect to an entity. While an entity is something that can exist by itself; context is what can be said about an entity. Therefore, context cannot exist by itself; that is, it existentially depends on other entities. Although, they have extended their models with the ontological concept of situation, they have only presented them using an ad-hoc graphical notation. Later, in [8] the authors continued their work to propose an approach to the specification and realization of situation detection for attentive context-aware applications.

As the regards the use of context and ontologies in e-learning, [9] present an ontological framework for e-learning environments and apply it in two applications based on this framework: TANGRAM, to reuse of existing content units to dynamically generate new learning content adapted to the learner's knowledge, preferences, and learning styles, and LOCO-Analyst to help instructors rethink the quality of the learning content and learning design of the courses they teach. In [10] the authors discuss examples of ontologies used both to model material in a Java e-lecture and to model learners' performance and interactions with the e-learning system. This information is used to propose annotated recommendations of different learning resources. Finally, the importance of the user's context of work (given by user platform, user location, and affective state) in adaptive educational systems is discussed in [2].

3 Context Modeling in E-Learning

To be effective, a learning process must be adapted to the student's context. A *context-aware e-learning environment* is a web-based educational application that adapts its behavior according to its students' context. *Context-aware applications* use and manipulate context information to detect the situations of users and adapt their behavior accordingly. Context-aware applications not only use context information to react to a user's request, but also take initiative as a result of context reasoning activities [8].

Ontologies are the most promising technology to support context modeling because they are very useful to disambiguate and also to identify the semantic categories of a particular domain. Ontologies are the description of the entities, relations and restrictions of a domain, expressed in a formal language to enable machine understanding. In particular, an upper-level ontology defines a range of top-level domain-independent ontological categories, which form a general foundation for more elaborated domain-specific ontologies [11]. In this paper, we present a model based on upper-level ontologies to describe a user's context for e-learning. A user might be involved in several overlapping contexts. Consequently, his/her educational activity might be influenced by the interactions between these contexts. Overlapping contexts contribute to and influence the interactions and experiences that people have when performing certain activities [3]. The definition of an overlapping context is not new. Context can be considered as a multi-dimensional space where each dimension is represented by one specific ontology which should be handled separately ([12], [3]). Such a context should be described at least from pedagogical, technological and learning perspectives [13]. Learning processes have to provide extremely contextualized content that is highly coupled with context information, barring their reuse in some other context. Thus, ontologies can be used not only to model domain information but mainly to personalize the services provided to users, in adaptive systems as well as in agent-based ones [14].

As deeply described in [4], our model has three levels: a *meta-model*, a *model* and an *object* level (Figure 1). The meta-model level is represented by an upper-level ontology, the model level with several ontologies to describe context and in the lower level we find the instantiations of the context ontologies. In other words, the ontology concepts of one level are the instantiations of its immediate superior level. Thus, the concepts of the *object* level are instances of the *model* level which is further formed by instances of the *meta-model* level.

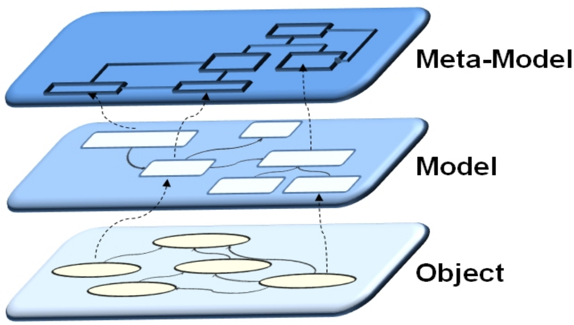

Fig. 1. Three-level context model

There are two main reasons for modeling context for e-learning: task oriented focus and reuse. First, the professor might not know which the context differences among the students are. Even though he/she knows them, he/she should concentrate on the educational material; without taking care of how to adapt that material to different students. Second, context might be the same for different students among different courses. Therefore, the e-learning environment could provide support to reuse those repetitive contexts descriptions.

4 Context Dimensions

An e-learning environment aims to support the structuring and adaptation of web-based courses material, according to the particular student's model. However, they may be dynamically adjusted not only according to the student's model but also depending on the context. In practice, 'context' is very difficult to define and most general-purpose definitions are inadequate. In this work, 'context' is considered as having *personal*, *cultural*, *technological* and *pedagogical* dimensions.

Personal context is widely considered in e-learning. This type of context is usually gathered in user profiles. A user profile is a model containing the most important or interesting facts about the user, such as user preferences or user interests [2]. For general purposes, typical characteristics of user profiles include age, scholarship, background, genre, among others. It considers the student's personal information (such as name or address) and also the student's personal preferences (like colors or layouts).

Cultural context is also vital for e-learning environments. Cultural aspects are preferences and ways of behavior determined by the person's culture. Regarding e-learning environments, the cultural aspects are just the features that distinguish between the preferences of students from different regions [15]. Cultural context is referred to different languages, values, norms, gender, social or ethnic aspects. An e-learning environment must be personalized in relation to a particular student's cultural properties. Thus, modeling culture profiles can be a tool to improve cultural awareness in global knowledge sharing and learning processes. They describe cultural characteristics on different levels, such as national, organizational or individual characteristics. In turn, culture can be analyzed in some levels: national and regional aspects, organizational aspects, professional aspects and fields, and individual aspects. Thus, cultural profiles describe cultural and individual characteristics on diverse levels.

Technological context is related to many different technological constraints (e.g., device processing power, display ability, network bandwidth, connectivity options, location and time). Indeed, cultural and technological adaptation is an important and hot research topic that has not been yet supported by most of e-learning environments, although some pioneering work has been reported by [13]. Technological context includes concepts such as browser type and version, operating system, IP address, devices, processing power, display ability, network bandwidth or connectivity options.

Pedagogical context is multifaceted knowledge. In fact, there are many distinct works about different viewpoints of pedagogical information needed to personalize e-learning. In practice, many adaptive systems take advantage of users' knowledge of the subject being taught or the domain represent in hyperspace and the knowledge is frequently the only user feature being modeled [2]. Recently, various researches started using others characteristics, such as learning styles [16]. In general, for educational web sites or e-learning environments we may be concerned with some specific aspects related to user role or information related to the activity being done like the student's background or preferences, the student's objectives, hyperspace experience, learning styles, personality stereotypes, cultural and contextual aspects.

5 E-Learning Personalization Using Context Information

We personalize an e-learning environment for each user based on the information stored in a user profile. In our work, the typical characteristics of students are extended to include the context dimensions mentioned in the previous section. Among all the information gathered in the user profile, in this paper we are especially interested in modeling *user preferences* because they change according to context. Preferences may depend on the situation the user is in and on external factors. Therefore, it is important to model in which context the user prefers something. Hence, we define user preference as an *entity* that the user prefers in a given *situation*, a *relevance* denoting the user's preference for that entity, a *certainty* representing how sure we are about the user having that preference and a *date* indicating when that preference is stored:

User Preference = {entity, situation, relevance, certainty, date}

Situations are the key to include temporal aspects of context in a comprehensive ontology for context modeling, since they can be related to suitable notions of time

[7]. As context varies during certain time intervals, it is vital to consider it within the concept of *Situation*. Examples of situations could be "John was at home using his notebook to read lesson number 3 of the Human Computer Interaction course" or "A Japanese Professor who speaks English is adding new exercises to the course Introduction to Java using a high speed connection while she travels by train". Therefore, we define situation as a set of contextual information in a particular period of time:

$$\text{Situation} = \{\text{Context, initial time, final time}\}$$

An example of contextual information would be: *"The student named John is reading lesson number 7"*. This is a description relating an entity (*the student John*) to another entity (*the lesson number 7*) via a property (*is reading*). We represent this contextual information as (Student.john, isReading, Lesson.lesson#7). We define context as a set of triples composed by concepts, instances and relations between them. It is important to emphasize that the concepts and instances might belong to the same ontology or different context ontologies:

$$Context = \{(\text{Concept}_{a1}.\text{Instance}_{a1}, \text{Relation}_1, \text{Concept}_{b1}.\text{Instance}_{b1}), ..., (\text{Concept}_{aN}.\text{Instance}_{aN}, \text{Relation}_N, \text{Concept}_{bN}.\text{Instance}_{bN})\}$$

To clarify these ideas, consider again John's example. As we mentioned before, John prefers to read visual learning material when he is at home using his notebook to read lesson number 3 of the Human Computer Interaction course. Hence, the corresponding context1 will be:

Context1={ (Person.*John*, **locatedIn**, Location.*home*),
(Person.*John*, **uses**, Device.*notebook*),
(Person.*john*, **reads**, Lesson.*lesson#3*),
(Lesson.*lesson#3*, **belongsTo**, Course.*HCI*)}

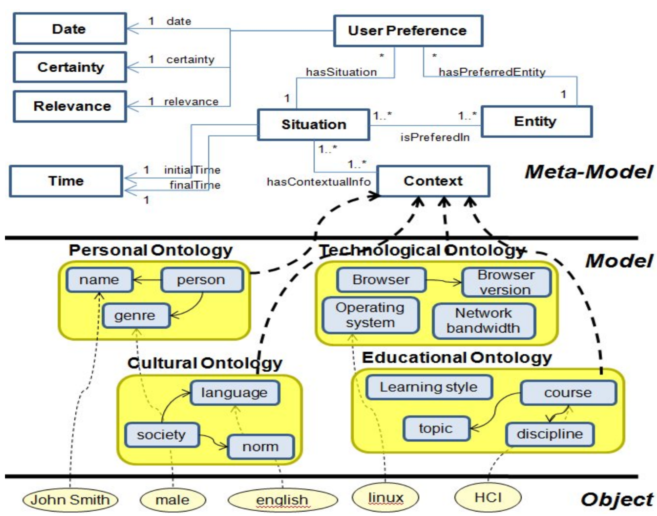

Fig. 2. Example of a situation model

Figure 2 depicts the situation model proposed. The meta-model is an upper-level ontology describing abstract concepts like *user*, *application*, *user profile*, *situation* or *date*. The model depicts the different contextual dimensions. Each contextual dimension is represented by a different ontology, such as a cultural ontology (with concepts like *culture*, *social norm* or *language*), education ontology (*course*, *learning style*, *discipline*), personal ontology (*name*, *genre*, *birthday*) or technological ontology (*operating system*, *browser*, *network bandwidth*). Finally, the object model will comprise instances describing the context of a particular user like a concrete name (*John Smith*), a course (*Human Computer Interaction*) or a particular language (*English*).

6 Adopting Contextual Modeling in AdaptWeb

In this section we describe some improvements of the personalization capabilities of the e-learning environment: AdaptWeb [5] in order to provide support to this contextual modeling purpose. Particularly, we improved the models used in those e-learning environments in order to incorporate the notion of context and situation.

AdaptWeb[1] (Adaptive Web-based learning Environment) is an adaptive application for Web-based learning, whose purpose is to adapt the content, the presentation and the navigation in an educational web course, according to the student model. Currently, it is an open source environment in operation on different universities. The environment is adapted to the student's profile and domain model that nowadays uses characteristics of personal, pedagogical and technological context: the student's preferences, learning styles, background, knowledge, navigational history, network characteristics, time of presentation, and quality of didactic material components presentation.

In our approach, the fundamental metadata describing the instructional material is partial generated automatically and stored in a web ontology. Now, we are incorporating more characteristics of context-awareness, as some culturally aspects into the student model, expecting the environment to become more adaptive to the students and reusable.

For each situation, the AdaptWeb e-learning environment is dynamically adjusted depending on the context information available. Once the learning situation is modeled, it is important to associate one (or more) situation(s) to each learning activity in order to contextualize the student preferences. That is to say, in situation 1 the student prefers the activity A; on the contrary, when situation 2 holds, the user prefers the activity B. For example, John prefers to see visual learning material when he is reading about the course "human computer interaction" and he has a high network connection. On the contrary, John prefers to listen to the teacher explanation when the course is "Algebra" and his network connection is slow.

We show some examples of contextual adaptation in AdaptWeb in an Artificial Intelligence course. In this paper, for a simplification purpose, we have a few variables: user's knowledge, subject, network connection and learning style.

In a *situation 1*, Mary does not have knowledge about the subject Bayesian networks. She is trying to do exercises about that subject but unfortunately she is not doing well. In addition, she has a high network connection and according to Felder's model [17] is active. As others students are on-line, the system infers that the best action is to suggest her to talk with them through chat in order to solve the exercises

[1] http://sourceforge.net/projects/adaptweb

and acquire knowledge in that subject. Thus, the adaptive system shows the "chat" link in a different and blinking color.

In another *situation 2*, the learner John is also learning the subject Bayesian networks but he has a low network connection and his Felder's learning style is reflective. In consequence, the system sends a message by email to his teacher advising to contact the student and disables links related to videos material.

Finally, suppose another *situation 3* in which Mary (the same learner in situation 1) now is learning decision trees and she has obtained enough knowledge about that subject. She continues having the same network connection and Felder's learning style. Therefore, the system suggests her to read the next subject of the course by hiding links to known subjects and highlighting those pointing to new subjects.

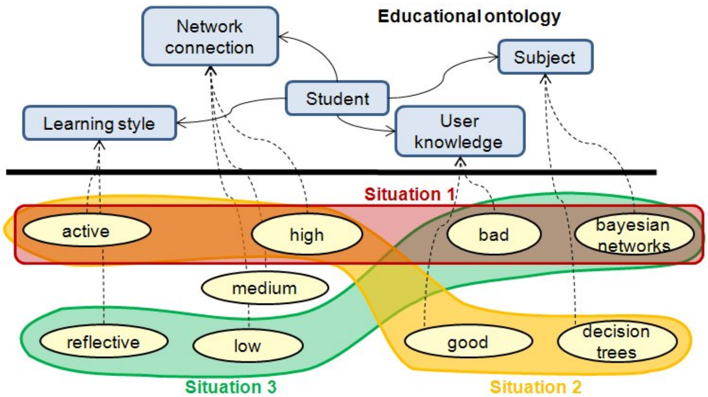

Fig. 3. Proposed user profiling technique

These situations are depicted in figure 3 and described as follows according to the notation in section 5.

Context1 = {(Student.*Mary*, **isLearning**, Subject.*bayesianNetworks*),
(Student.*Mary*, **hasKnowledge**, Knowledge.*bad*),
(Student.*Mary*, **hasConnection**, NetworkConnection.*high*),
(Student.*Mary*, **hasStyle**, LearningStyle.*active*)}
Context2 = {(Student.*John*, **isLearning**, Subject.*bayesianNetworks*),
(Student.*John*, **hasKnowledge**, Knowledge.*bad*),
(Student.*John*, **hasConnection**, NetworkConnection.*low*),
(Student.*John*, **hasStyle**, LearningStyle.*reflective*)}
Context3 = {(Student.*Mary*, **isLearning**, Subject.*decisionTrees*),
(Student.*Mary*, **hasKnowledge**, Knowledge.*good*),
(Student.*Mary*, **hasConnection**, NetworkConnection.*high*),
(Student.*Mary*, **hasStyle**, LearningStyle.*active*)}

The adaptation mechanisms in AdaptWeb decide to assist students by the following actions:

Context1 → "show highlighted links"
Context2 → "hide or disable links" + "show highlighted links"
Context3 → "hide already known content"

7 Conclusions

As e-learning systems become more sophisticated, it is interesting to investigate more sophisticated personalization mechanisms. One example is the need to deal with context modeling and its relation with user modeling. Context modeling extends traditional user modeling techniques, by explicitly dealing with aspects we suppose to have a significant influence on the learning process assisted by an e-learning environment, such as personal, pedagogical, technological and cultural aspects. We propose the use of ontologies to model this contextual information. Particularly we propose a three level model to capture different levels of detail.

As described in this article, AdaptWeb adapts the student's model depending on the pedagogical, technological and students' personal context information available. The main traits are the student's preferences, learning styles, background, knowledge, navigational history, network characteristics, time of presentation, and quality of didactic material components presentation. Our work has been applied to academic examples but has yet to be tested in actual use.

As e-learning systems progress increasingly towards more personalized configurations, it is becoming ever more important to have approaches that can help to improve the dramatic benefits of context modeling to personalization and also to allow reuse of this contextual information. In this paper, we offer only one approach for that. Therefore, it is yet a limited excursion into a territory which includes many other possible perspectives and paths to explore.

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Software *Junctus*: Joining Sign Language and Alphabetical Writing

Carla Beatris Valentini, Cláudia A. Bisol, and Cristiane Dalla Santa

Universidade de Caxias do Sul, Rua Francisco Getúlio Vargas, 1130
95070 Caxias do Sul, Brazil
cbvalent@ucs.br, cabisol@ucs.br, crisdallas@gmail.com

Abstract. The authors' aim is to describe the workshops developed to test the use of an authorship program that allows the simultaneous use of sign language and alphabetical writing. The workshops were prepared and conducted by a Computer Science undergraduate, with the support of the Program of Students' Integration and Mediation (Programa de Integração e Mediação do Acadêmico – PIMA) at the University of Caxias do Sul. Two sign language interpreters, two deaf students and one hearing student, who also teach at a special school for the deaf, participated in the workshops. The main characteristics of the software and the development of the workshops are presented with examples of educational projects created during their development. Possible improvements are also outlined.

Keywords: Computerized learning environment, authorship software, deafness, sign language, alphabetical writing.

1 Introduction

Sign languages are natural and complex languages shared by individuals who identify themselves as deaf. These individuals belong to a community, a linguistic and cultural minority with distinctive mores, attitudes and values [1]. In each country the deaf community developed their own language. In Brazil, Brazilian Sign Language (Libras) was recognized as an official language in 2002, and bilingual education has been the approach chosen by a large number of special schools for the deaf since it was introduced in the country in the 1990s [2]. This approach is based on the understanding that the deaf children's cognitive and linguistic development will be facilitated when sign language is used to create a natural and rich context of communication. The oral language of the country is then introduced to the deaf child as a second language for the development of reading and writing skills [3] and [4].

The ability to make use of the dominant language of a country in its written form broadens the horizon of deaf individuals, allowing them more access to the information that circulates in society through different media and increasing their chances for better educational and job opportunities. However, reading and writing is difficult for deaf pupils. Researchers have well established this fact and teachers know it from their daily experience [5]. Deaf children lack access to spoken language so they are

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not able to use efficiently sounding out processes that help them to learn how to read [6]. Also, the form and structure of the signed language that they use is not related to the spoken or written form of oral language.

Considering that digital technology can increase capacity for communication and learning, new strategies can be created to improve the education of deaf children. With the objective of allowing the simultaneous use of sign language and alphabetical writing, the authorship program *Junctus* was developed [7]. This article describes workshops developed in the year of 2008 to test the use of this software. The workshops were organized and conducted by an undergraduate Computing trainee at the facilities of the Program of Students' Integration and Mediation (Programa de Integração e Mediação do Acadêmico – PIMA[1]) at the University of Caxias do Sul. Two sign language interpreters, two deaf students and one hearing student who also teaches at a special school for the deaf participated in the workshops. After a short introduction describing the main characteristics of the software, this article discusses how the workshops were developed, presents examples of educational projects created during these activities, and outlines possible improvements.

2 The Autorship Program *Junctus*

The learning environment *Junctus* was developed using Java platform, created by *Sun Microsystems* [8], which is available as an open-source system. One principle that guided the development of this framework was the need of guaranteeing adequate usability. Therefore, all efforts were made to create an interface that should be simple to use and, at the same time, should offer the functionalities proposed to allow the integration of different forms of representation.

In the development of this framework, the main functionalities were encapsulated in modules (classes) as independent as possible, so each module is responsible for one form of representation. In the current prototype these forms are video and text. As the rest of the framework is independent of the implementations of the other modules, it is possible to extend the system to incorporate other forms of representation.

Videos are captured from several forms of digital recordings. The framework allows the integration of video and text, so the simultaneous use of video-recorded narratives in sign language and the corresponding written text is possible. To establish the links between video and text, the user selects in the video the segments corresponding to the segment selected in the text, "editing" the project. Each project developed by a user-apprentice corresponds to the construction of this relation between text and video. Therefore, it is possible to construct representations in a visuo-space language (sign language) and alphabetical writing simultaneously.

Junctus presents several functionalities that can be adapted to the user's needs. The Menu Bar shows the following options: File (to create new files, open existing files, save and exit), Edit (including a creation option that makes available a specific window to link video and text) and Help (general information about *Junctus*).

2.1 Creation Mode

Figure 1 presents the interface of the environment when beginning a new project. This interface presents the following windows: Creation, Video, Text, and List of Links. Next, the functions of these windows will be briefly described.

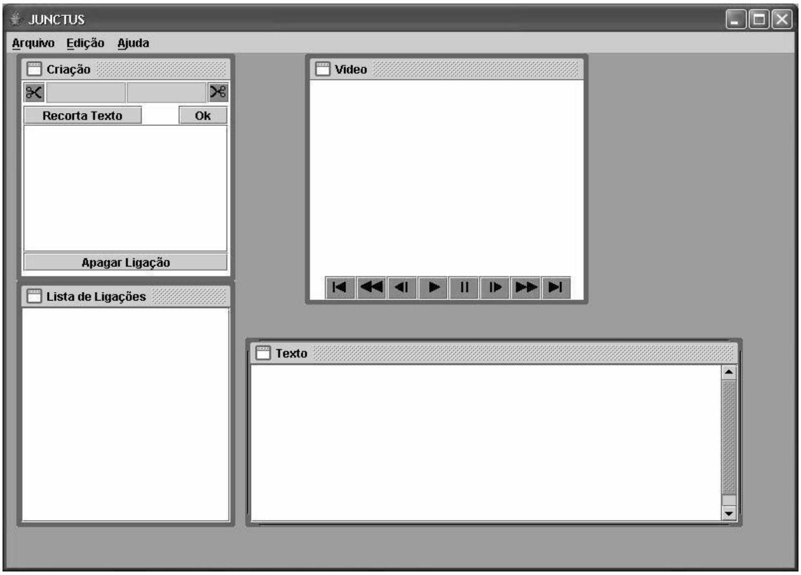

Fig. 1. Interface of the environment *Junctus*

The Text window can be used for the editing of a new document and/or addition of a document that already exists. Video handling is executed with the tools located in the Video window. After positioning the video in the desired frame, the cutting tools that appear in the Creation window can be used. With these tools it is it is possible to capture the beginning and the end of the video segment that one wishes to link to a part of the text. Once the text and the video segments are defined, clicking the OK button will confirm the creation of a new link between the two forms of representation.

2.2 Visualization Tools

Clicking one of the items presented in the List of Links window allows the visualization of the text associated to the link. A double click on a text segment in the List of Links window will begin the corresponding video segment and the text segment will be marked, as shown in Figure 2:

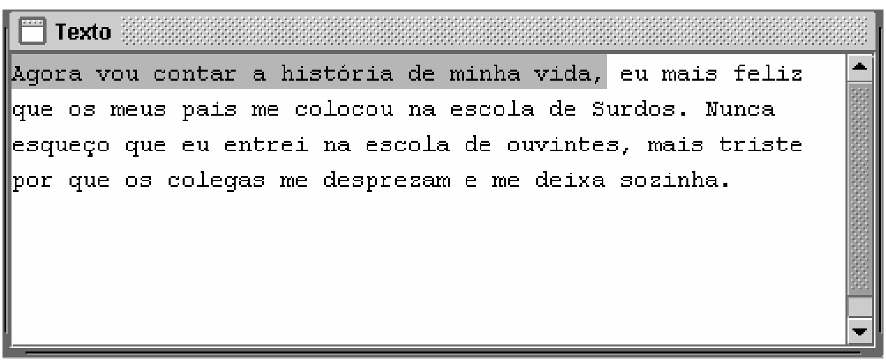

Fig. 2. Visualization of text linked to the video segment

3 Learning Scenario: Testing the Use of the Software

The application scenario of the authorship program *Junctus* that was analyzed in this article is related to the possibilities of using this computerized learning environment in educational projects to support the inclusion of deaf students in higher education. The objective of this proposal was to offer deaf students who are regularly enrolled in undergraduate courses of the University of Caxias do Sul and sign language interpreters the opportunity to learn how to use the software, knowing and applying its functionalities in an independent way. Also, they were given the opportunity to evaluate the software and its use and suggest modifications or inclusion of new functionalities.

In order to develop this proposal, the research group relied on the participation of an undergraduate Computing trainee. She developed the workshops and prepared a manual focusing on the needs of this clientele. Her work was oriented by the researchers who author this article and by the trainee's academic supervisor. The work proposal was organized to be developed in three workshops of five meetings each. The activities took place in a special room at PIMA, equipped with computers and webcams that are available to be used by the deaf students and the sign language interpreters. The workshops were organized in such a way as to consider four stages for learning the abilities necessary for the appropriation of the software by the users, and for the development of a project using the environment offered by *Junctus*.

First, an overview of the workshop was presented in power point slides. Also in this first stage, the focus was on the abilities necessary for installing the program, understanding the functionalities of the software and capturing and storing videos. Through dialogued exposition, a general view of the program was presented, detailing the form of installation, the procedures for video recording and for management of archives and folders. Each subject presented were followed by guided practical activities. The general view of the program allowed participants to anticipate possibilities for developing educational projects that could answer some of their needs.

In the second stage the work focused on text, video and project differentiation, open and save commands, understanding the functionality "creation" and how to start making links. Activities were conducted so that participants could use and experiment with the software. They received a printed manual that guided their progress step by step, and could take individual notes to facilitate understanding of the procedures. Three tasks were then developed: the first was to insert text; the second was to create links between video and text; the third was to recognize the extension of the archives that were generated and present an idea for a practical use of the software.

In the third stage, the contents presented so far were reviewed and the levels of understanding were evaluated. Also, participants were asked to start to develop their own educational projects involving sign language.

It is important to emphasize that the growing access that deaf people have in higher education has led to the need to develop new signs in Brazilian Sign Language (Libras) related to each specific area of knowledge. The deaf community has been using different strategies to transmit to one another the new vocabulary they create. Among these strategies one can find the use of Libras-Portuguese dictionaries available on the internet, the use of drawings to represent the signs, and their full description in Portuguese. However, the full description of signs in Portuguese or their drawing is not very simple and might present certain difficulties for representation and interpretation, because sign languages are gestural and visual languages; therefore they make use of three-dimensional space.

Understanding how the software functioned and the possibilities it offered allowed participants to propose a small educational project to be developed during the workshops. The two sign language interpreters and the hearing student decided to use the computerized learning environment to share new technical concepts, especially because *Junctus* allows the explanation of technical concepts to be linked with the word or sign. The interpreters' objectives were to register these new signs and make them available to other interpreters and deaf students so communication in the classroom could be further enhanced. One of the screens of one of the projects developed by the interpreters can be seen in the figure below.

While working with the deaf students to decide which educational project they would develop, students also came up with the idea of using *Junctus* as a way to transmit technical concepts and the disciplines' contents of each course and to share specific signs usually used during classes. For the project to be developed during the workshop, they chose some of the disciplines they successfully attended. For instance, they chose the basic course in Embryology and summarized its objectives, the kind of content that was developed, and the difficulties that are usually faced by students in this course.

The forth and last stage of the workshop aimed at finishing the projects initiated in stage three and conducting an evaluation of the software and of the workshops as a whole. All the educational projects were finished successfully. The workshops were evaluated positively: the didactic techniques used by the trainee was considered good and respectful of the linguistic differences when working with the deaf students; the organization of the workshop in four stages helped participants to clearly identify the objectives of each meeting and what was expected of the participants to do; participants found the printed manual helpful and easy to understand. Suggestions regarding the improvement of the software as well as critiques are discussed in the conclusion session.

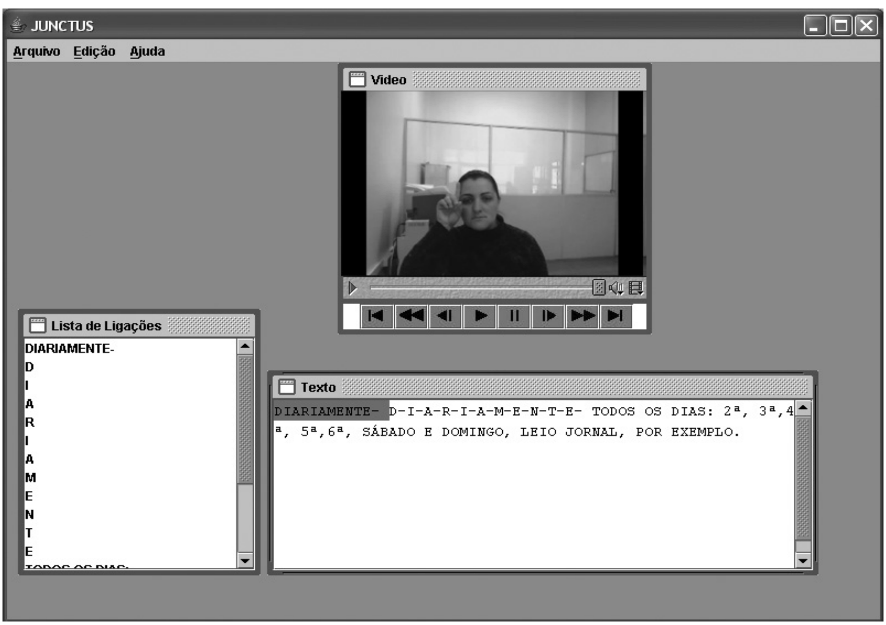

Fig. 3. Sign language interpreter's project about new signs

4 Conclusion

For a computerized learning environment to be successful, it has to be used and tested in real-life situations. The workshops that were presented in this article provided the chance to test the authorship program *Junctus* in a university setting, with the help of a Computing trainee and with the participation of hearing and deaf students and sign language interpreters. Validation includes evaluation of functionality, usability, performance, and pedagogical potential. This process can lead to a proposal for an improved version of the software.

Suggestions in terms of functionality included: a) create the possibility to save videos within the software; b) add an orthographic corrector and c) use different kinds of video files and not VCD exclusively. Usability could be enhanced if: a) different colors could be chosen for each link; b) the video window could be resized according to the users' preferences; c) the way files are saved and opened could be improved; and d) selection of videos could be more precise. Also, improving the visualization of the links (text and video) when the user searches for a single sign or phrase can optimize the performance of the software.

Several aspects can be thought of when considering the pedagogical potential of *Junctus*. As an authorship software, it showed flexibility to adapt to different pedagogical contexts such as those required by hearing and deaf students. The software can be used by the students to create educational projects such as those exemplified in this article, but it could also be used by teachers to organize learning materials. Also, evaluation with deaf students is challenging both for teachers and students due to the use of sign language and the need for interpreters. With the use of this software, students could prepare their material both in sign language and alphabetical writing, allowing teachers to better understand their learning processes.

The actual use of this computerized learning environment has opened new application possibilities and future perspectives. For instance, after the use of the software in the workshops at the Program of Students' Integration and Mediation, the coordinators and interpreters decided to use it to create a database of documents and guidelines of the university. The objective of this database is to provide deaf students with an easy access to important information regarding academic life. As for future perspectives, a second version of the software is being studied. The aim is to allow users to develop their projects in collaboration, interacting via the web.

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Innovative Teaching/Learning with Geotechnologies in Secondary Education

Eric Sanchez

EducTice, Institut National de Recherche Pédagogique
LEPS, Université de Lyon,
19, allée de Fontenay 69007 Lyon, France
eric.sanchez@inrp.fr

Abstract. The development of the use of Geographical Information Systems (GIS) for professional purposes and the success of virtual globes (VG) for personal uses leads to addressing the question of the integration of geotechnologies into secondary education. In this paper, we examine the changes in geography education linked to the increasing use of geotechnologies by the general public. The diversity of teacher practices can be linked to the powerful potential of these technologies for the access and the analysis of geographical and geological information. The characteristics of these tools suit pedagogies based on projects, problem-solving or collaborative work even if it has to be considered that a majority of teachers use them in more traditional ways. Furthermore, the paper underlines the importance of the integration of geotechnologies into the curriculum for the elaboration of the digital culture of the 21^{st} century citizen.

Keywords: Geotechnologies, virtual globes, Geographic Information Systems, innovation, teacher practices.

1 Introduction

In one of his books about the uses of technology for teaching, Larry Cuban [1] introduced a picture taken in a plane (fig. 1). The picture was published in 1928 by the New York Times. It shows a female teacher and young students during a geography course. The purpose of this picture of an “aerial lesson” permitted by the use of a plane – a very recent technology in 1928 – was probably to demonstrate that technologies had the power to enhance the learning process by allowing the students to have a better access to geographical information. With a closer look at the picture it is obvious that the use of this technology did not really change the way of geography teaching. The teacher is showing the globe of the earth and the students are not looking through the windows. This lesson looks traditional despite the use of recent and powerful technology.

This anecdote shows that the link between the uses of technology and changes in education is not obvious. The changes mostly result from the willingness of teachers. They depend also on the opportunity offered by technology. But technology is only a proposition that teachers can integrate – or not – into their practices.

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Fig. 1. An aerial geography lesson

Starting with this point, this paper examines the changes for geography education linked to the increasing uses of geotechnologies by the general public. Therefore we address the following questions:

(a) In which way can these technologies be integrated into the geography curriculum for secondary education? What do the teachers do with geotechnologies?
(b) What are the effects of the uses of geotechnologies for educational purposes in terms of pedagogical setting or its relation to knowledge?
(c) What are the goals and the stakes of the integration of geotechnologies in the curriculum for secondary education?

2 The Development of Geotechnologies

Geotechnologies include both the data and the systems that can be used to deal with these data. The acquisition of data is through remote sensors that can be used to measure different physical and chemical parameters in the field and Global Positioning Systems (GPS) that allow to geolocalise these data. The professional systems that are used for the representation and the analysis of the data are named *Geographical Information Systems* (GIS). Much of these data is available on the Internet for free or at low cost and can be visualized by the general public. This visualization is possible with the use of *virtual globes*. *Virtual globes* permit an access to a tri-dimensional representation of the Earth. They allow the access, usually via the Internet, to different geographical digital data on economic, sociological, cultural or environmental topics [2]. They can be considered as virtual worlds that permit access to a huge quantity of geolocalized information.

The professional uses of geotechnologies are increasing [3]. Many sectors of activity need precise and localised information. It is the case for transports, construction, trading or military domains. It is also true for most other human activities. Therefore there is a need for a qualified workforce in the domain.

There is also an increasing personal use of geotechnologies. Nowadays, more and more cell phones include a GPS and virtual globes such as Google Earth encounter a great success. The success of virtual globes probably results from the fact that they allow access to a piece of information which is, on the one hand, of an individual and personal dimension and, on the other hand, of a global dimension. Therefore, it is possible to look at one's home or one's next holiday destination but also, to give only one example, to locate the villages that have been destroyed during the conflict in Darfour[1].

Another aspect which seems to be taken into account to explain the success of virtual globes is the fact that the frontier between the roles of provider and consumer of geographical information is not clear. Everybody can geolocalize a picture on Google Earth and share this picture with other people on the Web. The virtual globes are virtual worlds that belong to Web 2.0, a digital space which allows the mutual sharing of information. The content is partly user-generated and Turner [4] points out that we are witnessing the birth of *neogeography*. The value of the role of this *Volunteered Geographic Information* has been underlined as a potential significant source for geographers' understanding of the surface of the Earth [5].

Geotechnologies give access to a Digital Earth. This term, coined by Al Gore in 1998, is used to name a tridimensional model of worldwide geographical data.

As a consequence, the advent of geotechnologies has revived interest in cartography [6]. In the next paragraphs we examine the impact of this neogeography on geography/geology education.

3 The Success of Geotechnologies in Education

Different experimentations relate to the uses of Geographical Information Systems (GIS) for educational purposes (see for example [7-10]. Nevertheless, little attention has been paid to the pedagogical issues of the uses of geomatics and this question must be explored [11, 12]. Some recent surveys give some information about teacher practices using geotechnologies. Kerski [7] reports different studies that emphasize the link between the uses of geotechnologies and a context of reform for a long term impact [7, 13, 14]. A French study (862 geography and geology teachers) [15] shows that these teachers express a high interest in the uses of GIS material for educational purposes. Beyond the diversity of the tools used by teachers, the *virtual globes* - such as *Google Earth* or the French *Geoportail* – meet a real success. If a minority uses GIS, 49% of geography and geology teachers use virtual globes such as *Google Earth* or the French *Geoportail*. This success is also attested by the fact that 80% of the teachers express the willingness to use geotechnologies for geography or geology teaching.

The use of virtual globes rather than GIS can be explained by the transfer of personal practices - the use of online geotechnologies to locate a place, to determine a

[1] See for example : http://www.ushmm.org/maps/projects/darfur/

means of public transport or driving itinerary, to look at a holiday destination – into the professional domain. Furthermore, due to the fact that these technologies are recent, most teachers have not benefited from adequate training. They do not master most of the concepts embedded in GIS material and the software applications designed for professional purposes are too difficult to use for the majority of teachers and of course for students.

The French survey also points out that these tools are used in different pedagogical contexts: with the whole class through the use of a video projector, with small groups of students or individual use, a student is alone in front of a computer. Different clues indicate that the pedagogical features that permit Problem-Based-Learning have a positive impact on the use of geotechnologies.

The topics to learn seem to have little effect on the uses. The curricula of the grades that are the most concerned by the uses of geotechnologies include the study of geology or the geography of environment or development. But the survey shows that all the grades of secondary education are involved and the teachers indicate a wide diversity of topics to be learnt with these technologies such as plate tectonics, earthquakes and volcanoes, environment, landscapes, urbanisation, globalization. The diversity of the themes can be explained by the fact that 80% of all our decisions involve a spatial component [3]. These topics can concern local problems close to the school as well as regional or worldwide subjects. The favourite topics indicated by teachers' concern regional or worldwide subjects.

The arsenal of geospatial tools available for the educator has greatly expanded. Nevertheless, the uses declared by teachers mainly concern visualization. The teachers express their interest in the fact that *virtual globes* allow access to geological and geographical data. Data gathering or data processing are more uncommon. Nevertheless 7.5% of geography and geosciences secondary teachers in France declare that they use GIS material to carry out field investigations with students. In the next paragraph we examine these different kinds of uses.

4 Uses of Geotechnologies for Secondary Education

4.1 Visualization

The visualization of geological or geographical features is the preferred practice declared by teachers [15]. The power of geotechnologies to give access to geological and geographical visualization is obvious. This interest results from the fact that geotechnologies provide tools for the high-quality production of multiple forms of representation [16]. Geotechnologies give access to a tridimensional representation of space. They allow for the changing of the scale of visualization by using a continued zoom. They also give the possibility to combine different layers of information and, therefore, to identify correlations between data. The diachronic dimension of a phenomenon can be studied by using different functions that allow the creation of animations.

There are many examples of visualization practices in secondary education available on the Internet. MJ Brousseau[2], a secondary teacher, has created a set of data from the

[2] http://acces.inrp.fr/eduterre-usages/ressources_gge/afar/afar.htm

Afar rift for pupils (upper secondary school). This set of data has been designed for Google Earth. It encompasses a geological map and layers of data about earthquakes and volcanoes. It is expected that the exploration of this set of data mapped on the digital elevation model and satellite images of Google Earth will help the student to identify different aspects of the forming of an ocean (the geomorphology of the region, the localisation of earthquakes and volcanoes) to understand the functioning of a mid-ocean ridge. Different scientific institutions give access to databases where the data are available in a format which can be visualized with Google Earth. An educational French website[3] gives a list of such databases for geology teaching.

Other functions of virtual globes are used by teachers to promote a better understanding of phenomena. The website, Google Earth Outreach[4], gives the possibility to download different animations such as the changes in forest cover worldwide. The animated overlays show which area has been worst hit. The use of this animation with students offers them the opportunity to visualize a phenomenon which is difficult to observe.

Pedagogies based on visualization are grounded on the idea that "a picture is worth a thousand words" and it is true that geotechnologies give new and powerful tools to access a useful representation of worldwide spatial data for teaching. Nevertheless a risk remains. This risk relates to the illusionary belief that visualization automatically leads to understanding. The vision of the expert can be very different from the vision of the novice and, as a result, this leads to different interpretations. It has to be considered that a good interpretation of the pictures available on virtual globes or GIS implies certain skills. This is due to the choice of semiotic representation for the producing of the pictures. Therefore the teachers should be able to guide the students' interpretation of the pictures by giving them some basic features of the process for the producing of these pictures.

4.2 Data Analysis

The *virtual globes* allow some basic processing of data. It is possible, for example, to measure distances or to use different layers of information in order to show correlations. It is also possible to create thematic maps by giving a value to entities such as points, cities, areas or countries. Nevertheless, the virtual globes are mostly designed for visualization and only GIS systems allow for performing functions by manipulating the structural relations of spacialized data sets.

There is a wide variety of software applications used by teachers. These include desktop GIS, mobile or handheld GIS, server-based GIS tools, and embeddable GIS [16]. GIS applications present a large variety of functions. Some of them are used by teachers as illustrated by the following examples.

A well-known example of data analysis was conducted by secondary school pupils who were asked to investigate the location of coffee shops in their city, The Hague, [17]. The students mapped out schools and coffee shops by using public data, produced maps which were combined and drew buffers around the coffee shops. The result of this study carried out by students was that the law which states that a coffee

[3] http://pedagogie.ac-montpellier.fr:8080/disciplines/svt/spip/spip.php?article230
[4] http://earth.google.com/outreach

shop should not be located within 500 meters of a school is infringed by numerous coffee shops and the students wrote a report for the local newspaper.

The work carried out by Peter O'Connor, Head of Geography in a UK school is also a good example of map producing[5]. His pupils produced a map of land use in their city. The realization of the map implied the use of advanced functions of a GIS: data geolocalization, choice of the symbols and attributes for the data, combination of different layers of information, measure of distances, data aggregation… Therefore, the students had to handle the different tasks of the process of digital map-producing from the gathering of data during fieldwork to the different digital treatments with a GIS application.

These examples illustrate the power of GIS for modelling activities. The process implies choices of data and variables to produce a digital representation of a system.

4.3 Data Gathering

The databases are an important part of GIS and the gathering of data is a central step in geography or geology studies and fieldwork can play an important role for geography or geology education. As a result, different surveys have identified the use of geotechnologies during educational fieldworks [7, 15].

There are numerous examples of the uses of geotechnologies for data gathering. In most cases, the pupils use a Global Positioning System (GPS). The GPS can be used to identify waypoints or to register an itinerary. Some examples relate to the use of Personal Digital Assistant (PDA), tablet PC or netbooks. Coupled with a GPS, these devices allow for using a portable GIS and for having access to digital maps. The use of remote sensors to measure parameters such as temperature, pH or light is less frequent.

Sébastien Cathala, a geography teacher, reports different projects[6] that he carried out with upper secondary school pupils. One of these relates to the waste management for a school. The students had to create a digital map of the dustbins of the school and to propose new implantations. This teacher reports also the realization of a database by pupils on the pollution of a river. The chemical measures were located and the values represented on a digital map created with a GIS.

The work of François Cordelier is another example of Project-Based-Learning with geotechnologies. The project[7] relates to the diachronic study of the vegetation in an estuary. The digital map of vegetation created by pupils was based on the data gathered during fieldwork. The map was compared to a historical map in order to identify the evolution of the environment.

Research into the uses of geotechnologies for fieldwork [18] emphasized the role of these technologies for learning. The benefit of technology does not result from the fact that it facilitates the work of the learner but from its capacity to mediate the interactions between the learner and the data collected on the field. The next paragraph is devoted to a discussion about the changes that occur with the use of geotechnologies for educational purposes.

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[5] http://www.geographyteachingtoday.org.uk/fieldwork/info/teaching-technology/using-esri-arcgis/
[6] http://eductice.inrp.fr/EducTice/projets/geomatique/Journees_etude/intervention_cathala
[7] http://appli-etna.ac-nantes.fr:8080/peda/disc/svt/sig_port_lavigne/index.htm

5 New Relations with Geographical/Geological Knowledge

One of the more obvious consequences of the use of geotechnologies for educational purposes is a better access to geographical and geological knowledge. This consequence results from the development of databases for geolocalized information. This information is often available for free *via* the Internet. As a result, the teachers have the choice of a wide range of topics for integration into the curriculum. The availability of worldwide data gives the opportunity to carry out studies at different levels. The relatively easy access to information allows for the implementation of new local studies or the improvement of former practices by giving access to new data. It is also possible to obtain remote or global data and to widen the pupils' viewpoint. Nevertheless, the question of the quality of the data and the validity of the information remains. The pupils are generally not able to detect and assess the accuracy of the source of data.

The use of "real data" is a source of motivation for students. The studies carried out by students can relate to the "real world" and, sometimes, as seen above, can have an impact on the school or the city. The availability of data gives the opportunity to study the complexity of systems and phenomena. Therefore, the learning relates to embedded knowledge and it facilitates the linking of conceptual models to empirical evidence. The access to the process of information gives the possibility to understand the nature of knowledge.

It has been pointed out that geotechnologies facilitate the implementation of Inquiry-Based-Learning [19] and open-ended projects for teaching [7]. It is probably partly due to the fact that GIS allows implementing different classroom procedures that are close to professional procedures. The reasoning can encompass modelling or simulation [20]. The implementation of such procedures addresses the question of the accuracy of the methods used by pupils and their validity for the discipline. The second question relates to the training of teachers who need to be able to understand the core concepts of geotechnologies. Pairform@nce[8], a French online training course for teachers, tries to reach this goal.

The modification of the relation between students and knowledge also results from the properties of geotechnologies. As the content can be user-generated the students are encouraged to participate in the process of knowledge production. They can shift from the role of consumer of information to the role of provider of information under the guidance of the teacher. Geotechnologies also allow for aggregating information from different sources. Therefore, geotechnologies also offer the opportunity to implement collaborative work in the classroom.

The changes that can occur are not intrinsic to these technologies. GIS and Virtual Globes can be used in a very traditional way. Geotechnologies are only propositions that have to be adopted and adapted by teachers. These changes depend on the willingness of teachers to change their practices. It depends on their acceptance to change their roles in the classroom. It depends also on their agreement to being involved in open-ended projects in which they can face difficulties in solving problems. These points are probably the critical dimensions to be taken into account to support the introduction of geotechnologies in secondary education.

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[8] http://www.pairformance.education.fr

6 Conclusions: Goals and Stakes

There is an increasing use of geotechnologies that are mostly adopted by teachers to give their students a better access to information. Geotechnologies offer new opportunities for teaching/learning geography and geology. These opportunities relate to the subjects, geotechnologies make it possible to deal with embedded knowledge by taking into account the complexity of the world. Therefore these technologies are adapted for education in sustainable development. These opportunities relate also to the type of teaching that could be practised with the use of virtual globes, GIS and mobile devices such as GPS. Fieldwork, Project-Based-Learning, Inquiry-Based-Learning and collaborative learning are fostered by the uses of geotechnologies.

One of the most important goals regarding the use of geotechnologies is the improvement of the capacity of students to handle the geographic information as a part of their digital culture. Geotechnologies such as *virtual globes* or itinerary information websites meet a real success and it is necessary to give citizens basic knowledge about digital geographic information. This can be easily illustrated with the reading forums devoted to exchanges about artefacts in Google Earth. Some people find a boat in the middle of Greenland and others a “flying car” [9]. This lack of knowledge about how digital geographic information is gathered and processed leads to widespread misunderstandings: the satellite digital pictures become photos, there is a confusion between the scale of study allowed by the use of the zoom and the scale resolution which depends on the quality of pictures. The capacity to handle digital geographic information should be a part of the digital culture of the XXIst century citizen. The stakes of the integration of geotechnologies into the curriculum consist of a better understanding of geographical/geological concepts and the development of the capacity of the students to develop relevant uses for these tools (e.g. critical reading, interpretation or production of cartographic display). The awareness of the source and the quality of information - to avoid disinformation - and the knowledge of the domain of validity of these tools for the processing of data are also dimensions to take into account.

A recent study emphasizes that the development of new habits of young people with digital technology must be taken into account by educators [21]. The uses of geotechnologies for gaming or the uses of virtual globes as virtual worlds that give access to geolocalized information are examples of such habits. Furthermore, it has been claimed that young people are *digital natives* as they have grown up with digital technology [22] but the general uses of technologies are not necessary valid due to the lack of criticism by non-educated people. The frontiers between real and virtual worlds, between the models implemented in the software applications and the reality are blurred, tools and data are used outside their domain of validity. The integration of geotechnologies in the curriculum should contribute to helping the students to localize these frontiers, to distinguish between models and reality and to understand the relations that connect these two dimensions.

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[9] Different examples are available on: http://comenius.blogspirit.com/archive/2008/01/01/betisier-geomatique.html

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A New Virtual and Remote Experimental Environment for Teaching and Learning Science

Zdena Lustigova[1] and Frantisek Lustig[2]

[1] Charles University, Faculty of Mathematics and Physics, Laboratory of Online Learning, Prague, V Holesovickach 4, CZ-180 00 Praha 8, Czech Republic
lustigo@plk.mff.cuni.cz
[2] Charles University, Faculty of Mathematics and Physics, Prague, Ke Karlovu 3, CZ-121 16 Praha 2, Czech Republic
fl@plk.mff.cuni.cz

Abstract. This paper describes how a scientifically exact and problem-solving-oriented remote and virtual science experimental environment might help to build a new strategy for science education. The main features are: the remote observations and control of real world phenomena, their processing and evaluation, verification of hypotheses combined with the development of critical thinking, supported by sophisticated relevant information search, classification and storing tools and collaborative environment, supporting argumentative writing and teamwork, public presentations and defense of achieved results, all either in real presence, in telepresence or in combination of both. Only then real understanding of generalized science laws and their consequences can be developed. This science learning and teaching environment (called ROL - Remote and Open Laboratory), has been developed and used by Charles University in Prague since 1996, offered to science students in both formal and informal learning, and also to science teachers within their professional development studies, since 2003.

Keywords: Remote laboratory, blended learning, science education.

1 Introduction

1.1 Contemporary Problems in Science Education – The Needs

Contemporary problems in science education are closely connected to a general teaching and learning paradigm shift, as a result of the reality of the globalized world together with the information revolution and ongoing knowledge society needs.

According to Derrick [3], some general features can be recognized in this movement, and all of them should be reflected in teaching and learning science.

- A focus on uncertain (not exactly defined) situations

Much of the academic environment today, presents students with ready-made problems, but the reality is rarely that clearly defined. Today's learners and teachers have to be more familiar and comfortable with uncertain situations.

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- A focus on conceptual understanding

Conceptual understanding is the ability to apply knowledge across a variety of instances or circumstances. Several strategies can be used to teach and assess concepts, e.g., inquiry, exposition, analogies, mnemonics, imagery, concept maps, and concept questions.

- Uses a holistic, as opposed to discrete, approach

Much of the education and learning environment today is still divided into rigid academic disciplines, focused on discrete units of research. However, the holistic understanding of systems thinking and inter-disciplinary research approaches are seen as critical to achieving a more comprehensive understanding of the complex reality currently facing the world system.

- Team work and virtual teams around the world

There are many arguments that collaborative learning (also computer-supported or mediated) enhances team performance through tools for communicating each person's ideas, structuring group dialogue and decision making, recording the rationales for choices, and facilitating collective activities. Closely related to this point is the need for enhanced virtual and networked activity.

- Blur the difference between mental and physical labour

The global system of production and distribution is based upon the blurring of the distinctions between mental and physical labour and the increase in the application of knowledge to the production process itself [3]. This change is so significant that it represents a fundamental shift for much of the world, and it is necessary to respect it in underlying teaching and learning strategies.

1.2 Contemporary Problems in Science Teaching – The Reality

The general teaching and learning paradigm shift mentioned above is not yet reflected in contemporary teaching methods at many traditional teaching and learning environments.

Over the past couple of decades, science education researchers have studied the effectiveness of existing teaching and learning practices: conceptual understanding, transfer of information and ideas, beliefs about science and problem solving in science. The definitive conclusion is that no matter what the quality of the teacher, typical students in a traditionally taught course are learning mechanically, memorizing facts and recipes for problem solving, but not gaining a true understanding. In spite of the best efforts of teachers, students often consider science boring and irrelevant to the world around them.

1.3 The Role of Cognition of Real World Phenomena in Science

There is no doubt that lab-based courses, in particular, play an important role in scientific education and mainly in the cognition of the real world.

Clough [2] goes so far as to claim that "hands-on experience is at the heart of science learning" and declares that laboratory experiences "make science come alive." Lab courses have a strong impact on students' learning outcomes, according to [8]. The role of labs in sciences is well described in the very instructive and still valid document of the American Association of Physics Teachers [1], formulating five goals that the physics laboratory should achieve.

2 E-Labs – General Issues

At the present time, information and communication technologies have invaded science education in all directions. They have undoubtedly changed the laboratory "landscape".

The nature and practices of laboratories have been changed dramatically by the new technology-intensive automations:

- simulated labs (also called virtual labs),
- remote labs, and
- computer mediated hands-on labs as an alternative for conventional hands-on labs.

The present state of art is characterized as reaching the level of the quantitative increase of parameters that can bring about very deep qualitative changes. In the very recent issue of European Journal of Physics, devoted to Student undergraduate laboratory and project work, Schumacher [13] brings the examples of the invasion of computers in contemporary laboratory work reaching from project labs, modeling tools, interactive screen experiments, remotely controlled labs, etc. It is plausible to adopt the statement that these kinds of e-labs will be the typical learning environment for physics students in the future.

2.1 Educational Issues of E-Labs

Although the researchers still discuss each type of e-lab from different perspectives, the relative effectiveness of the new laboratories compared to traditional hands-on ("recipe based") labs seems to be undoubted. The following aspects are often discussed:

- Design skills
- Conceptual understanding
- Social skills (including team work and networking)
- Professional skills

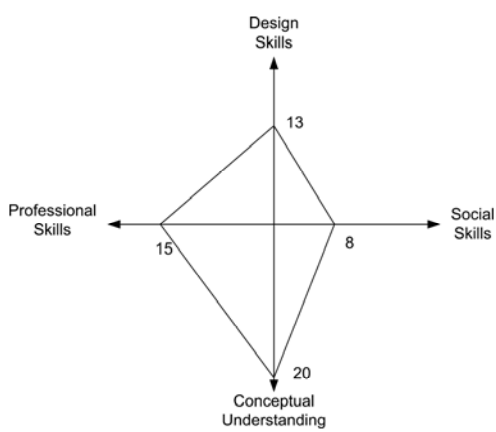

Fig. 1. Educational goals of hands-on labs [7]

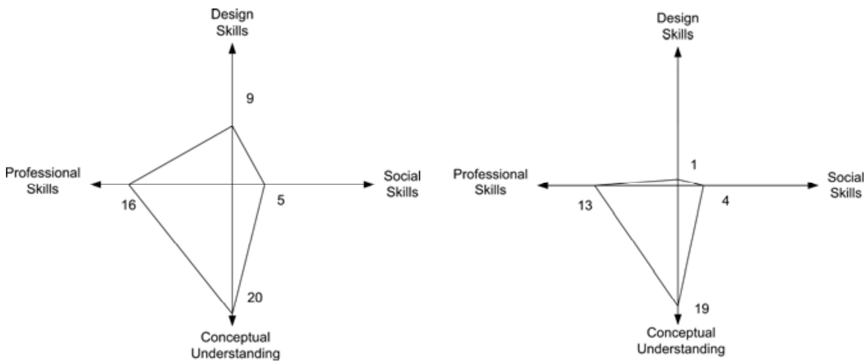

Fig. 2. Educational goals of e-labs – a) virtual labs (left), b) remote labs (right) [7]

Although there is a lack of criteria for judging and the evaluation of the effectiveness of the three new types of labs: computer mediated hands-on, virtual and remote labs, the results of the comparative literature study [7], including more then 60 research studies, are very instructive.

2.2 Economic Issues

As a backdrop for these phenomenological issues (more details in [7]), there is a set of economic issues.

Traditional hands-on labs put a high demand on space, instructor time, expensive apparatus and experimental infrastructure, often in a number of identical lab stations, which can be little used for other purposes. All of these aspects are subject to rising costs. Remote and virtual laboratories may provide a way to share specialized skills and resources (also with research institutions) and thus to reduce overall costs and enrich the learning experience.

2.3 Psychological Issues and the Problem of "Presence"

Sheridan [9] identified three types of presence: physical presence, telepresence, and virtual presence. Physical presence is associated with real labs and understood as "physically being there."

Telepresence is "feeling like you are actually there at the remote site of operation," and virtual presence is "feeling like you are present in the environment generated by the computer". The author argued that by suspending disbelief, we can experience presence in a virtual environment. Others claimed that the critical issue in designing virtual environments is to create a psychologically real setting rather than to recreate the entire physical reality. In our strategy we offer students the combination of all three kinds of presence identified by Sheridan.

2.4 New E-Learning Strategy in Science Education

The motivation and inspiration for this new e-learning strategy in science education came from our own research work on remote and open laboratories (ROL project)

[4],[5], introducing the very early stage of virtual presence through a remote labs potential for blended learning in Science, then from the recent paper of Wieman [15] and Wieman, Perkins [16], supporting and calling for the change in the educational technology, seeing the remedy at hand in the existence of simulations, and also from Thomsen and his co-workers [14], who present the new approach called e-LTR (eLearning, eTeaching, eResearch) using the remote experiments (RLC). They also introduce eResearch, based on the existing e-laboratories, composed of the remote internet-mediated experiments, enabled to fill link (missing till recently) to e-Learning.

This new e-learning strategy in science education is actually copied from the method that sciences use in their cognitive work. It is based on the observations of phenomena in the real world, together with the processing and interpretation of ensuing data and their presentation, and the effective search for relevant information and effective ways of classification and storing. Teachers are not bound by strict rules of the teaching unit; some unveiled problems are proposed to students for their own independent and project work.

The learning process itself is based on the active participation of students, whose involvement is strengthened by dynamical simulations of the real phenomena, co-operative teamwork (both real and virtual), public presentations and the defence of achieved results, all either in real presence or in telepresence.

3 ROL Components and First Experience

3.1 Remote Observation and Data Collection

This set of modules teaches basic concepts in remote sensing. Learners are shown how characteristics of the system and sensors are used, and how they affect the amount and quality of data collected. A sampling of ways to use the data for activities such as weather forecasting and scientific research are demonstrated. At the completion of each module, learners are given opportunities to apply what they have learned to actual data collected by MFF researchers.

Learners are starting from the simplest observations (weather observations - temperature, air pressure, wind speed and direction, sunshine, etc.,) and continue to more and more sophisticated data acquisition and research design.

3.2 Hands-On Remote Labs and Process Control

The oldest, most popular and the most fun part of this blended learning environment is the “hands on” remote laboratory, which allows learners to operate equipment such as simple robots, mechatronic systems, programmable logic controllers and wet process control systems over the Internet. It includes detailed expert instruction, video and audio feedback and evaluation. Each component takes students through a complete, progressive learning system that first teaches through simulation, and then allows interaction through real-time remote lab operation.

Fig. 3. Remote process controlling – Charles University in Prague

3.3 E-Simulations (Virtual Labs)

Virtual lab tools offer a large variety of e-simulations and models, including Java applets, Flash visualization and/or different kinds of computer mediated mathematical models. Applets were primarily developed to visualize the phenomena and help to understanding in a graphic way. They are not primarily focused on data providing, although some of the applet creators enable the drawing out of the full data set. That is why the vast majority of virtual laboratories, spread all over the "web world", do not provide the data output or input we need in science for the comparison of real experiments and models. The new and the most far-sighted branch of applets or models, offered by the Remote and Open Lab, is connected to the real experimental setup (even physically) and thus enables the import of real measured data as well as their simulation.

3.4 E-Simulation in Connection to Real Data Acquisition and Process Controlling

This sophisticated and complex approach enables students to observe specific and rare phenomena (earthquakes for example) without losing the sense of being in a place, to manipulate remotely dangerous objects and chemicals in a very safe way, and to accomplish complicated measurement and data acquisition on a high level without being lost in technical problems and setups; and thus to focus on conceptual understanding through different methodological approaches (e.g., social constructivism - virtual team discussion and co-operation tools, consultancy services, or individual inquiry– e.g. real data and mathematical simulation results comparison).

As an example of what is mentioned above, we propose the Heisenberg uncertainty principle experiment, which experimental setup enables telepresence through computer mediated mechanical manipulation with real objects (e.g. laser, aperture), computer-mediated set up of the experiment (frequency of the light, parameters of the aperture) and through visual observation of the observed phenomena (web camera). It also enables computer aided data acquisition (pure data and visualized data – graph), together with the possibility for immediate comparison of the real data and simulated results.

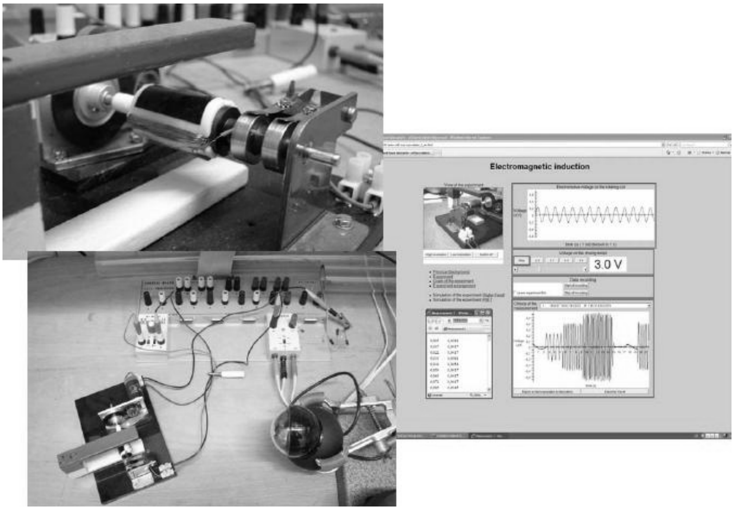

Fig. 4. Real remote data collection and process controlling in connection with e-simulation and modelling – Charles University in Prague

3.5 E-Worksheets for the Teamwork

The new e-learning strategy is part of interactive teaching and learning, based on the observation of the real world phenomena by the real E-experiment and E-simulations, and includes also e-teaching and learning tools and interactive E-worksheets for team work, and E-manuals and instructions providing information and theoretical background for the understanding and quantification of observed phenomena.

The E-worksheets present the theory, offering exercises and pre-solved problems, glossaries for quick orientation in the theory covered, and multiple-choice tests with immediate evaluation of the acquired knowledge, etc.

4 Conclusions

Although the whole problem of the cognition of the real world via remote tools has many philosophical and methodological aspects, and the effective use of blended learning environments based on it definitely needs further research, in the following we would like to publish selected conclusions, based on a comparative literature review (11 papers, results obtained from different schools of physics and faculties, preparing physics teachers - e.g. [10], [11]). Most of the reviewed papers' authors adopted e-labs within the two-semester course of an introductory physics laboratory, oriented mainly toward mechanical and thermal properties, electric and non-electric properties, oscillations, waves and optics, and microphysical phenomena. The data collection was computerized, mostly by ISES, some experiments (app. one half) were designed to use different tools and methods of proposed ROL environment, including virtual consultancy services and e-sheets for the virtual team work. The comparative study has not yet been published.

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Investment in Information and Communication Technologies in the Irish Education Sector

Clare McInerney, Mike Hinchey, and Eamonn McQuade

Lero—the Irish Software Engineering Research Centre
University of Limerick, Ireland
{clare.mcinerney,mike.hinchey,eamonn.mcquade}@lero.ie

Abstract. Ireland's economy has experienced phenomenal growth over the last ten years, in particular in the ICT sector. With today's rising global competition, Ireland faces the challenge of sustaining this growth, particularly in the software sector. A core component of this challenge is to produce a steady stream of qualified graduates in the ICT area. Funded by the Irish government, Lero—the Irish Software Engineering Research Centre has begun two educational initiatives to address this issue: the establishment of the Lero Graduate School in Software Engineering (LGSSE) and the Lero Education and Outreach Programme. This paper describes both initiatives in detail and their uniqueness in the Irish context.

Keywords: ICT, Education, Outreach, LGSSE, Networking and Collaborations, Informatics, Programming and Problem Solving.

1 Introduction

Ireland is one of the world's largest exporters of software. This sector is worth €12 billion per annum to the Irish economy. There are more than 800 software companies employing 32,000 people in the country[1]. A key action outlined in the government's Strategy for Science Technology and Innovation is to "double the number of PhDs by 2013"[2]. This strategy paper also acknowledges that research programmes in innovative economies are underpinned by graduate schools. The success of the software industry and strong research foundations in Ireland along with government strategy for science, technology and innovation inspired the successful establishment in 2008 of the first of the educational initiatives undertaken by Lero: the Lero Graduate School in Software Engineering.

A full time Education and Outreach Manager was hired in July 2007 to run the Lero Education and Outreach programme. Lero is a Centre for Science, Engineering and Technology (CSET). Science Foundation Ireland (SFI), the funding body for 7 CSETs in Ireland in areas of ICT and biotechnology, mandates the establishment of Education and Outreach Programmes by CSETs.

[1] http://www.idaireland.com
[2] http://www.entemp.ie/publications/science/2006/sciencestrategy.pdf

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The goal of such programmes is to encourage an interest in science and technology in the education sectors. Since the "dot com" bubble burst in 2001, following global trends, Ireland has witnessed significant decreases in the number of students completing degrees in Computing and related areas. The Lero Education and Outreach Manager has been working to address this problem.

2 LGSSE

In order to create and sustain a knowledge-based economy and conduct world class research, Ireland aims to double the number of PhD students by 2013 to around 120 in computer science [4]. LGSSE is contributing to this national governmental goal, enrolling the first batch of students in September 2008.

These students are embarking on a 4-year structured PhD program at University of Limerick, Dublin City University, Trinity College Dublin and University College Dublin, the four partners in the Lero consortium of universities. LGSSE is funded by the Higher Education Authority (HEA) Program for Research in Third Level Institutions Cycle 4 (PRTLI 4).

2.1 Rationale for the Programme

The LGSSE academic programme was proposed to deal with a number of key issues facing high quality graduates in Ireland today. These issues include:

- Little uniformity in time-scales for completion of postgraduate studies. There is little by way of widely-accepted milestones to monitor progress.
- Some of the current models in Irish graduate education can leave students feeling quite isolated due in part to the lack of access to other graduate students, caused by the relatively small population of the country and hence the small size of its academic community.
- There is significant duplication of courses across the universities—for example, each department in each university may teach a course on research methods.

2.2 Programme Structure

The programme was designed to address each of the key issues outlined above. The LGSSE programme is unique in that it combines the best of the US and European PhD models. The PhD programme is four years in duration. The first year includes taught modules in research philosophies and methods as well as technical software engineering modules that support the students' research interests. During the first year of the programme, the student will prepare a research proposal for the 3-year research project. The taught component allows students to experience a more collegiate atmosphere among their classmates and reduce feelings of isolation. LGSSE will draw on the existing expertise of the four Lero partner Universities. The advantages include:

- A leading-edge curriculum drawn from four of Ireland's leading universities.
- Access to a critical mass of world-class software researchers who form an expert advisory board for each student.
- Ability to leverage your research collaborations with leading research institutions and industry worldwide.

2.3 Programme Challenges

As with any collaborative project, a number of challenges have arisen. How does a non-academic institution like Lero (a research centre) award academic qualifications?

Essentially, Lero serves as a shop window for the four partner universities. Lero can offer short term internships to students while they are finalizing their research areas and looking for a supervisor. If a student enrolled in a particular university wishes to avail of modules at another university, how does this work? The logistics of taking a course remotely can be solved technically using podcasts or distance learning techniques. But how is the module credited? If the student enrolled in one institution, takes a module in another institution, what institution gives the credit? How can we normalize and make consistent the examination strategy and marking schemes across institutions? How are universities billed for making courses available remotely?

These are all complicated and complex questions that we are currently examining and plan to resolve.

2.4 Programme Rollout

After much planning and coordination among the 4 Lero partners, the LGSSE Programme Cycle began in September 2008 with 11 students enrolled. The students are from Ireland, Pakistan, Germany, England, Wales, and India. There has been significant interest in the LGSSE with over 155 applications received from 34 countries and 5 continents. Generous PhD studentships covering stipend, equipment and fees were awarded on a competitive basis for the first year of operation. The recruitment drive for September 2009 is currently underway and, at the time of writing, we are evaluating 168 applications from 39 countries and all continents (except Antarctica!). The establishment of LGSSE is a significant milestone in Irish software engineering graduate education.

3 Lero Education and Outreach Programme

Seventy per cent of Irish technology companies believe there is currently a very real and genuine skills shortage[3]. These companies are looking elsewhere to fill vacant positions. The Future Requirements for High-level ICT skills in the ICT Sector published by the Expert Group on Future Skills Needs at Forfas highlights the need to increase the supply of people with high-level ICT skills and "to reverse the recent decline in the domestic supply of high-level computing" graduates[4].

The Lero Education and Outreach programme aims to instill an interest among students in computer science and programming at second-level. Career development

[3] http://www.siliconrepublic.com/news/article/11494/randd/irelands-talent-meltdown
[4] http://www.forfas.ie/publications/forfas080623/egfsn080623_future_ict_skills.pdf

literature highlights the value of experience as an important source of career development, as well as formal training [1, 2]. Research reports that a hands-on component to the IT curriculum appears to facilitate IT career choice [2]. We have designed a programme that allows students to develop their own computer programs while at the same time learning fundamental computational concepts. These programs include games, animations and stories using a combination of graphics, photos, music and sound.

We want students to experience the enjoyable and engaging aspects of designing and building software. We want to introduce them to computational thinking [3] and present examples of Computer Science grand challenges in an accessible manner.

3.1 Irish Secondary Schools

The Irish secondary school cycle consists of a 3-year junior cycle, then an optional 1-year transition year, followed by a 2-year senior cycle. At the end of the 3-year junior cycle, students take the Junior Certificate state examination. At the end of the 2-year senior cycle, students take the Leaving Certificate examination. During the final year at secondary school, students choose what they would like to study at university. A points system, based on grades in the state-run exams, determines which student gets access to which course in all of the Irish universities, institutes of higher education, and a handful of other institutions.

The Lero Education and Outreach Program is targeting the optional year between the junior and senior cycle: transition year. Transition year is unique in that it is an exam-free stress-free year and it "promotes the personal, social, vocational and educational development of students and prepares them for their role as autonomous, participative and responsible members of society"[5]. We feel it is the perfect time to introduce students to computational concepts and computational thinking. In designing an outreach programme for transition year students, a certain number of constraints needed to be considered. Sections 3.2, 3.3 and 3.4 outline these constraints.

It is worth noting that, currently, the European Computing Drivers Licence (ECDL) is being taught extensively in Irish secondary schools. This is a certificate that verifies competence in computer use. However, anecdotal evidence from teachers and students suggests this does little to inspire students and encourage an interest in the field of Computing or Computer Science.

3.2 Technology Infrastructure in Irish Secondary Schools

The technology infrastructure in Irish secondary schools is under-funded. Between 1998 and 2004 the Department of Education invested €157M in the ICT in Schools Programme, where technology infrastructure, skills infrastructure and support infrastructure were developed.[6] The planned investment of €252M as part of the NDP 2007-2013 ICT in Schools Programme period has not materialized[7]. In comparison

[5] Transition Year Guidelines, 1994, Department of Education. http://ty.slss.ie/
[6] http://www.ncte.ie/AbouttheNCTE/ICTPolicy/
[7] http://www.ndp.ie/documents/NDP2007-2013/NDP_Main_Ch09.pdf

Northern Ireland receives €75 million annually, with approximately 1/3 of the population of the Republic of Ireland.[8]

Many schools rely on fund raising to upgrade and maintain their computers and technology infrastructure. There is a wide range of technology infrastructure in Irish schools. A school may have a single computer laboratory with 30 computers running 2 or 3 different operating systems shared among 500-600 pupils. A school may have 3, 4 or 5 computer labs running the latest operating systems shared among 500-600 pupils. Some schools employ and pay for technical support out of their core budgets. Some schools engage technical support services on a weekly basis for 2-3 hours per week. Some schools engage technical support services as required or as budgets allow. Some schools install wireless Internet connections. Other schools avail themselves of the broadband connection offered by the National Centre for Technology in Education (NCTE). The wide range of technology infrastructure set-up in Irish secondary schools needs to be considered when designing an outreach programme, especially one that will be rolled out at a national level.

3.3 Skills Infrastructure in Irish Secondary Schools

Currently there is no state exam in Computing or Computer Science at second-level in the Irish secondary school system. Four technology subjects (Architectural Technology, Design and Communications Graphics, Engineering Technology, and Technology) are on the curriculum and examined, but these do not involve a programming/Computer Science component. Generally teachers responsible for teaching “computers” at second-level are the mathematics, science or technology teachers. When designing an outreach programme, one needs to design something that is accessible to teachers that do not necessarily have a Computer Science background.

3.4 Choosing a Software Tool for Teaching Computer Programming at Second-Level

We evaluated a number of software tools that could be used to teach programming to second-level students. First we considered Greenfoot. This is a “combination between a framework for creating two-dimensional grid assignments in Java and an integrated development environment (class browser, editor, compiler, execution, etc.) suitable for novice programmers”[9]. Is it an excellent tool for teaching programming and freely available; but given the limitations of technology infrastructure in schools (a JVM generally requires more than 256MB of RAM) and lack of Java programmers amongst second-level computer teachers, the tool was deemed unsuitable for the Irish secondary school system.

Next we considered, and selected, Scratch as the software tool used to teach computational concepts. Scratch is a freely-available programming tool that was developed by the Lifelong Kindergarten group at the MIT Media Lab. It is very interactive, easy to run and install, even on 10-year-old machines, and allows students to create their first computer programs and games using a drag and drop easy-to-use interface.

[8] http://www.irishtimes.com/newspaper/ireland/2008/0807/1218047756866.html

[9] http://www.greenfoot.org/

3.5 Materials Developed

It is vital to provide teachers with good support material that includes lots of illustrative examples. Taking the constraints above (§ 3.2, 3.3 and 3.4) into consideration, during the summer of 2008, we designed a set of materials for schools, "Having Fun with Computer Programming and Games". Under the SFI STARs (Secondary Teaching Assistant Researchers) programme, we were fortunate to have two second-level ICT teachers work with us at Lero developing the materials. We developed a set of 10 modules with approximately 45 hours of teaching materials.

The materials teach computational concepts and computational thinking to students. The modules are designed so that an ICT/computer teacher provided with half a day of training is equipped to teach the materials to students. Students build computer games, create animations that use art and music, design and work in teams, test components of their games, modify and add new functionality to existing programs, present their projects to their classmates and provide feedback to their peers. The materials developed are available[10] under a Creative Commons licence.

3.5.1 Materials Described

This section describes each of the modules in detail.

Module 1: Getting Started

The goal of Module 1 is to give students their first taste of programming and to engage them using Scratch. Module 1 contains five lessons. In the first lesson students discuss the impact of software on our lives. Lesson 2 introduces students to Scratch and they write their first computer program. Lesson 3 teaches students how to import and how to modify different characters in Scratch. In lesson 4, students are introduced to algorithms. Lesson 5 introduces event handlers.

Module 2: Drawing Shapes and Repeating

Module 2, which contains 3 lessons, covers algorithms and turtle graphics. Lesson 1 explores algorithms in more detail. Lesson 2 introduces iteration and the debugger. Students are asked to draw simple shapes, starting with a square, then triangles, pentagons and circles. Lesson 3 builds on lesson two and teaches nested loops.

Module 3: Searching and Sorting

Module 3 includes paper based activities and can be taught away from the computer. Module 3 covers searching and sorting, and contains 3 lessons. Lesson 1 introduces searching. This lesson uses materials developed for the Computer Science Unplugged project, http://csunplugged.org/. Students play a battleship game to learn about linear search, binary search and hash table search methods. Lesson 2 introduces the bubble sort, selection sort and quicksort methods. Students perform various sorting tasks and the efficiency of the different sorting mechanisms is discussed. Search engines and performing web searches are covered in Lesson 3.

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[10] http://www.lero.ie/educationoutreach/transitionunit/

Module 4: Build a Game

In Module 4, students build a game. Module 4 contains 4 lessons. In lesson 1, students design a game on paper and implement their design in Scratch. Conditional statements are introduced in Lesson 1. In Lesson 2, students add more functionality to the game designed in Lesson 1. Variables are introduced in Lesson 2. Lesson 3 discusses images and image formats. Lesson 4 covers sound and sound formats.

Module 5: Revision with Scratch Cards

In Module 5, we want to make sure that all students have learnt and understood computational concepts taught so far. Module 5 contains three lessons. Different level Scratch cards—easy, difficult and extreme—are presented to students each containing a simple assignment. Each assignment revises concepts taught in the materials up to Module 5. When the assignments are completed, students can swap cards with their classmates until they complete all Scratch cards at each level.

Module 6: Changing Things

In Module 6, we want students to understand that code maintenance is very important and that writing software does not necessarily mean writing code from scratch. Module 6 contains two lessons in which students modify existing projects. They identify the part of the script that needs to be modified and program new or different behaviour.

Module 7: Solving Complex Problems

Module 7 introduces two complex computer science problems, The Towers of Hanoi and The Travelling Salesman Problem. The goal of this module is to introduce computational complexity to students in an accessible way. By playing the Towers of Hanoi, students should get a feel for how the complexity of the problem and the time required to solve the problem increases as the input or in this case the number of discs increases. Similarly, by playing a game to try and find the optimal route through a set of cities, students should get a feel for how the complexity of the problem and the time required to solve the problem for all possible routes increases as more cities are added.

Module 8: Research Project

Anecdotal evidence from teachers suggests that when students are asked to research a topic on the Internet, they generally search for the topic on Wikipedia, cut and paste the response and present this as the “answer” to the research topic. Module 8 attempts to address this problem. All research work is documented in a research worksheet and students are assessed using this worksheet at the end of the project. Students are required to present and answer questions on their research topic. Module 8 contains four lessons. In Lesson 1, students choose a topic of interest from a set of topics, all computing related and start working in teams. In Lesson 2, students spend time researching their topic of interest on the Internet. Lesson 3 teaches PowerPoint basics. In Lesson 4, all students present their research project and answer questions from their classmates and teacher.

Module 9: Advanced Game
Students build an advanced game in Module 9. Module 9 contains four lessons. In Lesson 1, students build an advanced game. In Lesson 2, additional functionality is added to the game designed and implemented in Lesson 1. This includes adding variables and programming characters to behave in a certain way when they touch each other. In Lesson 3, additional functionality is added to the game built in Lesson 2. This includes enhancing the game play aspect of the game. In Lesson 4, students learn about software testing.

Module 10: Scratch Project
In Module 10 students combine their knowledge of computational concepts with their creative, artistic and musical ideas to create an original final project. Module 10 contains five lessons. In this module, students are divided into project teams, design and implement their final Scratch project.

3.6 Pilot Project and Plan for National Rollout

We are currently running a pilot project in a number of schools and we are planning to roll out the materials on a national scale starting in September 2009. In order to do this, we are building alliances and partnerships in Ireland so that we are a presenting a united front and adopting a coordinated approach with schools.

There are 730 second level schools in Ireland. Lero has formed partnerships with CIO Ireland and the Institute of Technology Tallaght (IT Tallaght). CIO Ireland are a group of senior ICT executives that

- Influence Government policy on ICT in Ireland;
- Promote ICT as an exciting career opportunity;
- Aim for a strong ICT entrepreneur and start-up environment in Ireland.

IT Tallaght have run a number of very successful Scratch workshops for transition year students. The Department of Education Transition Year Support Service are supporting our initiative. We will continue to build alliances with other organisations nationally over the next 12 months.

The pilot project is focused on rollout nationally. However, materials are freely available online to all registered users and we welcome increased participation. Currently over 130 people have registered for materials from 22 countries.

4 Conclusions and Future Work

Both educational initiatives are successfully up and running. The next step is to set up a process of evaluation so that we can track the effectiveness of the two educational endeavours initiated by Lero.

In four years, when the first graduates of LGSSE graduate, we will need to evaluate the outputs of the graduate students and the effectiveness of their research. For the Education and Outreach Programme, we will need to evaluate if students who have completed “Having Fun with Computer Programming and Games” have a more positive outlook on computer science and if the numbers taking computer science courses at third-level increases. This will involve working with teachers, guidance councillors, students etc., and putting something in place that will allow us to track students over time.

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Pyramids in Logo: A School Project in 'Search' of the Fourth Dimension

Jesús Jiménez-Molotla[1], Alessio Gutiérrez-Gómez[2], and Ana Isabel Sacristán[3]

[1] Escuelas Secundarias Diurnas #229 "Ludmila Yivkova" T. Matutino, &
#139 "José Enrique Rodo T. Verpertino, Distrito Federal, Mexico
jj_molotla@hotmail.com
[2] Escuela Secundaria Diurna No. 229 "Ludmila Yivkova", Distrito Federal, Mexico
alessio@starmedia.com
[3] Center for Research and Advanced Studies (Cinvestav), Dpto. de Matemática Educativa,
Av. Instituto Politécnico Nacional 6058, Distrito Federal, Mexico
asacrist@cinvestav.mx

Abstract. In this paper we present a school project where students constructed three-dimensional pyramids using the Logo programming language, complemented with paper-and-pencil, dynamic geometry (Cabri) and spreadsheet (Excel) investigations. The aim of this project was to give, through a fun and meaningful way, and using a *constructionist* approach, junior secondary students (12-14 year olds), early access to advanced topics such the applications of the Pythagorean Theorem and of trigonometric functions, as well as three-dimensional work, while at the same time covering one of the themes included in the curriculum for this age-group (the pyramid).

Keywords: School project, three dimensions, mathematics, trigonometry, computer programming, Logo, Cabri-Géomètre.

1 Introduction and Background

Since 2001-02, we have been working in our mathematics classrooms with the materials and digital tools provided by a government-sponsored national program: the Teaching Mathematics with Technology program (EMAT).

1.1 The EMAT Program and Its Implementation in Our Schools

EMAT is a program that was sponsored, beginning in 1997, by the Mexican Ministry of Education to promote the use of new technologies, using a constructivist approach, to enrich and improve the current teaching and learning of junior secondary mathematics in Mexico. A study [1] carried out in Mexico and England involving mathematical practices in science classes, revealed that in Mexico few students were able to close the gap between the formal treatment of the curricular topics and their possible applications. This suggested that it was necessary to replace the formal approach of the then official curriculum, with a "down-up" approach capable of fostering the students' explorative, manipulative, and communication skills. Thus, a major part of the EMAT program is a

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pedagogical model that emphasizes exploratory and collaborative learning. The main computer tools of the EMAT program are spreadsheets (Excel), Dynamic Geometry (Cabri-Géomètre), and the Logo (MSWLogo) programming language. These pieces of software were chosen [2] on the criteria that they would be open tools; that is, where the user could be in control and have the power of deciding how to use the software, and flexible enough so that they could be used with different didactical objectives.

At the beginning we used these tools independently, covering different themes with each of them. Logo was the last tool that we incorporated into our schools, and one of the immediate things we noticed was how much it enriched both children's motivations for exploring mathematical topics and also the use of the other tools. Because of the programming experience with Logo, students began asking if it was possible to also program the other tools. This led us, for example, to show them how to create macros in Excel and Cabri.

We now believe in the importance of using in an integrated and complementary way, a variety of tools for learning, since we consider that each tool brings with it a different type of knowledge and constitutes a different epistemological domain [3]. We also believe in the importance of constructionist [4] or programming activities for meaningful learning. We have in fact observed that students who otherwise have difficulties in learning, exhibit other kinds of abilities through these computer-based approaches to mathematics teaching and learning.

1.2 From Isolated Activities to Long-Term Projects: The "Painless Trigonometry" Project

In recent years we have tried to develop long-term projects that incorporate powerful tools, and also serve as a means to introduce students to topics of mathematics that are normally considered too advanced for them (such as trigonometry). We have realized that through these projects we can cover, in a fun and meaningful way, most of the topic in the compulsory curriculum.

In particular, in the academic year 2005-06 we developed a long-term trigonometry project called "Painless Trigonometry" [5] for introducing young students to the Pythagorean theorem, basic trigonometry concepts, and their applications using explorations and constructive activities with Cabri-Géomètre, Excel and Logo. Through trigonometry, we covered other mathematical topics in the curriculum such as addition, subtraction, multiplication and division; powers and square roots of whole and rational numbers; algebra (including constants and variables). Approximately 250 students of 12-14 years of age participated, in the project in that first year, in 6 groups of the first two grades of two junior secondary schools in Mexico. Students thoroughly enjoyed the activities and gained interest in mathematics. They also developed problem-solving and collaborative skills. Furthermore, in written tests after the project, the students showed an understanding of the "advanced" trigonometry concepts, as well as of other algebraic ideas. Through the programming activities in Logo, students also learned to work with three-dimensional elements and animations.

The project taught us that mathematics can be learned through different tools and ways to traditional ones, that one can go further than usual standards, and that students can learn to see the world of mathematics in more than two dimensions.

2 "In Search of the Fourth Dimension, While in Three": A New School Project

In the academic year 2007-2008, a question came up when our junior secondary first-year students (12-13 year-olds) were learning Logo: "Is it possible to work in four dimensions in Logo?" The reply was that we could "search" for the fourth dimension but we would work and learn in three dimensions; and that is what gave rise to the idea of a new school project for working in three dimensions, that was named for fun: "In search of the fourth dimension, while in three". We then needed to find a curricular topic for junior secondary grades 1 and 2 that could be worked in three dimensions, so we chose the pyramid.

We started playing with paper-and-pencil in a geometry game to draw triangles and squares and whatever else was needed for a pyramid. We then transferred that activity to doing it with dynamic geometry (in Cabri-Géomètre) and used an Excel spreadsheet to help us in computing areas and perimeters. In the end, we programmed a pyramid in Logo. Although not the same students as in 2006-2007, we worked in this new project with approximately the same number of participants (between the ages of 12 and 14), as we did in the "Painless Trigonometry" project.

2.1 Laying the Foundations for the Construction of a Pyramid

After the paper-and-pencil activities mentioned above, we had students constructing triangles (of different shapes and sizes) and regular polygons in both Cabri and Logo, with the construction and epistemological difference that each software-environment implies (in Logo, the construction is more linear). The programming of the basic shapes, not only served as the foundation for the pyramid, but also helped children gain experience in programming. Below are the sample basic procedures that students built in Logo:

```
to square
repeat 4 [fd 100 rt 90]
end
```

```
to triangle
repeat 3 [fd 100 rt 360/3]
end
```

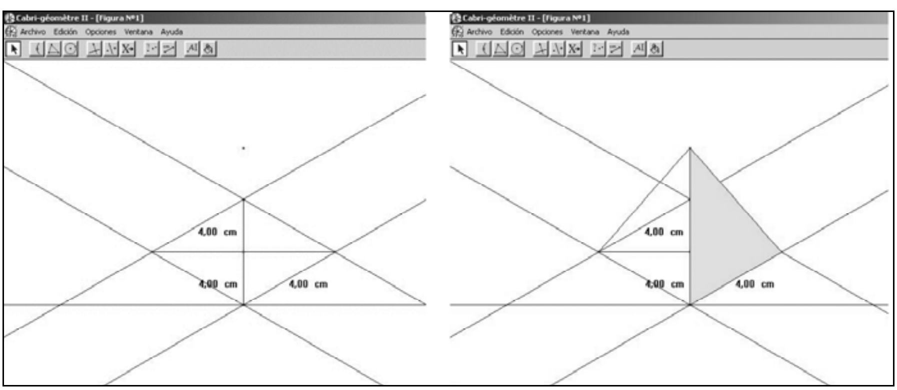


Fig. 1. Construction process of the pyramid's isometric projection in Cabri

In order to facilitate the construction of the pyramid the students first constructed concrete models with wooden sticks, which helped them visualize what they had to do on the screen. Then, students attempted to construct a pyramid in Cabri, but they were only able to do an isometric projection (Fig. 1).

2.2 From Two to Three Dimensions

In Logo, students can work in three-dimensional mode (using the perspective command in MSWLogo). They began working in this mode by constructing a cube, Sometimes they lost the sense of direction because they lacked a reference. But the project had been previously enriched by an interaction with a fellow teacher to whom we were teaching Logo. This teacher felt disoriented when moving the turtle around the screen. It occurred to us that if that could happen to some people in two dimensions, it would be more common in three. So as an aid we added the task in our project for students to construct a system of axes in three dimensions; that is, a system with an x-axis, a y-axis and a z-axis. The construction of a system of axes helped them greatly to find their orientation:

```
to axis
setpencolor 2
forward 150 back 300 forward 150
setpencolor 4
right 90
forward 150 back 300 forward 150
left 90
setpencolor 5
downpitch 90
forward 150 back 300 forward 150
end
```

Once they had a set of axes, they constructed cubes (Fig. 2) by joining squares, going forward then left, forward then right, then down and left, and then played with those cubes (Fig. 3).

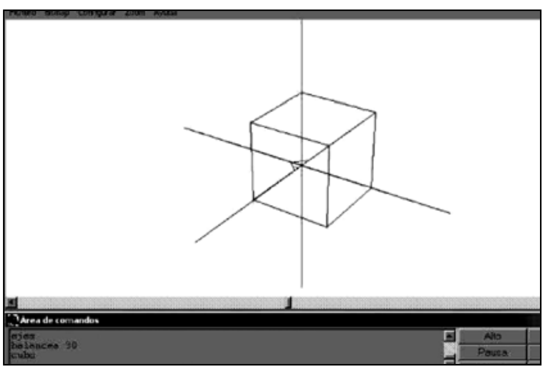


Fig. 2. Construction in 3 dimensions of the cube using a set of axis

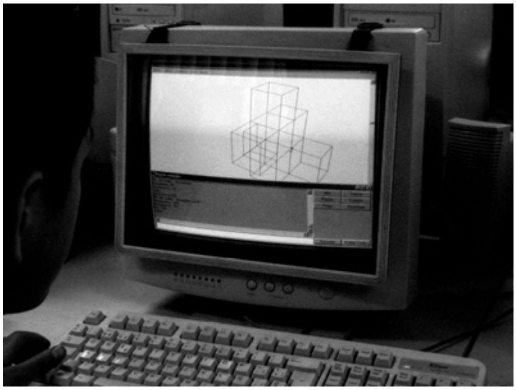
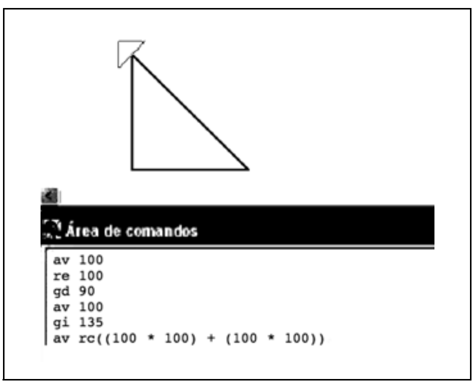


Fig. 3. Playing with cubes before moving on to the Pyramid task

2.3 The Pyramid Task

After constructing a cube the children felt ready to tackle the objective: building a pyramid. For this, in the classroom discussions on how to proceed it was felt that the center of the base-square of the pyramid was needed as a reference for the tip of the pyramid. For this, they used Cabri to help them in their visualization of the figure.

They then discovered that in Logo they could use Pythagoras Theorem to draw the inner diagonals. Thus, in order to construct the pyramid in Logo, the students required the use of trigonometric ideas and functions. So, for this project, we also used the activities of the "Painless Trigonometry" project. This meant that this project was even longer and more complex, but we carried forward because the students were highly motivated. Using Pythagoras Theorem, students were able to construct right triangles in Logo (Fig. 4):




```
to righttriangle
forward 100 back 100
right 90
forward 100
left 135
forward sqrt((100 * 100)
 + (100 * 100))
end
```

Fig. 4. A right triangle in Logo

They even wrote procedures for drawing a generic right triangle (which some called `pythagoras`), and for which they had to also use the `arctan` function for calculating the angle. We found this particularly interesting since these were 12-13 year-old children and that kind of mathematical application of trigonometry is only seen in our country after the age of 15 or 16. But we observed that the children acted in this as experts, in their quest to reach the goal of the "game". On our side we didn't push them, we let them progress at their own pace, letting them be the discoverers of their constructions.

```
to pythagoras :a :b
forward :a back :a
right 90
forward :b
left 180
right arctan (:a/:b)
forward sqrt (:a*:a)+(:b*:b)
end
```

Using the knowledge from the right triangle experience, the students moved to constructing a pyramid. They used their procedures for the axis and for the square, as well as Pythagoras Theorem to find the center of the base-square and height of the pyramid. For a base-square of size 100, the center of the square is located at half the diagonal that is at a distance of 70.71067811865 (= sqrt(100 *100 + 100 *100))/2 = $100\sqrt{2} / 2$). For the height of the pyramid they used the same distance as half of the diagonal of the base-square. In this way they were able to reach the upper tip of the pyramid (Fig. 5).

```
to pyramid
square
right 45
forward (sqrt(100 *100 + 100 *100))/2
downpitch -90
forward (sqrt(100 *100 + 100 *100))/2
downpitch 135
end
```

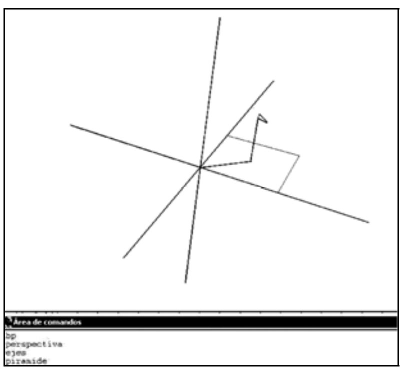


Fig. 5. Placing Logo's turtle at the tip of the pyramid-to-be, above the center of the base-square

The next step was to join the vertices of the square with the tip of the pyramid. They used again Pythagoras Theorem to find the length from the tip of the pyramid to the vertices of the base-square (the hypotenuse of a right isosceles triangle of side 70.7106781186548).

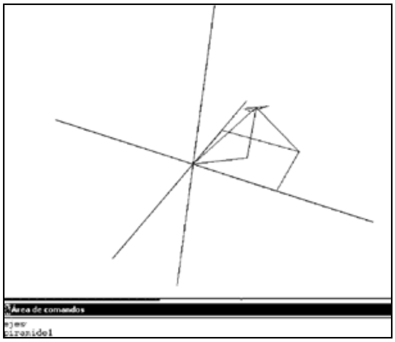


Fig. 6. The completed pyramid with the reference axis-system

The completed procedure for constructing the pyramid (Fig. 6) was something as follows[1]:

```
to pyramid
square
right 45
forward (sqrt(100 *100 + 100 *100))/2
downpitch -90
forward (sqrt(100 *100 + 100 *100))/2
downpitch 135
forward sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
back sqrt( 70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
downpitch -270
forward sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
back sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
downpitch 135
rightroll 90
downpitch 135
forward sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
back sqrt( 70.7106781186548 * 70.7106781186548 +
70.7106781186548 * 70.7106781186548)
downpitch -270
forward sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
back sqrt(70.7106781186548 * 70.7106781186548 +
 70.7106781186548 * 70.7106781186548)
downpitch 135
back (sqrt(100 *100 + 100 *100))/2
```

[1] Please note that all the programs presented in this paper are sample procedures written by students. They illustrate their ways of thinking of the problem. Thus, they may not be examples of the most efficient ways of programming the figures in question.

```
rightroll -90
downpitch -90
forward (sqrt(100 *100 + 100 *100))/2
downpitch 90
rightroll 45
downpitch 90
end
```

The last step was to change the height, so they needed to use the tangent trigonometric function in order to find the necessary turning angles.

2.4 From Static Images to 3D Animation

A few months after we had finished the project, some observers came to the school and we decided to show them what we had done in that project. We assumed that the children would have forgotten much of what they had done, but to our surprise they were able to rebuild everything they had originally done over the course of many weeks, in a single 50 min. session! Then one of the observers asked if it was possible to rotate the figure in three dimensions to see it from different perspectives. In the short time available, many of the children were able to animate the figure with respect to the vertical axis, by turning the starting point and redrawing the figure several times over. This was quite a surprise for us, and a pleasant reminder that students' potential should never be underestimated.

3 Discussion and Concluding Remarks

Our school project "In search of the fourth dimension while in the third" had as aims to introduce, though a *constructionist* approach [4], junior secondary students to the applications of the Pythagorean Theorem and of trigonometric functions, while at the same time covering some of the themes included in the curriculum for this age-group, such as the study of the pyramid, but going beyond it (e.g. into three dimensions). The project was time consuming and lasted several months, but we consider it a worthwhile investment. Projects such as this one not only deal with the topic they are designed for, but also develop a need for the use of many other mathematical concepts. We are reminded of Papert's vision in his book *Mindstorms* [6] when he described the gears of his childhood.

One thing that we observed was that the students treated these computer-based projects as challenging games. This meant that they never wanted the sessions to end, and students who are shy and withdrawn in other classes and environments began to express brilliant and clever ideas which filled them with fulfillment of their self-discovery abilities and of their learning. Other students who otherwise did not engage in mathematical thinking, suddenly became leaders in this project, taking the initiative to present and "teach" to the whole class their advances and imaginative ideas. This is something that happens mostly with the Logo programming activities. Students assume the role of teachers to show their classmates how they solved the problems that emerge. The whole project was fun and motivating for students. And some students even had the opportunity to present this work at National forums.

We gave the children freedom to explore their own ideas and follow their own path. But this does not mean that we left the children on their own, we supported them but let them construct their own intellectual paths and structures.

Our students are now able to perceive mathematics as something meaningful, something that they can apply for solving a project; instead of something boring, meaningless and forced upon them –as is so often the case. It's not just giving the students access to a computer; it is the way of doing things (in our case the constructionist approach), which can awaken the creativity inside the students. As Kofi Annan expressed it [7]:

> *"[It] is not just a matter of giving a laptop to each child, as if bestowing on them some magical charm. The magic lies within—within each child, within each scientist—, scholar—, or just-plain-citizen-in-the-making."*

Logo, in particular, is an invaluable environment for this, a tool for constructing, developing abilities, and learning how to think. Some people have put this tool aside considering it a relic of times past. But amongst the sophistication of much modern software, our students still like Logo best. When we asked one of 13 year-old student why he liked Logo so much as opposed to other more modern software, he said "because [in Logo] I can express myself… [whereas] I think buttons make human beings obsolete" (!).

On the other hand, we realize also that these types of projects are challenging for educational institutions, and can be hard to accept by the educational community. At the time of this school project, we were involved in the writing of a mathematics textbook. We wanted to include activities in three dimensions, but some of our co-authors felt it would be too difficult for both teachers and students. It saddens us that student abilities are often underestimated. As was shown with the example in this paper, where students had to engage trigonometric knowledge as well as think in a three-dimensional way (going beyond the usual two-dimensional thinking of school mathematics), the computer can act as *scaffolding* [8] to give early access to powerful ideas and advanced topics.

In the words of Seymour Papert [9]:

> *"Opportunity means more than just "access" to computers. It means an intellectual culture in which individual projects are encouraged and contact with powerful ideas is facilitated." (p. xv).*

Acknowledgement

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Towards Transformation: AlwaysOn Students and Health Education

Andrew Fluck[1] and Mary Burston[2]

[1] University of Tasmania, Australia
Andrew.Fluck@utas.edu.au
[2] LaTrobe University, Australia
M.Burston@latrobe.edu.au

Abstract. How can teachers integrate ICT into student school learning? How does ICT contribute to improved or extended learning? This study compared m-learning, e-learning and contemporary learning pedagogies in the context of Health Education. It was undertaken in schools located in the states of Victoria and Tasmania, Australia. Findings from 170 Year 7 (age 13) students in two linked schools are described in this preliminary report. In general, students were more adaptable to technology, but teachers felt ICT was an imposition requiring additional planning and management. We show schools can overcome many significant barriers to integrate ICT into learning.

Keywords: ICT, transformation, AlwaysOn, PDAs Health Education.

1 Introduction

Much research has been done on the evolving form of m-learning, where students use highly portable digital devices to manage their studies and provide access to content, mentors and peers [1, 2]. Examples of success show how such devices can facilitate authentic learning in the field [3] together with classroom studies and learning at home. Amongst the related literature are opinions about pedagogies, appropriate software and the affordances of various hardware [4], including debate about device formats such as personal digital assistant (PDA), laptop, tablet etc. There is also a significant discourse on the barriers to ICT adoption by teachers [5, 6]. Some of these are cultural and systemic; others relate to infrastructure availability and performance.

These two backgrounds formed the context for our investigations. The M-Learning landscapes: transforming school cultures through next generational thinking project was funded for three years (2006-8) by the Australian Research Council. It examines the ways in which teaching is altered by information and communication technology (ICT), and how student learning is changed. Of particular interest were the behaviours of teachers, the way ICT affected their patterns of work, methods of classroom management and their accommodation to technical innovation within the governance structures of the school. In respect of students, were keen to monitor opportunities for extended time on task and inter-school communication to enrich learning. This was a Linkage Project jointly conducted by La Trobe University, the University of Tasmania, and the Departments of Education in Victoria & Tasmania. Our co-researcher was Margaret Robertson.

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2 Method

The aim of this project was to investigate authentic learning strategies which link digital learn-spaces (see Fig. 1) with ubiquitous access for Year 7 and Year 9 (age 13 & 15) learners in Victoria and Tasmania. We planned to do this by comparing learning about the same content (a topic selected by the school in the Health curriculum) by learners in three distinctly different kinds of classes:

- Traditional or contemporary classes where teachers taught using their usual methods (which may have involved a video or even the occasional group session in a computer laboratory);
- Online classes where students mostly used material from a learning content management system;
- PDA classes where all students were allocated a personal handheld device for the duration of the course, and trained in its use. Students were encouraged to personalise the handhelds and take them home, but learning could also encompass the online content management system.

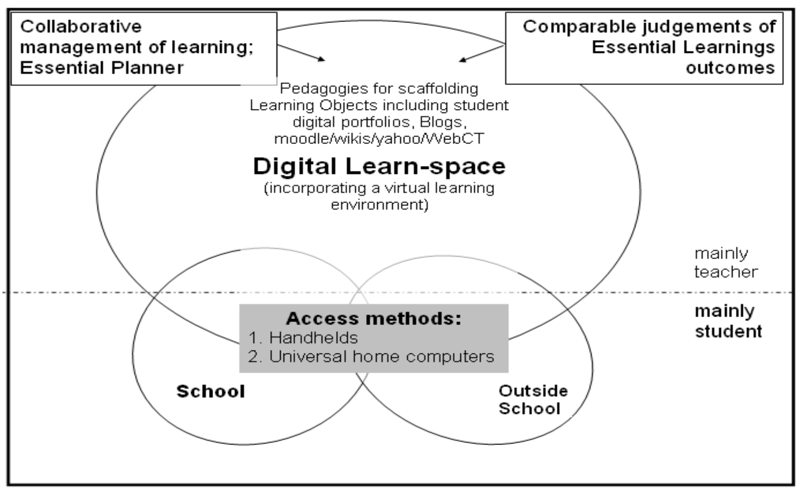

Fig. 1. The ‘Learn Space’ concept model [7]

Setting up the learning online content management system proved problematic, since no jurisdiction would permit access by extra-territorial persons. The project contracted with a web-hosting provider in Brisbane to provide a Moodle and Drupal installation[1] which we administered remotely. Funding for the PDAs proved difficult to obtain, but we were supported by the Victorian Department of Education to provide several class sets of HP iPAQ rx4240 units. In Tasmania we obtained one set of these units, and another set of the older Palm Zire 31s. The iPAQs had wireless and Bluetooth connectivity, whilst the Zires could only use infra-red beaming to transfer data between individual units. The iPAQ units had microphones, so could record

[1] http://www.alwayson.edu.au

sounds to make podcasts. Text input was done on both models using handwriting recognition, and both could play audio and video. All PDAs were equipped with 1Gb SD storage cards, which provided ample capacity to store books, videos, courseware and personal pictures and documents. The PDAs deployed to selected classes in schools were allocated to individual students throughout the experimental period. With parental consent the students were able to take the PDA home and use it for personal purposes provided it was brought to the relevant class sessions in operating order. This personal 'ownership' was an important part of the project.

The research design involved 4 phases (repeated in each of the three years of the project). The phases shifted involvement progressively from local to national levels.

1. Identification and formation of class clusters in schools. Teachers were asked to complete an ICT literacy checklist and introduced through group meetings to the 'Learn-Space' concept.
2. Local Cluster Learn-Space activity. During this phase each cluster of classes 'taught' within their digital environment for a period of approximately 3-4 weeks. The research involved monitoring access, interactions and conversations of all participants (i.e. teachers and students within each school).
3. State Cluster Learn-Space activity. All clusters were linked to a project-wide digital space within which they were encouraged through common negotiated tasks to interact widely and participate in shared communication tools.
4. Interstate link-up during which students were encouraged to interact with learners in other states.

In 2007, our project proceeded with entire year group cohorts in 10 schools. Each year group was divided into the three types of class. One class was equipped with PDAs (we will use this acronym for shortness and consistency) for every student; another class booked into a computer laboratory for online learning and all the remaining classes learnt in contemporary/traditional ways. This procedure was followed with small variations in 24 contexts over a two year period. We noticed maturation of approaches in schools which used the protocol in both years.

3 Results

We were initially sceptical about the way in which students were using the online materials in a school. Data were collected using six main instruments:

- National benchmark testing for literacy and numeracy
- Content-knowledge pre-test and post-test using calibrated open-ended response items from a bank supplied by the Education Department, Tasmania.
- Survey of personal computer use devised for a previous project, giving background descriptors of student computer use in their lives
- Observations of classroom practice by experienced teachers
- Focus group interviews with students participating in the project
- Automatic logs and chat records from the Moodle learning content management system

These data revealed some immediate problems to confound analysis. Here are some examples of the difficulties and the responses of the research team. In the first year, students in different states used different national benchmark tests. We therefore converted scores to percentile ranks for comparability. Some schools could, or would not, connect PDAs to their wireless networks. Thus the entire set of course materials was re-formatted to fit onto the SD storage card and a *PDA only* class was subsequently included in analysis. Students forgot their usernames and passwords, so we supplied a spreadsheet of these to their teachers. PDAs locked up so needed to be reset by students using self-help instructions and access to re-installation software on a web-site. Students were provided with at least one hour of formal instruction and 2-3 weeks of practice time with the PDA before the project content learning commenced. Teachers were given a one-day course in Moodle design.

In this paper we focus upon the activity of 170 Year 7 students from two linked schools in rural Victoria. This is just a snapshot of the project as a whole, but will serve to illustrate how the project is proceeding.

Over the life of the project, there was evidence of maturation: some teachers adopted the mental shift from whole class progression to individualised learning. In planning activities and individual interviews, teachers often found the biggest change in their practices was the complete preparation of learning materials for a complete unit of work in advance of delivery. There were some objections to this, because it removed some element of control from the teacher – there was no opportunity to adapt material to suit student interests, or to follow a line of engagement on the spur of the moment. On the other hand, teachers did acknowledge that students were consequently able to proceed at their own rates, an individualisation of learning.

For those classes using PDAs or online materials, the digital format was unfamiliar for some teachers. Translating familiar activities (such as ‘create a poster’ about a topic), was difficult to implement on a PDA screen. Other affordances of the technology, such as automatically marked quizzes, were not part of normal practices, and were sometimes difficult to accommodate.

Once they had changed some routines because of the ICT, teachers adapted in different ways to the potential of the equipment. One teacher became adept at identifying useful digital educational resources on TeacherTube[2] and YouTube[3] to augment interactive materials for student learning. Another teacher established good classroom routines to make worksheets available to all the PDA students via Bluetooth from a public read-only folder, and accepted completed work in the same way.

Following the experimental period, teachers in both Tasmania and Victoria requested courses be set up in the AlwaysOn web-site for purposes outside the original project intention:

- For low ability readers – with the option to hear spoken texts. In addition, there were some spin-off projects associated with teachers who had taken on the role of PDA mentors.
- Languages other than English (Japanese) could be facilitated by the capacity of the handhelds to record and playback podcasts. This was useful for correcting pronunciation.
- In SOSE (Studies of Society and the Environment), GPS receivers were linked to the PDAs running MediaScape[4] to allow students to create learning adventure based upon location-based digital clues around the school.

[2] http://www.teachertube.com/
[3] www.youtube.com/
[4] http://www.mscapers.com/

- In Mathematics, teachers used the PDAs for task checking and for the calculator function.
- Generally the PDAs were also used to organise social meetings after school (covert bluetoothing) and to transport data between school and home digital environments.
- Fitness (health) was supported by using the PDAs for recording exercise diaries and mapping increasing walking distances.

These latter examples illustrate the degree to which students adopted the PDAs into their lives, using different ways to address learning needs outside the formal curriculum. It was clear from the focus group interviews that students were disappointed they had to give back the PDAs at the end of the project period.

Quantitative analysis was conducted by bringing together the data from the national benchmark testing, the pre- and post-tests of content knowledge, and the computer use survey. For this report, the data from two campuses of a school in Victoria were selected.

The initial findings compared the pre-test and post-test achievement scores for Year 7 students (age 13) in the three types of classes. 170 students were involved in 16 classes. After elimination of incomplete records, data from 129 students were used for the analysis, with 28 students in the PDA & online group, 22 in the online group and the remainder in the contemporary/traditional classes. Standard errors have been used in the chart (Fig. 2) and are presented in the form of 95% confidence intervals (1.96 times SE) following Kay [8].

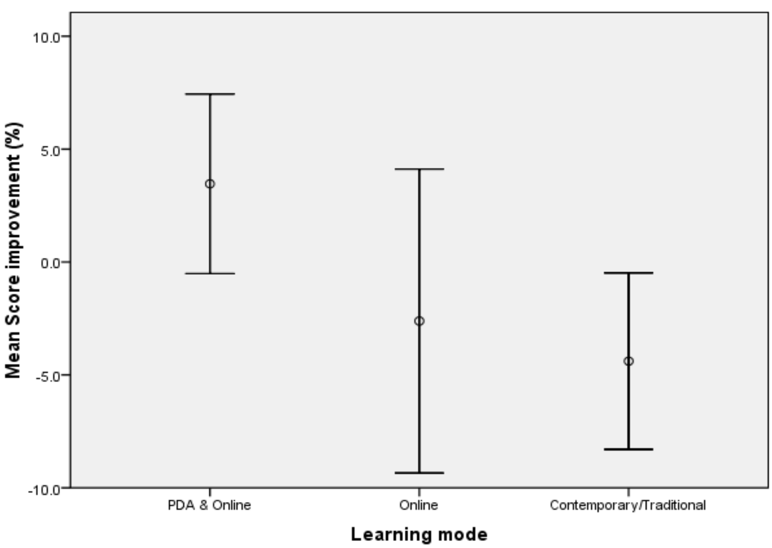

Fig. 2. Learning achievements of the three groups

Lower score improvements were shown in the contemporary classes. The highest score improvements were in the PDA class. With this small sample the confidence bars do not make this a significant finding, but indicates what may be shown by the entire project when the data from many more schools is analysed using Rasch modelling to account for varying item difficulty and linking different tests using calibrated items.

It is important to examine other variables, other than the different learning modes, which might explain the differences in attainment. In educational research, there are many variables over which there is little control. The classes had different teachers, and the influence of the teacher has been shown to be very important in many studies. Did the PDA group have students with ability above the average? On advice from the Victorian Department of Education and Early Childhood, we combined the reading and writing scores equally weighted to create an overall Literacy score for Victorian students. After students who had omitted one of more tests had been culled, all scores were then converted to percentile rankings using the Excel function PERCENTRANK. Higher rankings indicate better performing students. This sensitive data has been reported in bulk terms which do not identify any of the project schools.

High and low computer users were identified from the student surveys:

- High computer user: uses computers outside school, uses computers for personal purposes at home and uses computers for any task more than 2 hours a week.
- Low computer user: uses computers at school for less than one hour a week and rates personal computer skills at school as average or worse.

Table 1 shows the PDA group had literacy skills equal to the Online group and above the contemporary classes. However, their numeracy skills were lower than the other groups. The PDA group were not particularly well situated to adopt ICT for learning, with just as few high computer using students as the online group. The group did however have slightly fewer low computer-using students than the contemporary group.

This additional data is therefore insufficient to convince us that the PDA group were particularly more able or better prepared to use ICT than the other groups. The learning achievements (although not at this scale statistically significant) appear to be due to the presence of the technology. We make no claims at this stage about the process which may have made this possible, but our initial speculation is a combination of additional time on task and a Hawthorne innovation effect leading to improved motivation.

Table 1. Differences between the three groups

Group	*n*	*Mean Literacy percentile ranking*	*Mean Numeracy percentile ranking*	*Percentage of group who were high computer users*	*Percentage of group who were low computer users*
Contemporary	79	52	48	19	15
Online	22	58	54	14	32
PDA	28	58	47	14	14

It is not easy to study time on task by PDA users since it would require a logging program to be installed in the device. This alone would not be certain to record all activity, since students could (and did) re-image their PDA whenever required.

Logging data would therefore not be secure in such an environment, and additional ethical concerns about privacy would need to be addressed. However, we were able to log the activity of persons accessing the online materials, both individually and collectively. Fig. 3 shows the initial work done by teaching staff to prepare the course (to 1st April) and the student introduction just before 22nd April. The main learning period began just after 6th May and continued to 1st July.

The research team also plotted access against time of day, showing little activity in the early morning, but quite a long afternoon tail after school closed. 8% of accesses were outside school hours, indicating a moderate degree of additional time on task.

We wanted to know if students would use the online chat facility in the Moodle Learning management system. Students within a particular school had engaged highly with this technology, using it for discussions between school and home, and after school. Here are some examples of the discussions we found in the chatroom log files. Screen names have been changed and personal details masked. Each student was able to associate a picture such as a cartoon, drawing or photograph, with their screen-name. At an early stage the students (all from the same school) were observed exchanging phone and mobile phone numbers. This was strictly speaking a breach of internet etiquette, but since they could have done so face-to-face in class, probably not a serious breach. Conversation also considered personal friendship relationships (which was consonant with the Health and Wellness study). The dialogue then rapidly went on to personal circumstances and life-decisions which was precisely the focus for the study unit.

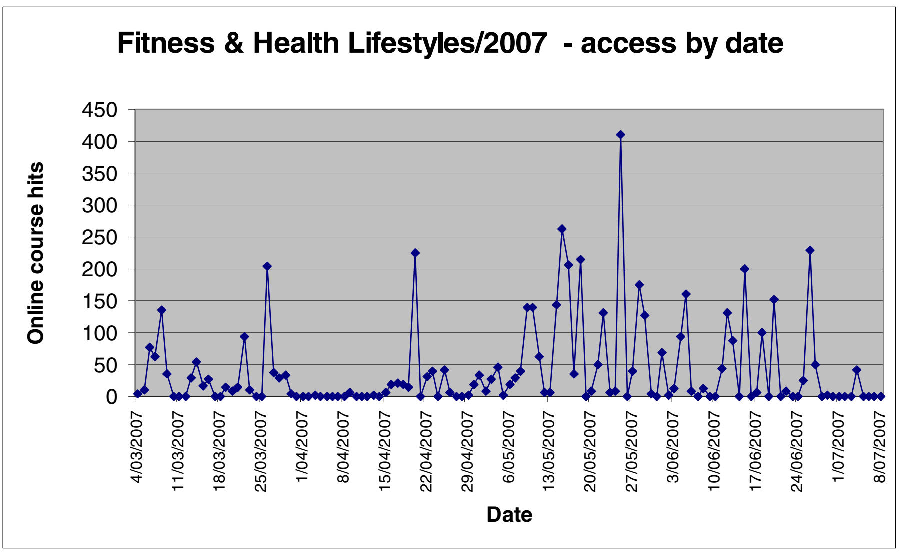

Fig. 3. Number of accesses to the learning content management system by date

The initial dialogue took place during school hours, but one of the participants was at home, sick:

Jacey: [I'm] just abit sad of everything that happening in my life
Jacey: god i HATE mylife. i will tell you something at lunch
Alice: well how do u think i feel when my mum is going to die and i have no dad then u will have to go to an orpanage
Jacey: im sorry

The conversation resumed after school hours:

Mary: On friday night me,Lana,ruth,Ethony,larry nerrng,and Katy are all stayin at jeremys lol fun xx
Jacey: oh cool
Mary: yeah lol xx
Jacey: Please dont tell that boy I like him Mary Please dont
Katy: mm are u and jeremy gonna sleep in a room by ur selfs
Jacey: Are you
Mary: yeah lol probably lol xx
Jacey: oh my god are you
Mary: yeah xx
Jacey: :0
Jacey: dont do any think dum

4 Discussion

The AlwaysOn project has run for only a short time, and this report is only an initial analysis of the outcomes. However, it appears to promise an insight into the changes required for new styles of learning to penetrate into schools. On one level the project may provide a statistically valid comparison of e-learning, m-learning and contemporary learning pedagogies. On another level, the project is already providing insights into the mechanisms of change management in schools.

Changes for teachers using ICT are significant. Online delivery and subsequent download of learning materials into PDAs requires a great deal of initial effort. Teacher work schedules are not well framed for this kind of cyclic change. The normal employment arrangement is for a set number of face-to-face teaching periods each week, with a small number of preparation and marking periods; these times do not change over the year. In addition to this re-framing of work intensity to accommodate ICT, teachers fear loss of control, abandoning the possibility of re-directing the flow of learning to suit particular circumstances or group dynamics.

The initial findings from this part of the AlwaysOn project show that m-learning with PDAs appears to give some learning advantages. Online learning was nearly as good as m-learning, with evidence of some extended time-on-task from the logs of the learning content management system. Students appeared to be very willing to exchange personal information within the protected 'learn-space' online, and discussed important health topics. For these students, using the digital space was natural and easy – a contrast to the impact upon their teacher's ways of working.

5 Conclusion

It seems that there are four main areas which need attention if secondary school classrooms are to be transformed through ICT:

Affordances of equipment (connectivity, portability, application software libraries, form factor, battery endurance)
Innovation adoption techniques (governance, equipment ownership issues, policy frameworks)
Pedagogical integration strategies (used by teachers as they link the computer to the curriculum)
Curriculum transformations (Negotiated by system leaders with parents)

This AlwaysOn project has illustrated the great difficulty of implementing significant pedagogical transformation in schools predicated upon online or mLearning. However, it has also had a useful impact. Granting ‘ownership’ of PDAs to students for extended periods has impacted another school in the project. Across Australia in 2008, the government digital education revolution began to allocate funds for all Year 9-12 students to have computers throughout the school day. An AlwaysOn school decided to augment this by planning to give every year 7 student a netbook for 2009:

> *AlwaysOn made at least two contributions to our decision - firstly the name, the underlying concept that students are always on the internet and what that means for classroom practice, and secondly the experience that when kids own something, they instinctively look after it much better than when it is shared. Even the nuts and bolts of not having to charge 130 devices (students will do that at home) will have spin offs for us, we hope.*

We make some suggestions to facilitate the uptake of new equipment and techniques in schools:

i) Before classroom deployment of new technology, teachers need to become moderately competent at using the learning content management system or portable computer.
ii) mLearning devices should be used right across the curriculum, not in single subjects in isolation, and this be supported by school-wide policies. This can be facilitated by granting ‘personal ownership’ of the devices to individual students who take on first line responsibility for charging, backing up data and initial diagnostic/re-imaging.
iii) Teachers practices need to change: for instance, porting a worksheet across to a learning content management system is not digital education. A series of problem-solving games suited to the equipment can be much more effective in promoting learning. Teachers should either create interactive multi-media online activities, or select these appropriately from library repositories.

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Virtual Cities as a Collaborative Educational Environment

Daniel Nehme Müller, Otto Lopes Braitback de Oliveira, Joelma Adriana Abrão Remião, Paloma Dias Silveira, Márcio André Rodrigues Martins, and Margarete Axt

Laboratório de Estudos em Linguagem, Interação e Cognição (LELIC), Faculdade de Educação (FACED), Programa de Pós-Graduação em Educação (PPGEDU), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Paulo Gama, 110, Porto Alegre, Brasil
danielnm@inf.ufrgs.br, ottolb@gmail.com, jremiao@brturbo.com.br, paloma.dias@gmail.com, mmartins2006@gmail.com, maaxt@ufrgs.br

Abstract. The CIVITAS (Virtual Cities with Technologies for Learning and Simulating) project presents a research, teaching and extension approach directed to the construction of cities imagined by students in the first years of elementary school, with an emphasis to the fourth grade. The teacher ventures on a deviation from the official curriculum proposed to reflect upon the invention of cities along with the children. Within this context, the game Città is introduced as an environment that allows the creation of digital real/virtual/imagined cities, and enables different forms of interaction among the students through networked computers. The cooperative situations, made possible by the access to the game, are tools for teachers and students to think about the information that operate as general rules and words of order with the invention of the city/knowledge.

Keywords: Educational simulation environment, Computer-Supported Collaborative Learning, Educational games.

1 Introduction

In the first years of elementary school in Brazil, the exploration of the city, its structure and dynamics, is often accomplished through a curricular activity based on building city models. This takes place in a short period of time, usually one or two days, and has the sole purpose of representing urban spaces such as buildings, roads, and public squares.

Within the context of the CIVITAS project and its proposal for a continuing development education for working teachers, the city's model is built as an *axis* of the pedagogical practice. This way, it operates not only as a temporary activity, but also as a mechanism for study throughout the school year as well, or while there is reason for its existence.

The city in which the child resides and lives is studied and represented as a municipality in the conventional curriculum; it participates as a memory, as strength of an entire past lived by the child. In our studies, this memory, this entire past, this

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city in its group of material, living and human relations constitutes the virtual of the cities created by the children [1].

The use of diversified materials such as cardboard, wood, clay, and paint (Figure 1), for the child to build collaboratively, based on imagination and conversation with fellow classmates, can be considered another curricular activity with a planned beginning and end. But the use of these materials, most of them recyclable, is far from being an activity with an established purpose, because the emphasis is given to the building process, the imagination. Furthermore, there is content that can be related to the city through its history, economy, geography, geometry, basic sanitation, health system, transport, social and political relations, among other things.

In discussion about new research and teaching methodologies for the classroom, the LELIC (Laboratory for Studies in Language, Interaction and Cognition, of the Faculty of Education of the Federal University of Rio Grande do Sul) team proposed a city editing software (the game Città) with which the children could, collectively, build virtual cities with other materials and technologies (like word processors and presentation tools) in the classroom. The opportunity to increase group work with the online interaction between classes, and the possibility to create simulations of other natures (natural or with human intervention events), formed the motivating nucleus in favor of making *virtual cities* in the most varied ways, including digital technology.

Fig. 1. Pict0075res of models built by students in the CIVITAS project

This was the beginning of a partnership between municipal governments, teachers and university, where all counterparts were involved in the creation of pedagogical practices regarding the virtual cities. The LELIC team and teachers worked together, in study and development groups, discussing traditional pedagogical practices and alternatives, considering the challenging world of teaching-learning relations contained in virtual cities as a central axis of this process.

Città, the educational game presented here, is a part of the CIVITAS project and it seeks to establish an environment that not only reproduces, but intensifies as well, the inventive possibilities of other city models. This article will present the CIVITAS project, where the game Città originated, a view on the technology of educational games, a description of the game and its components, future perspectives and some conclusions.

2 The CIVITAS Project

CIVITAS was born from the collaboration and partnership of LELIC-FACED-UFRGS, involving researchers, post-graduate students, undergraduate scholarship students and municipalities from the countryside of the state of Rio Grande do Sul through their schools, teachers, students and managers.

CIVITAS is intended as a project featuring classroom experiments, actively involving teachers and students in the first years of Elementary School. The project expects to open alternative spaces for doing-thinking-making *Virtual Cities* from the varied use of multiple technologies available in the classroom, including digital technologies.

From the beginning, the development team and teachers have worked together, discussing the methodological feasibility of the project in the classroom, including the beginning of the modeling process of the simulation editor Città before classroom use of the prototype was possible. The meetings with the teachers became systematic and evolved into a work and study group, configuring a continuing development education at the workplace. The group started being more concerned with contemporary teaching practices and how these practices can be changed. This was to prepare for the coming of the simulator in the classroom, as well as other technologies such as digital cameras and camcorders, in a way to avoid this equipment and software from becoming just one more technology without any qualified implication on the educational practice. However, this transformation process is not just a simple substitution of one pedagogical approach for another. There are activities and discussions about the coexistence of several practices in the same classroom, as well as the coexistence of several technologies, from the blackboard and chalk to computers and virtual simulation environments.

The project has the important goal of combining classroom curricular activity, content, and different methodologies with the exploration of possibilities in the construction of a virtual city, benefiting both the learning process and knowledge. Throughout this work, the teachers considered it important that they engage in a more systematic and deep discussion about the educational challenges emerging from the insertion of a new technology in the classroom. The description of practices, the identification of common problems, the need of theoretical reading to support the discussions about possible solutions, all this, step by step, led to the breaking up with routine practices and the creation of new lines of action. Just like they did in the study group, teachers began experimenting discussions with the children on how to study the city, how to organize in order to retrieve interesting data, what are interesting data, what was "necessary" to learn about the city they lived in.

The search for information and other elements to support the constructions at the varied levels of the children's interests (the urban infra-structure, the organizational structure, strictly speaking, and its relations with environments such as the natural-social, urban-rural, historical-cultural and so on) started being applied in several modalities. The children participated actively, along with the teachers, in the definition of different search possibilities – visitation, field research, interviews with family members, neighborhood residents and people of the city's public life, research in documents, videos, movies, music, virtual libraries, websites and interactions through virtual learning environments (VLE). The results were recorded according to the children's creativity (especially in written observations), in physical or digital support, in pictures and collections of materials, or in an exhibition of objects and relics.

Still without the use of the simulation editor Città, the children's productions, based on the results of their records and research, in this stage, were expressed: (i) through countless and varied ways of artistic productions[1]; (ii) with descriptions and narratives created over a determined plane of reference, in technical-scientific reports standards, like seminars and results discussion; (iii) or still, in an imminent plan of thought, exercising conceptual construction, unfolding in several and multiple manners of existence bounded by an ethics and aesthetics of respect regarding differences and life [2] [3].

Furthermore, the schools' computer labs connected to the internet have allowed the children and teachers access to the network. The VLEs have been used with several possibilities and purposes of discussion and research. Since 2004, the project proposed the insertion of technological islands (a set of three computers and a printer) connected to the internet in the classrooms: this device positively confronted the teaching practices with the demand for diversity, difference and multiplicity in the classroom.

3 From the Models to the Simulation Editor Città: Learning and Teaching Perspectives

The CIVITAS Project, while inserted into the classroom context, operates as an articulator of the goals, thematic blocks and contents found in the school curriculum, which is organized according to the National Curricular Parameters (NCPs) for elementary school. Therefore, the project is not a strange element in the teaching activity, but it joins the daily life of the school and questions how the curriculum contents are treated and developed, suggesting an intense degree of reflection on the possibilities of creating alternative spaces for the construction of the City.

In this perspective, the purpose is not to talk about the introduction of a project in schools as a model to determine the *best* curriculum or the *best* way of working in the application of this curriculum. What the project proposes is exactly the opposite: not to be regarded as a guideline to be followed, but to refrain the impulse of following an homogeneous ideal, where everyone must learn everything at the same time, and consider the challenge of opening up to instabilities; seeking, in the multiplicity of points of views, for a creative and ingenious insertion of the students in the learning process, finding new (other) ways of seeing, thinking and acting.

From the model to the simulation editor Città there is a set of actions that permits us to invest in the CIVITAS project as a space for thinking about the development of the teacher allied to new technologies, without disregarding the treatment given to the technologies that are already a part of the educational environment. Thus, the game Città does not arrive in the school as an accessory, or a technical device to improve planning, but to rather to allow ways of simulation that were not considered before,

[1] Deleuze and Guattari (1997) suggest three modes of thought – that of art, philosophy and science – which are respectively built on planes of aesthetic composition, planes of knowledge reference and planes of immanence of thought.

and offering new possibilities to create the virtual City. The planning and the way of teaching, in addition to the flexibility in its use in the classroom, features another understanding of how knowledge occurs from the perspective of how students learn, as well as in how teachers invest in their own development.

From the point of view of the student's involvement, it is observed that the knowledge occupies a place of pleasure, which is more than the simple acquisition of certain content. To create the City in the model the student needs, besides skills and cognitive and motor abilities, to know how to work in a team, in order to allow projects emerging in the group to come up and know how to deal with inevitable conflicts. The student also needs to know how to listen, analyze, discuss, stand-up for his/her point of view, find solutions, imagine, create, write, research, seek for information or alternatives. In Città, the interactions are broadened, new challenges are contextualized and other research issues are triggered from the needs that arise in its use in the classroom, joining students, teachers and researchers efforts.

4 Digital Educational Games

Città can be classified as a *civilization game*, where the game allows conquering of space and construction of the necessary infrastructure for the population's survival [4]. However, differently from commercial games, the goal of Città is not the conquering of other nations, but the construction of a city, similar to Simcity (by Electronic Arts), Caesar or Pharaoh (both by Impressions Games). Nevertheless, Città differs a lot from these because it is free software, less complex, collaborative and can be adjusted to specific curricular and educational needs. In other words Città is a collective game, but without a competitive purpose, based on a constructive logic of cooperation and collaboration.

Digital games are precious instruments for education, because they are attractive to children and teenagers. According to Mysirlaki and Paraskeva [5] many basic principles of social cognitive theory can be found in digital games, because they influence behavioral models, repetitive behaviors and construction of the imaginary, among other factors [5]. After examination of several commercial games, Mysirlaki and Paraskeva recommended the creation of networked educational simulation games, which coincides exactly the purpose of Città.

Along this line, Stone and Gutiérrez used games to guide the learning process and explained how the computer can intercede in the solution of problems in a teaching environment [6]. In their work tyhey try to generate, through an educational game, a continuing redefinition of the object being studied by the student, where the teacher acts as a collaborator in a process of discovery mediated by the computer instead of performing an analysis or previous orientation of knowledge. It is possible to say that the game Città is in alignment with this kind of practice because it intends to be a mediator in the process of discovery, especially in creation and shared knowledge construction.

The computer as a teaching tool of the 21st century is defended by Spires, Lee and Lester [7] who say that the new ways of work, communication and knowledge organization involve the computer as a means of communication between people. They also report that network games stimulate reasoning and the elaboration of strategies, besides the organization of virtual social interaction between the players. In this sense, Città being a multiplayer game provides an environment for social interaction in the virtual space, demanding the elaboration of rules to guide the players involved in the construction of the city.

According to Rieber [8] the act of *playing* is associated with several interactive activities and has an important role in mental and social development. In the digital educational game, when the *playing* appears involved with the micro-worlds and simulations environments, this role can be reinforced by the interaction with other people.

Therefore, multiplayer digital games allow the participation of more than one player at the same time and enable the occurrence of direct or indirect interactions among players, generally in the form of competition, cooperation or collaboration [9]. Digital multiplayer educational games present the same features of educational systems that can be used to promote computer-supported collaborative learning (CSCL).

The CIVITAS project focuses on collaborative educational games and is based on the CSCL definitions proposed by Dillenbourg [10], who defines a collaborative learning activity as one with the purpose of sharing an understanding or solving a problem. In this case, understanding refers to the actions and strategies developed by the players, and the problem refers to collectively winning or bypassing the challenges and obstacles presented by the educational game. For instance, when one of the CIVITAS teachers suggests a task to be done with Città, he/she imposes resource limitations or conflicting tasks that need to be solved by the players. Arising from the interaction among students as Città users, we have a favorable context for socialization, cooperation and learning processes when the students work to solve problems and overcome limitations imposed by the simulator program.

5 The Città Game

As mentioned in the previous section, Città is a collaborative educational game aimed at a collective construction involving cooperative and negotiating actions. To enable the simulation of cities with this collaborative format, Città was developed in Java language, specially for children's tridimensional (3D) modeling of cities under guidance from their teachers. To speed up the application development an OpenGL Graphic Engine API, developed by Jouvieje and available in its website [11], is being used. It offers many graphic resources compatible with JOGL, LWJGL, and GL4JAVA, and is distributed under a GNU license. The multiplayer resources are developed with the Java's RMI (Remote Method Invocation) command. The game's architecture was conceived under the MVC (Model-View-Controller) project standard, which solves the dependency problems between data and application interface through the separation of the development in data model, business logic, and user interface. Moreover, Città is a multiplayer game and should provide resources to enable real time construction by various authors on the city's elements, in a way that simulates the interaction in an actual physical model of cardboard or clay.

Each group of children can build its tridimensional virtual city in Città, from the topographic mapping through the *Mappa* component, to the layout of rivers and streets and the localization of constructions, as well as color customization through the *Edittore* component. The game still includes the intelligent assistant *Maga Vitta* to offer alerts about ecological events in the city.

Initially the game offers only a plain terrain over which the terrain's topography modeling will be applied. With the Mappa component the student can create hills, mountains and many other sorts of elevations where the city will be built. The user chooses the sector (tile) to alter, and selects its total elevation or one of the four sides to proceed with the inclination. Over the relief generated, the student can create roads and rivers. It is possible to select the kind of path, or to create lakes, rivers, etc. An example of the effect created with the terrain inclination can be seen in Figure 2.

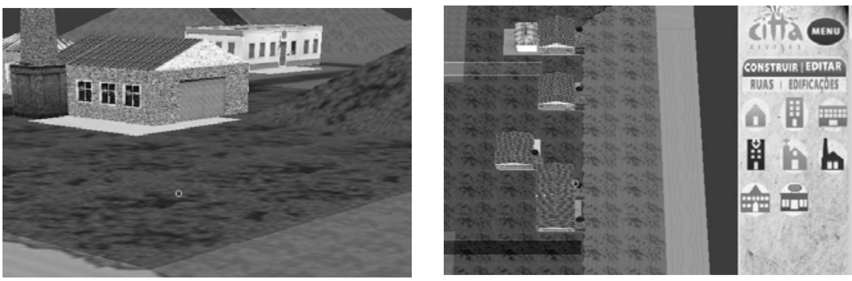

Fig. 2. Images of the pollution effect (dark area in the terrain)

The coherent organization of constructions is the first goal of Città. The users can freely create the structures they judge necessary, and place them over the terrain. The constructions available are house, building, church, city hall, factory, market, school and farm (for the rural zone).

To start creating, all the student needs to do is click on the button *construir* (*build*), then on the button corresponding to the image of the structure desired and place it on the terrain. After being created, each structure occupies a space in tiles, according to its size, and has a set of properties.

Just like in a physical model, the constructions can be painted in different colors. On selecting a structure, the Edittore component allows the possibility of changing its color, as well as write the history related to its creation. These resources can be accessed within the set of properties of each structure. To enable the color customization and maintain the texture, the *multi-texture* technique [12] was used, making it possible to use several textures on the 3D object at the same time.

The Maga Vitta assistant is an intelligent agent designed to be the ecological regulator in Città [13]. During the game, according to the user's actions, some factors such as signs of pollution around certain constructions can occur. For example, around a factory, the terrain will become more polluted over time, as shown in the dark area in Figure 2.

The actions of the Maga Vitta agent develop around four axes: *nature*, *water*, *energy* and *population*. In the *nature* axis, which is still under development, the air, water and land pollution aspects should be evaluated. In the other axes, the evaluation will be on the water contamination, waste and supply, the illumination and use of electric devices, and the monitoring of the population size and its relation to the infra-structure. The agent interacts with the user through alerts, with the intention of promoting discussion about critical situations that can be hazardous to the city population.

6 Conclusions

Ever since its beginning in 2003 the CIVITAS project has been engaging in an increasingly deeper way the teaching-learning processes involved with interactions in the construction of city models – the virtual cities. In this sense the digital collaborative educational game Città is used as a virtual model, and creates a new challenging environment for both educators and students.

Città is based on civilization games, but its goal is to be a environment for simultaneous collaboration among several players. Therefore the city can be constantly built and modified, demanding from the teacher an elaboration of challenges for the students and promotion of the construction of knowledge and mutual managing of the city's priorities as a whole, aiming at its long term survival.

It is also important to mention that Città is an educational game, developed not *for* the teachers but *with* them, and based on their needs and reality. Unlike commercial games Città is not intended to be a product for mass use, but rather a means for innovation of teaching methodologies and pedagogical practices in early elementary grades.

The project is evaluated weekly by the teachers involved, along with the University team, in meetings at the schools. The project results, as a whole, are presented once a year by the teachers participating in the project, in an event of shared evaluation with the University team and guests. This year the children suggested a "kids seminar" to present their experiences to parents and interested public, which shows how they are building their place as student-researchers.

Città is not finished yet; it is still under development, and it may never be completed because it is a game under constant construction and reconstruction. Besides following the natural technological evolution, it will also attend to the needs – in constant growth – of students and teachers in a globalized world.

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ICT Action School Development at Helen Parkhurst Dalton School, Part II

Pieter Hogenbirk and Peter van de Braak

Helen Parkhurst Dalton School, Bongerdstraat 1, 1326 AA Almere, The Netherlands
p.hogenbirk@helenpark.nl, p.vandebraak@helenpark.nl

Abstract. The paper presents the progress of the action plan for improvement of the ICT usage at the Helen Parkhurst Dalton School for secondary education. At the start of the described action period in 2007 the ICT-usage in education was assessed through an review performed by a group of European inspectors. This assessment formed the basis for a continuous development in the school for promoting and improving the usage of ICT. This was done by addressing the observed weaknesses with special measures, and continuing the action plans which were already put in place. For four main points of criticism the following measures were taken.

(1) The coherence in the ICT use was improved by appointing school wide operating coordinators. (2) The use of ICT in teaching was encouraged by offering a variety of teacher training and dedicated workshops. (3) The measurement of gains in learner achievement through ICT use was addressed by a comparative study on the effects of ICT in international learners collaboration. (4) The perspective on new ICT developments in ICT and pedagogy was broadened by purchasing new equipment, as interactive white boards, laptop trolleys and other digital devices and realizing new ICT-laboratories. One year after the inspectorates' assessment new plans arose. The leadership of the school has organized a so called 'Scenario Debate', aimed at addressing the near future of the school. In this debate the view on education has been renewed in relation to the organizational aspects. One of the outcomes of the debate was the awareness of the growing role of ICT. So plans for the near future have been set up. This paper is the second contribution in a row in order to describe action based school development.

Keywords: Integration of ICT, Secondary Education, Quality, Policy, Teacher, Evaluation, Management, Pedagogy.

1 Introduction

In September 2007 an assessment on ICT in education took place at the Helen Parkhurst Dalton School in the Netherlands through an inspectorates' visit, by using the European Framework for the Evaluation of ICT in Education [1][1]. This framework

[1] The original European Framework for the Evaluation of ICT in Education was developed by the contribution of: Guy Ménant, Mireille Golaszewski, Michel Perez, Sven Borg, Peter Ekborg, Ken Dyson, Pádraig Mac Fhlannchadha, Iain Lowson, Wray Bodys, Kenneth Muir, Martin Uunk, Pieter Hogenbirk, Ferry de Rijcke and edited by Bert Jaap van Oel, the Netherlands.

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is developed as part of the P2V-project, the part in which European inspectorates collaborate[2]. The framework has been tested afterwards in several countries: Lithuania, Spain, Scotland, France and Sweden. The results were discussed in a joint meeting in September 2008 leading to a final report on the project [2][3].

After the visit the Helen Parkhurst Dalton School continued its development in using ICT to improve the educational process. In the paper we will describe the actions performed in the school year 2007-2008 and in more detail the organization and results of the debate on the future of the school, carried out in the fall of 2008.

It is the ambition of the authors of this paper to report on a yearly base on the progress made in the school, since September 2007.

2 The Helen Parkhurst Dalton School

In order to understand the developments a short characterization of the school is presented and a summary of the assessment is given.

2.1 Brief Description of the School

Helen Parkhurst (see figure 1) is located in Almere, in Dutch New Land, and is founded only 10 years ago. It is a school for general secondary education for students in the age of 12 up till 18 years. All streams are preparing for intermediate and higher vocational education and university. The school concept is based on the Dalton Educational System. This means that the education is based on three principles: (1) responsibility and accountability, (2) independence and reflection and (3) relationship and collaboration. In daily practice these principles are translated into the following. The objectives for 6 (young students) to 12 weeks (older students) are fixed through so called ‘curriculum lines’ by the teachers in the different subjects. But the order of activities, pace and to some extent the way how to reach the objectives can be

Fig. 1. Artist Impression of Helen Parkhurst Dalton School

[2] The inspectorates work packages of P2V and P2P were developed under the auspices of SICI (www.sici.org.uk) and were coordinated by The Dutch Inspectorate of Education. P2P and P2V are initiatives of European Schoolnet (http://www.europeanschoolnet.org).

[3] The Inspectorates evaluation team consisted of Ferry de Rijcke, Pieter Hogenbirk, Iain Lowson, Alistair Brown, Asta Buineviciute, Sven Borg, Mireille Golaszewski, Joan Escué. The date of the school visit was September 18, 2007.

determined by the students themselves, in close agreement with the teacher. Many activities are based on collaboration with other students. Important are the reflection on the different activities and the results of the learning process in relation to collaborative and planning skills.

In the 10 years of its existence the school's population has grown from 360 up to about 2050 students, divided over five departments: A, C, D, E and Villa Parkhurst, VP. The four departments A, C, D and E are housed in a very modern building; the VP department is housed in a more informal housing. Two departments prepare for access to intermediate vocational education, one department has an emphasis on culture and arts, one department on economics and one department provides extra challenge for students that are well performing in science. There are special facilities for top sport.

Every department has its own head of department, ICT-coordinator, counselors for pupils as well as coaches for teachers and its own team of some 40 teachers and educational assistants. There is one central ICT-coordinator.

2.2 The Assessment by Using the European Framework for the Evaluation of ICT in Education

For the sake of understanding the developments in ICT in school year 2007-2008 in the school the results of the assessment of September 2007 are cited in table 1 [1]. The European framework consists of three main themes: Conditions (C1 to C4), Use (U1 to U3) and Outcomes (O1). There are a number of quality areas within each theme, eight in total. Quality indicators with corresponding evidence pointers are identified within each quality area. The assessment consists of indicators with the values 0 or 1 to 4. Their meaning is:

0.	No evidence available or not relevant.
1. Bad	There is hardly any positive evidence for a particular indicator.
2. Insufficient	There is not enough positive evidence for a particular indicator.
3. Sufficient	There is enough positive evidence for a particular indicator but improvement is possible.
4. Good	Most or all evidence for a particular indicator is positive.

In the written report [2] the main points of criticism were:

- a lack of variety of equipment and resources;
- a limited usage of subject specific ICT-applications and hardly any use in international collaborative projects;
- an informal and not very explicit relationship between pedagogical vision and the implementation of ICT;
- a lack of awareness from the teachers of special ICT resources, specific applications, new pedagogical features for ICT use within their subjects and ICT based assessments and testing;
- the absence of a general coordination on the ICT-curriculum;
- a lack of coherence in the use of the Digital Learning Environment;
- a general lack of coherence between departments in their ICT policy and planning;
- no systematic reflection, review or evaluation on the ICT plans on one hand and on the outcome of ICT use on the other hand.

The assessment procedure and the framework were discussed in a final meeting of European Inspectors in September 2008 in Brussels. The major findings are to be found at the site of the P2V project [3].

Table 1. ICT Assessment September 2007, Indicators for ICT Quality

Leadership	Score
C1.1There is a clear vision for the use of ICT	0|1|2|**3**|4
C1.2 There is a strategy to realize the vision	0|1|2|**3**|4
Infrastructure and access	**Score**
C2.1 The available resources reflect the needs and vision of the school	0|1|2|**3**|4
C2.2 The deployment of ICT resources enables efficient use of them	0|1|2|3|**4**
C2.3 Support systems optimize the use of ICT	0|1|2|3|**4**
Curriculum planning	**Score**
C3.1 Meeting local, regional and national requirements	0|1|2|**3**|4
C3.2 Coherence, balance and consistency	0|1|**2**|3|4
C3.3 New developments in ICT and pedagogy	0|**1**|2|3|4
Quality assurance and improvement	**Score**
C4.1 Review and self-evaluation of ICT policy and practice	0|1|2|**3**|4
C4.2 Action planning and implementation	0|1|2|**3**|4
C4.3 Action monitoring and revision	0|1|**2**|3|4
Pupil use	**Score**
U1.1 Development of ICT skills	0|1|2|3|**4**
U1.2 Enhancement of learning	0|1|2|**3**|4
The teaching process	**Score**
U2.1 Developing pupils' ICT capabilities	0|1|2|**3**|4
U2.2 Use of ICT to enhance teaching	0|1|**2**|3|4
U2.3 Teaching staff competence and confidence	**0**|1|2|3|4
Administrative use	**Score**
U3.1 Identifying issues impacting learning and teaching	0|1|2|**3**|4
U3.2 Communication is supported.	0|1|2|3|**4**
Impact on learning and standards	**Score**
O1.1 Gains in broad learner achievement	0|1|**2**|3|4
O1.2 Effects of ICT use on pupil attainment	**0**|1|2|3|4

3 Developments in School Year 2007-2008

After the assessment Helen Parkhurst Dalton School continued to carry out the special action plans for the running school year. In short the following objectives were realized in school-year 2007-2008:

- More infrastructure available; in September 2008 the following was realised:
  - wireless network
  - laptop trolleys (now 8 with 140 laptops)
  - 395 fixed computers: computer ratio: 1 to 3.8
  - some 220 computers for teachers
  - some 10 interactive whiteboards
- Increase of teacher training by a system of voluntary vouchers;
- Supporting and establishing good ICT-practices by participating in the national Grassroots project;
- Developing a research project on ICT effectiveness in international collaborative projects;
- Newly built studios for music and art with all kinds of digital equipment;
- Further development of the Digital Learning Environment.

The coherence between the departments was addressed by co-ordinated action plans. In the spring of 2008 Helen Parkhurst Dalton School has evaluated itself by means of the so-called 'i-score rating', a new national initiative[4]. This rating system was set up by the Dutch Teachers Union of Informatics & Information Technology in close co-operation with the Dutch inspectorate and on the basis of the framework mentioned. In order to determine the i-score a website has been set up, where participants can fill in a questionnaire. A school then got log in codes for teachers and students, and they are asks to give a reliable image of the ICT situation in their school. On that basis the system assigns a rating of 1 – 5 stars. Helen Parkhurst was considered to 'earn' a 4 star rating. Every year the score has to be updated in order to keep it tenable.

4 Developments in School Year 2008-2009

At the end of the course of 2007-2008 leading teachers and deputies in the school had to develop in collaboration with their specialist colleagues a so called 'year action plan'. This is the rule for the school as a whole, for every single department and also for every school wide theme, such as pupils care, (in service) teacher training, quality assurance and ICT. We will briefly describe the overall core issues to be addressed in the school year 2008-2009 and go into more detail for the plans for ICT.

4.1 Key Issues for School Development

On the basis of several interviews with all personal, with the students parliament and with the council of parents five key issues for development of the education in the school were defined and elaborated on. These were:

- Revitalising the Dalton identity;
- Further development of pupils' coaching and skills development in mentor groups;

[4] An explanation of the i-score is available in Dutch on www.i-score.nl

- Improving the coherence between departments by common working gatherings:
- Further development of personal competences;
- Extending the use of ICT and setting up a system for international projects.

On top of these key elements for school innovation a so called ‘Scenario Debate’ was set up. The school faces some luxury problems. Because of the growth of the number of students the internal division of classes over the departments was not well-balanced any more. But this division over departments was well thought of and based on firm pedagogical starting points. So we could not debate on the organisational structure without discussing the pedagogical values shared among the personal. At the time this paper has to be submitted the ‘Scenario Debate’ has provided a series of proposals for improving the quality of education by changing some organisational aspects, but also rethinking the Dalton values of the school. In that the debate connected the practical issues of the departments to the basic issue of revitalising the Dalton identity. For the sake of describing the developments in ICT it is important that one of the core elements that came out of the ‘Scenario Debate’ was the importance of ICT and the use of it in coaching students and in subject didactics.

4.2 The Running Action Plan for ICT

In the action plan for ICT for the school-year 2008-2009 the following elements are brought up:

- Further and advanced educational use, e.g.
    - web quests for modern languages
    - more assignments on the DLE (Digital learning Environment)
    - experiencing the digital studios:
- Pilots on digital examinations;
- Setting up a web portal for more involvement of parents;
- Use of ICT for learners tracking;
- A next round of vouchers for voluntary teacher training;
- The introduction of netbooks for all teachers.

The current situation (January 1, 2009) is:

- Some subject teachers in some departments have stored their learners assignments in the DLE;
- The foreign language English is taught merely by materials on the DLE;
- Operational plans are written for implementation of
    - a system for learners tracking
    - a programme for cultural activities in lower secondary using the studios
    - the web portal
    - the intranet
- The introduction of netbooks for all teachers, completed with a risk analysis;
- One pilot on digital examinations in Science is started;
- Vouchers for voluntary teacher training are organised and two are organised;
- The council of parents has provides budget for grassroots for improving teaching methods;

- The research project on ICT effectiveness in international collaborative projects has been performed; the results were not very encouraging, because of practical problems in the international collaboration. A new project will start up and try to establish better conditions for better results;
- In the course of 2009 Microsoft will decide if Helen Parkhurst Dalton School will become a so called ‘Innovative School’ in the Partners In Learning Program[5].

4.3 The Emerging Vision on ICT in the Near Future

As a result of the ‘Scenario Debate’ there was a lot of emphasis on ICT and making the use of it profitable to achieve goals which were considered as basic or important. In short the following ambitions were formulated:

- (Parts of) the curriculum are fully organised through ICT;
- An ICT skills development line for students will be available;
- There will be full use of ICT for reflection, portfolios and learners tracking;
- ICT is widely used in examinations and tests;
- Laptops/netbooks for all teachers are in full operational use;
- Full transparency is reached by completion of the web portal and the intranet;
- The intention is made to develop a business model for netbooks for all students

5 Conclusions and Further Work

The assessment of the group of inspectors using the European framework has given the Helen Parkhurst a chance to evaluate the ICT situation, educational and technical. This was at a moment in time where many decisions had to be made and where the course has to be set for the following periods. The current action plans have addressed the findings of the inspectors’ investigation and also reflect the direction of development the school has chosen. The main points of criticism were addressed by concrete measures.

A variety of equipment was purchased; workshops on the educational use of ICT were organized; teachers were stimulated to use ICT in all kinds of ways; the Digital Learning Environment is promoted, however still a bit reluctant; the coherence between departments in their ICT policy and planning is improved; a s systematic reflection, review or evaluation on the ICT plans is in due course.

According to the way the ‘Scenario Debate’ has had its output, the role of ICT is without questioning. Therefore the use of ICT will be extended the coming years and play a major role in revitalizing the Dalton vision.

Looking back at the assessment through the inspectorates’ framework we conclude that the following indicators have improved:

C3.2, the coherence between ICT and development has increased
C3.3, new developments have been investigated and promoted
C4.3, action monitoring is in place by regular assessments

[5] The Partners In Learning Program is sponsored by Microsoft and is aimed at new ways of teaching and learning by the net-generation. The Dutch site is: http://www.microsoft.com/netherlands/onderwijs/pil/default.aspx. There are many other sites to visit.

U2.2, the enhancement of teaching is underway, but needs to be improved
O1.1 and 1.2, some attempts have been made to measure the impact if ICT but this is still a very difficult indicator too meet.

By this action research and by the 'Scenario Debate' which has been organized, we hope to improve education both in quality and learning outcome.

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E-Maturity and School Development: When the Tail Wants to Wag the Dog

Peter Micheuz

University Klagenfurt, Institute for Informatics Systems, 9020 Klagenfurt, Austria
peter.micheuz@uni-klu.ac.at

Abstract. E-maturity as synonym for successful integration of digital technologies in schools can be seen as the golden thread of this paper. It deals with an Austrian case study about recently conducted ICT-certifications within a ministerial e-Learning project. The process of awarding successful Austrian schools with ICT-certificates is founded on an evaluation framework which has been developed independently from other similar European approaches. Finally, it will be argued that understanding the interdependency of successful ICT integration and school development is a key issue to achieve the status of e-maturity.

Keywords: ICT in education, Certification, e-Learning, e-Maturity.

1 Introduction

Very often ICT implementation at school level is still driven by enthusiastic teachers, and the majority of schools can be stated to be on a low maturity level, where ICT is not strategic but something that only innovators take care of. This often results in uncoordinated use of ICT at school where digital technology is not seen as a part of a general strategy. A large-scale study for the Scandinavian countries [1] shows that many schools have developed an ICT strategy, but it was assessed that in many cases the strategies were developed years ago, and that they are not linked with other strategies, nor are they widely known among the stakeholders. Instead, digital technologies need to be integrated into a comprehensive concept of school development which supports the main goals and functions as a catalyst for change.

Probably it is the lack of sustainable guiding strategies for the roll out of the technology that ICT does not raise learning standards and learner's achievement [2]. A more fundamental reason may lie in the inherent malfunction of digital media within the present educational structure which is still based on the industrial paradigm [3].

Before addressing the Austrian case study of successful intervention of implementing digital technologies and e-learning in schools, I want to point out two different perspectives on innovation diffusion as a framework for further analysis.

Two different approaches – digital technologies as a catalyst for reform and that of a lever for reform – can be distinguished.

The catalyst pattern provokes or instigates far-reaching and sustainable change which exceeds initial intentions. No miracles derive from the mere presence of ICT in

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a school; it does not, except in unusual circumstances, act as a catalyst for wide scale improvements. Just "throwing technology into the classroom and hoping for good things" is not a good strategy to get a better teacher in the digital age [4].

However, ICT can be a powerful lever for change. In contrast to the catalyst pattern, the lever pattern implies that ICT is not used as an agent but as a tool. An agent, once introduced, can act beyond its immediate goal. A lever can only be applied to achieve an intended goal [5].

These different models are critical for policy which applies for large-scale national investments in IT infrastructure and in-service trainings as well as for the autonomously school administrations when they plan to invest in digital technologies without objectives for pedagogical improvements.

2 Structuring and Benchmarking ICT Integration in Schools

"Schools have now got unprecedented access to ICT tools to support teaching and learning. However, research indicates that many educational institutions fail to make full use of their ICT facilities, while at the same time ICT still has the potential for a positive impact on the education system" [6]. Despite many - technologically - fairly well-developed schools in Austria, there is evidence that these schools can be in fact considered as e-ready but not as e-mature [7]. Becta, UK, defines institutional e-maturity (sometimes described as 'e-enablement') as the capacity and capability of a college or learning institution to make strategic and effective use of technology to improve educational outcomes [8].

Even with the best (national) education system possible, much activity in schools is determined autonomously by the school itself, its management and its pedagogical staff and by the students. Embedded in a competitive culture in the educational area of some countries, there already exist (independent) approaches to assess whether schools are e-mature.

Based on a self-review framework, schools from the UK can apply for the so called "ICT Mark", a national accreditation scheme which recognizes them for their achievements in reaching a standard of maturity in their use of technology.

The (online) self-review framework is the backbone for schools to benchmark themselves in terms of ICT integration, to draw up action-plans and to review their progress over time.

In order to be awarded the ICT Mark schools need to show that they meet the threshold standards in:

1. Leadership and Management - ICT vision and strategy
2. ICT in the curriculum
3. Learning and Teaching with ICT
4. Assessment of and with ICT
5. Professional Development
6. Extending opportunities for learning
7. Resources - provision, access and management
8. Impact on pupil outcomes

Moreover, beyond recognizing well performing schools in form of this certification, Becta rewards the best schools with the ICT Excellence Award in the categories: best whole school; beyond the classroom; leadership; management and collaboration; learning experience and support for schools.

Another self-assessment tool, the European Framework for the Evaluation of ICT in Education, was developed as part of the P2P-Inspectorates from six countries [9]. Assessing ICT integration in schools from an holistic perspective, this project was undertaken by the P2P-Inspectorates and is available at the website of the European School Net [10].

This framework consists of three main themes: Conditions, Use and Outcomes.

Conditions

C1. Leadership
C2. Infrastructure and access
C3. Curriculum planning
C4. Quality assurance and improvement

Use

U1. Pupil use
U2. Teaching process
U3. Administrative use

Outcomes

O1. Impact on learning and standards

Twenty quality indicators with nearly 100 corresponding evidence pointers are identified within each quality area. This framework can be used in form of a checklist with the marks 1 (poor), 2 (insufficient), 3 (sufficient) and 4 (good) resulting from interviews with school management, teaching staff and students, by observations of lessons and by document review and student products.

A third self-evaluation instrument has been developed in Belgium [11]. This assessment framework draws on the EFQM excellence model which helps organizations, like schools, to determine at which point they find themselves on their way to excellence. Schreurs distinguishes three stages in the evolution of ICT at schools.

The first stands for basic principles in using the computers by teachers, the second for applying the computer as a passive and active medium such as the Internet and using it in various contexts. The third phase encompasses the seamless integration of ICT across the curriculum and learning activities where the focus lies on the learner.

The structure of the framework is divided into 5 sections:

1. The vision for ICT use in school (a strategy to achieve the ICT vision)
2. Secondary processes (school organization and management, ICT co-ordinators)
3. Resources (ICT infrastructure, government regulations, funding programs)
4. Primary processes (curriculum development, Integration of ICT)
5. Desired results (results for the learner, teacher, parents, society and government)

3 The Austrian Project eLSA

One major national Austrian top-down initiative, called eLSA, which is an acronym for "e-Learning in everyday school live" has been launched by the Ministry of Education in 2002. Apparently, within six years eLSA has become a trademark for successful integration of e-Learning for the lower secondary level (pupils are 10-14 years old). Even if there is less financial stimulation as it was at the beginning, the number of schools is still increasing and profiting from the enormous practical knowledge which has been gathered by innovative teachers within several years of classroom experience. By now about 60 out of 330 academic secondary schools take part. Each school involved in the eLSA-project has been financially supported for hardware and in-service training. Simultaneously they had to commit themselves to deliver regularly strategy plans and annual reports, and above all, to aim at the ambitious eight project goals.

1. Each student has to get in touch with e-Learning and has to try out "e-Learning sequences" in lower secondary education.
2. Each teacher has to experience e-Learning sequences in his/her own subjects (in at least one subject) and has to share his/her experience with all members of the teaching teams involved in these subjects and the participating classes.
3. Within their subject area, teachers have to discuss the potential and limits of e-Learning.
4. eLSA schools develop concrete models for evaluating e-Learning. They cooperate and share their experiences with other schools.
5. The school program should explicitly contain (revised) e-Learning aspects.
6. e-Learning must be an important concern of the school administration. The project has high priority in the school routine.
7. A steering group coordinates and harmonizes the "e-Learning" content developments, ensures their practical application and the progress of the project.
8. The school offers its students the possibility to obtain at least one IT or e-Learning certificate (on a voluntary basis).

It is important to enumerate these goals explicitly. They have little to do with clear and easy instructions for implementing ICT. Moreover, the goals 3, 5 and 7 aim directly at the existence of efficient structures of school development. Goal 3 assumes functioning collaboration among teachers, goal 5 needs an elaborated and an executed school program. Goal 7 demands knowledge and experiences in school governance in terms of controlling big projects at schools [12].

4 eLSA and School Development

The inherent nature of organizations can be considered conservative. They are protecting themselves from constant change [13]. At an early stage, Schön recognized the need for a "learning organization". As part of its improvement process, it is necessary that they make a transition from an "I-culture" to a "We-culture." This draws on Fullan's view [14] that "Learning on the job is the sine qua non of improvement."

By examining the theory of diffusion of innovation [15], change in schools can be better understood. Now and in the future, schools are faced with an unprecedented rate of change, forced by the "grown up digital" [4].

There is evidence that especially among teachers we can disproportionally find many who are resistant to personal and professional development. Moreover, it seems that the population of teachers in many schools perfectly confirms Roger's adoption/innovation curve with very few innovators, some early adopters, with a big late majority and a few laggards.

The ironical saying "Schools change slower than churches" from the American school researcher Richard Gross, Stanford, can be considered as the pedagogical analogy of the physical law of inertia.

ICT implementation at a school level should be viewed in the context of school improvement plans and not simply as a technical issue. The highest returns on ICT in education appear to come when ICT is seen as part of a holistic approach within a clearly defined school development strategy. Success of digital technologies in schools depends on appropriate embedding in didactical settings. This cannot be seen independently from an overall discussion of school quality. This holistic view must be taken into account when thinking of using new media for educational purposes.

Digital technologies can be convenient media for continual professional development through collaboration, capture and diffusion of tacit knowledge, and data recording, analysis, and display. Truly, many schools investigated in the OECD study [5] have implemented an IT infrastructure that support these ends; however, only a few report professional development outcomes from such applications.

There will always be a risk in adopting ICT solutions when the tail (ICT) wags the dog (the organization school). ICT is there to serve the needs of education, not the other way round. Successful implementation of ICT greater depends on the personalities of headmasters and teachers, They are the key players of "change" and responsible for (autonomous) school improvement.

Especially this aspect was strongly underestimated when the eLSA project as a driver for innovation processes was launched. In other words, some schools were not prepared well enough [12].

5 Recognizing e-Mature eLSA-Schools

As part of the "FutureLearning" program of the Austrian Ministry for Education [16] eLSA is still an active network driven by a motivated team, although fighting with decreasing budgets. After six years it was time to recognize and distinguish those schools which not only aimed at the goals set by eLSA, but also fairly tried to achieve them. This was the main rationale for developing the eLSA-certificate.

Having visions and defining ambitious goals to achieve is just one side of the coin. Finding descriptors and indicators for a valid and viable certification process, where theory meets practice is the other. Consequently, almost simultaneously and independently from the three already existing approaches in the UK, Belgium, and the P2P project within the European Schoolnet and described above, an Austrian evaluation framework for assessing and recognizing outstanding eLSA schools, has been developed.

By now, the eLSA-certificate is voluntary and the pilot eLSA schools applied for it. The evaluation and certification processes for these schools were conducted by national and regional eLSA-coordinators and then successfully completed in 2008.

So far, in Austria, except for very few vocational schools which are ISO 9001 certified, there is no experience with a certification process of this kind. Moreover, external evaluations have no noteworthy tradition in Austria's educational system, and inspectors are seen rather as managers and advisers than as external auditors.

Each certification and its preceding evaluation process require objectives and indicators. Based on the eight eLSA goals, the current evaluation framework encompasses more than 60 detailed descriptors with corresponding indicators [17].

This table impressively illustrates the hurdles and pitfalls of putting a (theoretical) framework into action and practice, especially when we look closer at the descriptors and indicators and bear in mind how to monitor and validate them. Executing the certification process reveals problems which arise by interpreting and quantifying indicators accurately. In some cases headmasters have been deterred by this framework. After silencing their scruples of failing to meet all requirements for being awarded with the eLSA-certificate, by the end of the year about twenty applied for it.

Questions which arise in the context of this framework may be: Are the terms "e-Learning" and "learning sequences" defined sharply enough? Both terms leave a wide room for interpretation. Does the school record all protocols and formal in-service trainings of the teachers? Do the class registers show adequate information?

Table 1. Exemplary descriptors and indicators for the second eLSA goal: Each teacher has to experience e-learning sequences in his/her own subjects (in at least one subject) and has to share his/her experience with all members of the teaching teams involved in these subjects and the participating classes

Descriptor	Indicator
At least 20% of the teachers are E-Learning experts. They are regularly using ICT in their lessons as an educational principle.	Talks with the teachers about whose activities show exemplarily examples of their work.
60% of the teachers are „watching" E-Learning activities at the school and are using ICT occasionally and know the LMS at school.	Documentation of the work and talk with the teachers.
All teachers severely coped with E-Learning and defined their role in the project.	Talks with the teachers, insight into the results of internal surveys.
The compulsory requirement of the curriculum, to use digital media in the lessons has been taken seriously from all.	Insight into class registers.
In all subjects there are E-Learning-sequences/materials or documentations for using digital media available.	Provision of materials or documentations.
In all subject areas there are experts who inform all the other teachers about innovations and try to get them into the project (playing missionary).	Protocols of meetings and conferences.

The first questions represent a qualitative problem, whereas the other addresses the quantitative issue if school administration has all relevant information about teachers at hand.

Already the very first proposed detailed objective “All pupils have verifiably come into contact with e-learning” brings up the question of interpreting the term e-learning and, moreover, the term “verifiably”. Considering an average school with several hundred pupils at lower secondary education level, validating this indicator is hardly manageable in time and within reasonable costs.

Another detailed objective, for example, affects the teachers’ e-literacy. The proposed indicators are teachers’ certificates, as the ECDL (European Computer Driving License) and attendance at in-service trainings. Normally, not even these data about hard facts are easily available at schools.

Other goals as “There is a pronounced culture of communication in the area of e-learning” and the corresponding indicators “conference protocols and insight into online-communications” represent rather a qualitative than a quantitative challenge and require records of all formal and informal meetings.

Probably this theoretical framework of descriptors will soon be revised by a feedback loop. First experiences showed that some indicators turned out to cause an unwarrantable expenditure in time and costs for the inspectors and an administrative overload for the schools.

6 Certification Procedure and Empirical Findings

The theory of structuring, evaluating and benchmarking (successful) ICT integration in schools is important and has independently resulted in different, although not too divergent European frameworks. They all have to prove themselves by practical feasibility.

Whereas already about one thousand of schools throughout the UK have been rewarded by Becta’s ICT Mark, the eLSA certification in Austria is still in an initial phase.

Recently, in the last month of 2008, the author took part in three certification processes with the following procedural structure:

1. The particular school determines if the goals are reached and applies for the eLSA-certificate at the regional eLSA-coordinator.
2. The regional coordinator conducts a preliminary visit and talks with school administration and fixes a day for the certification.
3. The chronology of the day of certification, where the regional eLSA coordinator in charge brings in an external expert is as follows:
   - Talk with the headmaster, the system administrator and the eLSA-coordinators of the school.
   - Meeting with a representative sample of pupils and students who show e-Learning in context and report about experiences in a computer lab.
   - Meeting with a representative sample of teachers involved.
   - Concluding meeting with the eLSA key players at the particular school, and the announcement of the results of the inspection.
4. Finally, the school gets a report from the regional eLSA-coordinator.

So far, the school audits yielded most valuable, but not necessarily surprising empirical results.

- eLSA-certified schools have already fairly good preconditions in terms of the IT infrastructure and engaged ICT teachers before the eLSA project.
- eLSA-certified schools are led by extraordinary supportive headmasters with (clear) visions and a sense of accountability.
- The IT-infrastructure in eLSA schools is maintained by very engaged system administrators who complain about the lack of a sufficient IT infrastructure and low budgets.
- Cooperation among teachers is still underdeveloped.
- Many teachers use computers in their lessons, but often only to show and distribute digital material.
- The dominating learning platform, with a fairly well usage is Moodle. However, most courses lack interactive and collaborative activities.
- Many special ICT related activities in various subjects could be observed.
- Almost all pupils explicitly expressed their joy with e-Learning. They liked working with computer because “one learns differently”, “it is a nice variety in view of everyday school”, “it is practical because we have less paper”, “you get quick feedback”, “you can choose exercises individually”.

These statements encompass the answer to the frequently asked question about the additional value of ICT integration. Here it is: It is joy, variety, individuality and a learner centered approach. Sometimes effective answers can be simple.

Further impacts of e-Learning with respect to “an improved and efficient learning” could not be recognized. Discussing Becta’s definition of e-maturity, which aims at the improvement of educational outcomes, could be a starting point for another paper. The author is quite aware of the fact that not one single school achieved all - perhaps too idealistic - goals of the eLSA-certificate.

Viewed from a pragmatic perspective, the eLSA coordinators consider the awarding of e-mature schools in this initial phase as an important undertaking. It is a necessary appreciation for innovative schools to make visible school development which has been put into practice.

7 Conclusions

It seems to be common sense that a rapidly changing world needs schools as learning organizations with an adequate use of digital technologies. Actually, the whole arsenal of digital technologies leads us to believe in their inherent potential of improved learning. But the fact is that successful school development (in terms of ICT) does not depend on perfect technology but on imperfect humans, teachers and students included.

As pointed out, digital technologies can exploit their full potential in education, however, only if the underlying mindsets aim at school development. It is simply more effective, when the dog wags the tail.

The interdependence of technology and education tends to be a pedagogical challenge with moving targets, according to the message “What is not measured will not change" [18]. There is hope that the spread of the Austrian eLSA-certificate, which benchmarks the e-maturity of schools against each other, can raise the educational efficacy of digital technologies.

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Toward a Learning/Instruction Process Model for Facilitating the Instructional Design Cycle

Yusuke Hayashi[1], Seiji Isotani[1], Jacqueline Bourdeau[2], and Riichiro Mizoguchi[1]

[1] ISIR, Osaka University, Japan
{hayashi,isotani,miz}@ei.sanken.osaka-u.ac.jp
[2] LICEF Research Center, TÉLUQ-UQAM, Canada
jacqueline.bourdeau@licef.ca

Abstract. Many instructional design models have been proposed and their benefits are evident. However, there is lack of a common and formal notation to describe the product of the design. This causes difficulty in evaluating the product (the course) in the development. To eliminate the difficulty, we need a formal framework which has enough semantics for keeping the consistency of the product. Thus, this work aims at proposing a unified modeling framework for learning and instruction based on ontologies that has the potential to support some phases of instructional design. Furthermore, we give an example of how one-to-one instruction and collaborative learning are modeled on the proposed framework.

Keywords: Ontological engineering, instructional design, collaborative learning.

1 Introduction

A considerable number of instructional design (ID) models have been proposed. The main contribution of them is to provide systematic and reflective *processes* for developing learning/instructional courses. All of these process models share most of the same basic components: analysis, design, development, implementation, and evaluation [17]. Each component has a discipline for an assessment of the course in bringing about learning and a mechanism to improve the course if learning fails to occur as expected. Therefore the final product of ID (learning/instructional process description as a course) can be modified until it reaches the desired quality level [5].

In order to go through the whole ID process, it is necessary to ensure the consistency of the *product* of each phase across the overall process. However, there is (still) no real tradition in education of making formal notations of course designs. Such lack of common and formal notations makes the course development very local which hampers broader sharing between ID phases or stakeholders and impedes a better evaluation of design products [16].

To establish a common and formal notation, development and use of EMLs [20] and scripts [7, 10] have been moderately adopted by the community. Currently EMLs are integrated into IMS learning design (LD) specification as a standard [11] providing a sufficiently flexible framework that can be used to describe formally the design

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of almost any teaching-learning process [16]. Although such approach is much better than free handwriting notations, it neither helps users to keep the consistency/validity of the course throughout the ID process nor allows for the development of intelligent tools that can support users during the design process.

Thus, the final goal of this study is to establish a comprehensive model for describing formally the design of variety forms of learning/instruction[1] (e.g. those summarized in [21]) through ontological engineering approach [3, 4, 18]. Especially, in this paper, we discuss a unification of one-to-one instruction, such as tutoring or individual e-learning course, and collaborative learning, in which learners teach and learn from each other. Although the attention to blended learning has been growing, most of the studies have been made on either type of them. Such a unified model will contribute to expansion of the range of instructional design and to share the design rationale of a course through the overall ID phases. Ontological engineering is expected to provide guidelines to find out the key concepts for such a unified model. In addition, while it cannot be discussed in this paper in detail, such a model is also expected to make contributions to modeling instructional design knowledge, which provides a valid composition of a model.

This paper is organized as follows: In section 2, instructional design processes are summarized and the requirements for comprehensive learning/instructional design process management are discussed together with its overview. In section 3, we describe ontologies we have proposed as the basis for a comprehensive model that support various forms of learning and instruction. The fourth section presents an example of modeling collaborative learning based on the Peer Tutoring theory. Finally, we conclude this paper with future directions of this study.

2 Towards a Comprehensive ID Process Management

This section gives an overview of the main phases of the available ID process models and discusses the requirement for comprehensive learning/instructional design process management. As mentioned in section 1, all ID process models share most of the same basic phases: The ***analysis*** phase involves analyzing a specific educational problem. The product of this phase is the terminal objective of the course. Usually, a list of questions is used to conduct analysis and the results are described narratively or in informal diagrams. In the ***design*** phase, learning/ instructional strategies to achieve the terminal objective are identified. The main product of this phase is a flow of learning/instruction which works as the mold for a particular learning/instruction. In the ***development*** phase, specific learning/ instructional materials used in the execution are assigned to the product of the design phase. In the ***implementation*** phase the course is delivered to learners and learning is conducted by it. The output of this phase is actual data of learning conducted by the course. Finally, in the ***evaluation*** phase, data collected in the implementation phase are compared with the design of the course. The gap between them is the point to be improved in the current course. Based on this result, the ID process returns to any other phase for improvement.

[1] The term “instruction” is used in the wider sense in this paper therefore this means not only what a person does to instruct others but also what one does to support or facilitate learning of others [2]. The term “instructor” is also used in the sense.

Through these phases, a course is produced as the final product that reaches the desired quality level. The problem pointed out here is that most of the products of each process are managed with narrative or simple, non-formal diagrams and tables [22]. Although IMS LD provides a formal framework to describe the products, this is just a format and does not have enough semantics for keeping their consistency or for assessing their validity [1].

This study proposes a framework to model the product (course) to manage the input and the output of each phase in the ID process comprehensively. If the framework has the potential to describe any learning/instruction process from the learning objective of a course to the learning materials employed in the course, the product can be maintained across the ID process consistently.

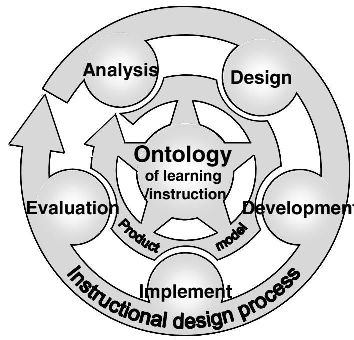


Fig. 1. ID process and ontology

We take the ontological engineering approach to tackle this issue through defining concepts related learning and instruction and organizing them as an ontology based on philosophical considerations. Figure 1 draws a rough sketch of a learning/instructional process model for facilitating the ID cycle based on such an ontology. The center of the figure denotes an ontology that defines concepts for modeling learning and instruction process as the product. The cycle around the ontology is the instructional design process composed of the typical basic phases. The ontology will be a foundation for maintenance of the product throughout the ID process. Currently the focus of this study is mainly on the input and output of the design phase (and a part of the development phase).

3 Ontologies for Modeling Learning and Instruction

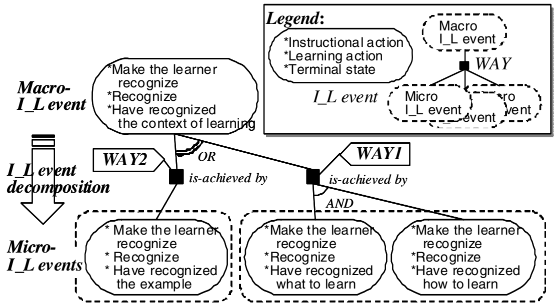
We have proposed two ontologies for modeling learning: OMNIBUS [18, 19] and the Collaborative Learning (CL) ontology [12, 15]. Although the target of the former is one-to-one/more instruction and the latter is collaborative learning, both of them are based on the same working hypothesis and aim at providing a conceptual framework to model learning and instruction as well as structuring learning/instructional theories as guidelines to compose good learning and instructional scenarios. The core idea of these ontologies is that "learning" can be modeled as state change of learners. This is based on our working hypothesis that a sharable "engineering approximation" of the concept "learning" can be found in terms of the changes that are taking place in the state of the learners [8].

This core idea is conceptualized as *I_L event* and shared by the two ontologies. This concept, in which "I_L" stands for the relationship between Instruction and Learning, describes a learner state is achieved by the learner's action affected by the other's action, which can be considered to have any instructional effect. Under the concept of I_L event, the relationships among the actions and the learner's state change are conceptualized as one. This makes it possible to describe the relationships among various learning/instructional actions and state changes.

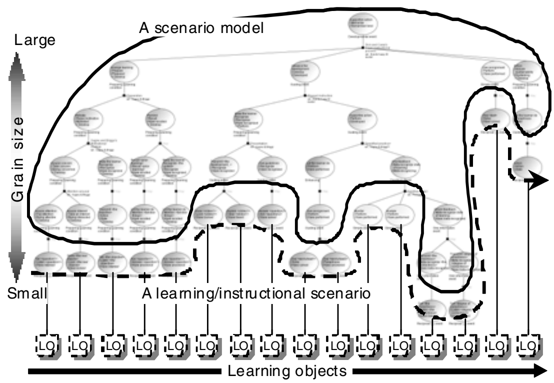
The following sub-sections describe, briefly, how individual learning and collaborative learning is modeled with I_L event in the two ontologies as the basis for a comprehensive modeling framework for the instructional design process.

3.1 OMNIBUS

One of the characteristics of OMNIBUS is to model learning/instructional process at various levels of granularity. At each level of granularity, learning/instruction process is modeled as a sequence of I_L event and the levels are multi-layered. In the layers, each I_L event at the upper level is related to I_L events at the lower one. This relation offers both top-down and bottom-down interpretations; the lower state changes of learner achieve the upper one and the upper action is realized by the lower ones, respectively. In OMNIBUS this is conceptualized as "WAY" In short, I_L events describe *what* to achieve and WAYs describe *how* to achieve it. Fig. 2 (a) shows an example of WAY. In the Fig. 2 (a), the oval nodes represent I_L events, and black squares linking the macro and the micro I_L events represent WAYs. Here, the macro I_L event has two WAYs; WAY1 and WAY2, and there is an "OR" relation between them. This indicates that there are two alternatives to achieve the macro I_L event.



(a) A basic unit of a scenario model



(b) An example of scenario model

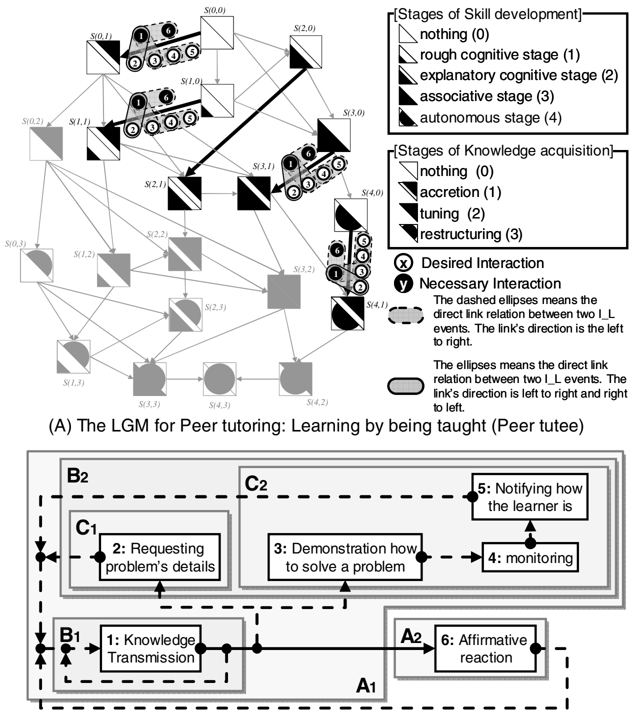
Fig. 2. Scenario modeling based on OMNIBUS

Based on OMNIBUS, a learning/instructional scenario is modeled described as a tree structure of I_L events decomposed by WAYs as shown in Fig. 2 (b). The leaf layer is a description of a learning/instructional scenario executed by instructors and learners, and is linked with LOs used in the execution. The tree structure excepting the leaf level explains the design rationale of the scenario and it works as the specifications of the LOs to be attached.

These concepts of I_L event and WAY also give a conceptual scheme to model strategies from learning/instructional theories. We have extracted 99 strategies from 11 theories and defined them as WAYs in OMNIBUS [9]. Such WAYs based on learning/instructional design knowledge, which includes learning/instructional theories, patterns and best practices, are called "WAY-knowledge" in OMNIBUS. This WAY-knowledge works as the guidelines for designing scenarios and as a justification to demonstrate their validity.

3.2 Collaborative Learning (CL) Ontology

The focal points of the CL ontology are also state changes, which are "learning", of each participant in collaborative learning and interactions between them. These are modeled as Growth Model Improved by Interaction Patterns (GMIP) [15] employing I_L event. Figure 3 shows an example of GMIP. GMIP has two components: one is Learner Growth Model (LGM) [13] and the other is Interaction pattern (IP) [14]. As shown in Figure 3(a), LGM represents, in a simplified way, possible transitions of states in the learner's knowledge acquisition process and skill development process as links in the graph. IP represents the flow of interaction between learners as shown in Figure 3(b), in which a node denotes an interaction modeled as I_L event. Through the connection of LGM and IP in GMIP each transition between states is connected with interactions between participants.



(A) The LGM for Peer tutoring: Learning by being taught (Peer tutee)

(B) The Interaction pattern for Peer tutoring

Fig. 3. Growth Model Improved by Interaction Patterns (GMIP)

In collaborative learning, each participant is a learner with his/her own learning objective and sometimes his/her action helps or facilitates learning of others, which is referred to as instructional action in the conceptualization of I_L event. For example, in the theory of "Peer tutoring" [6], two types of role are defined: *PeerTutor-role* and *PeerTutee-role*. Participants assigned to a *PeerTutee-role* (PeerTutees) learn through being taught by the others assigned to a *PeerTutee-role* (PeerTutors). And the PeerTutors also learn through teaching the PeerTutees. The important point here is that from the point of view of CL the PeerTutor does not act as a real instructor, who only teaches, because he/she is also a learner through learning by teaching. Such a dual-nature of a participant can be modeled by I_L events. Focusing on learning in *PeerTutee-role*, when a PeerTutee learns, a PeerTutor support the PeerTutee by teaching. On the other hand, focusing on learning in *PeerTutor-role*, when a PeerTutor learns, a PeerTutee support the learning by being taught. These are described in two different I_L events. Thus, in an I_L event, the PeerTutor teaches the PeerTutee, and, in another I_L event, he/she learns through teaching the PeerTutee.

GMIP defines one IP and one or more LGMs corresponding to each role. Thus, although Fig. 3 has only one LGM for PeerTutee-role, actually there is another LGM for PeerTutor-role. GMIP helps to explicitly show how learners in the group should interact with each other and the benefits for learners playing different roles. Thus, it becomes a powerful tool in helping designers to select appropriate interactions and roles to achieve desired learning goals.

4 An Integrated Model of Learning and Instruction

Based on the ontologies described in the previous section, we aim at modeling various forms of learning/instruction (e.g. those summarized in [21]), which is the product of the ID process. As discussed previously, employing I_L event as the basis, GMIP allows to model roles of participants in collaborative learning and interaction among them to achieve the learning goals. Thus, each interaction between two roles/participants is modeled as I_L events, defining which participant learns or supports the learning in a given interaction.

Although GMIP currently aims at describing CL, it can be used to model other forms of learning. Consider the case shown in Fig. 4 where three roles are defined. PeerTutor ($Role_1$) teaches PeerTutee ($Role_2$) and, from the behavior of PeerTutor, Observer ($Role_3$) learns how to teach others. As stated above, the basic unit of GMIP is a set of LGMs and an Interaction pattern. In the $interaction_{12}$ each of PeerTutor and PeerTutee has its role's learning goal described as LGM_1 and LGM_2, respectively. On the other hand, in the $interaction^{13}$, only Observer has the learning goal because PeerTutor is just observed and does not always need to be conscious of the Observer. The interaction pattern is an aggregation of the interactions between these roles. The I_L event decomposition tree ($DT_{1\sim3}$ in Fig. 4) discussed in Section 3.1 fulfills a role to explain how each of the goals relates to the interaction pattern. In addition, an interaction pattern and some LGMs connected with the I_L event decomposition trees work as a generic model for learning and instruction. Even if the number of roles and interactions are increased, it can be modeled with additional LGMs and decomposition trees. On the other hand, in the case of one-to-one instruction, only an LGM and a decomposition tree are related with the interaction pattern because the learning goal of the instructor can be ignored, as in the example of the interaction between PeerTutor and Observer in Fig. 4.

Using this idea, we will show how to model CL as a formal product of the ID process with our proposed modeling framework through an example based on the theory

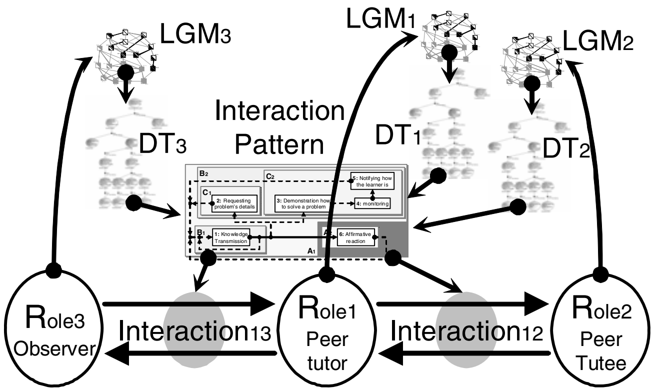


Fig. 4. An overview of the integrated model

"Peer tutoring" [6]. Figure 5 shows an example of collaborative learning model based on Peer tutoring. As mentioned above, in Peer tutoring, learners play two types of collaboration roles: the *peer tutor* role and the *peer tutee* role. The learning objective for each role can be described in the LGMs shown in Fig 5 (x). Although there are some active paths in the LGMs (emphasized arrows in Fig. 5 ($x_{1,2}$)), the essence is that the objective of peer tutor is *Tuning* and the one of peer tutee is *Accretion* as shown in Fig 5 (x').

These objectives are achieved by the activities of participants assigned to the roles, which are informing the topic to the peer tutee by the peer tutor, practice by the peer tutee, and guiding the practice by the peer tutor. These activities are defined as an interaction pattern shown as Fig. 5 (z), which is the one redrawn from Fig. 3 (b) in order to establish it to the I_L event decomposition trees (Fig. 5 (y)). The I_L event decomposition tree supplies □□links between the objective and the interaction pattern, and explains the design rationale of the link.

I_L event decomposition trees are constructed along the decomposition of learning objectives. Here the root of each decomposition tree is set as the objective defined by the LGM. This state (change) is decomposed into smaller-grain-sized ones with learning and instructional actions. Fig. 5 (y) illustrates a path of decomposition to a leaf I_L event in each I_L event decomposition tree. Each I_L event is decomposed into some I_L events or embodied in a much more concrete I_L event until the objectives are achieved by actions. The interaction pattern is the same as the sequence of the leaves of decomposition, which is interaction between the participants as a cycle of activities shown in Fig. 5 (z). A cluster of the components in the interaction pattern corresponds to intermediate I_L event in the tree. For example, A_1 in Fig 5 (z) corresponds to both of A_1 in Fig 5 (y), and each of them are decomposed into B_1 and B_2 in Fig 5 (y) because A_1 is composed of B_1 and B_2 in Fig 5 (z').

As discussed in this section, through the line from LGM to Interaction pattern through I_L event decomposition tree, the design rationale of collaborative learning scenario can be revealed and maintained across the phases of instructional design. In addition, I_L event decomposition tree is helpful to assess the consistency between the learning objectives and the interactions. For example, there are other ways to achieve making the peer tutee meta-recognize his/her own understanding (Fig. 5 (y_2)-B_2) than informing the peer tutee's performance (Fig. 5 (y_2)-5). An example is that the peer tutor demonstrates how the tutee solved the problem. In this case, although it is more difficult for the peer tutee to achieve, he/she can be trained in monitoring his/her own performance additionally. However, if the way is adopted, a problem occurs in

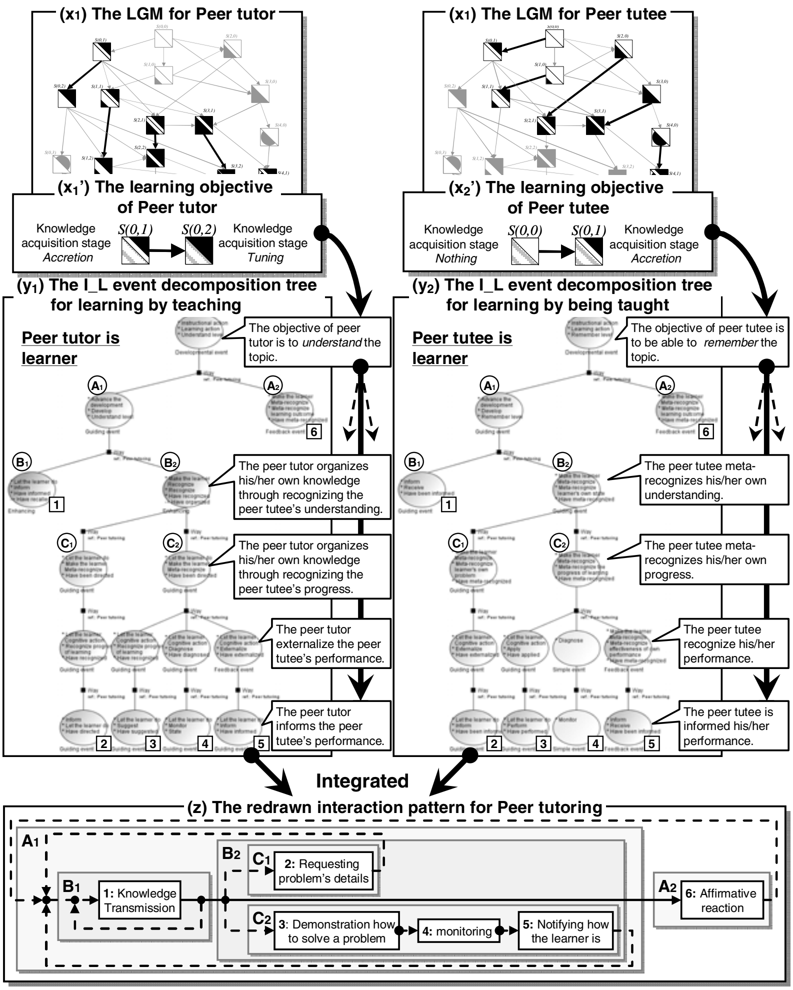


Fig. 5. An example of the integrated model

learning of peer tutor. In this scenario the peer tutor learns through diagnosing the peer tutee's performance and informing the result. The peer tutor cannot learn by just demonstrating again. Like this, in our proposed modeling framework, such inconsistency between collaboration roles can be identified easier than other modeling such as IMS LD.

If learning of PeerTutor is not intended in a learning session, this model can be considered to be the same as one-to-one instruction, in which PeerTutee learns through being taught by PeerTutor, neglecting GMIP and I_L event decomposition tree of PeerTutor. A set of a GMIP, an I_L event decomposition tree and an Interaction pattern is a basic unit for describing a learning session. Depending on the form of learning and on the number of roles that have intended learning objectives in the learning session, the composition of the integrated model of the session is decided.

In conclusion, the presented framework allows for formally describing the product of the ID process for different forms of learning and, therefore, it helps to ensure the consistency of the *product* across the overall ID process and to manage the input/output of each phase of the ID process comprehensively.

5 Conclusion

The ID process is a complex task composed of many phases (analysis, design, development, implementation, and evaluation). To keep the consistency and the validity of the product (the course) in each phase, it is necessary to have a formal and semantically rich framework that allows for a better model of the product. Therefore, this paper discussed previous achievements on modeling individual and collaborative learning/instruction using ontologies, and how the accumulation of these past results together with a shared key concept to represent "learning" (I_L event) allow for the development of a framework that can describe formally learning and instructional scenarios. Such a description facilitates the sharing of the product of each ID phase and enables the systematic design of the course. To show the potential use of our framework, section 4 presented an example that covers the design phase of the ID process showing the creation of collaborative learning activities based on the Peer Tutoring theory. Due to space limitation, we could neither discuss the usability of our model in other ID phases nor present more details about the framework. However its potential benefits to support the ID process has been demonstrated.

The future direction of this study will expand the proposed modeling framework to tackle many other difficulties found in other phases of the ID process. For example, the analysis and development phases need much more detailed attributes in the context of learning and the implementation and evaluation phases require a mechanism for data collection and comparison of it to the design of course.

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The Making of an Online Masters Program in the North American Context

Ana-Paula Correia, Connie Hargrave, Patricia Leigh, Clyciane Michelini, Dale Niederhauser, Denise Schmidt, and Ann Thompson

N131 Lagomarcino Hall, Ames, Iowa 50011-3192, USA
{acorreia,cph,pleigh,clyciane,dsn,dschmidt,eat}@iastate.edu

Abstract. The department of Curriculum and Instruction at Iowa State University, USA offers a leading residential program of information communication technology (ICT) in teacher education. Based on the success of this program, in 2003, faculty members and instructional developers at Iowa State University Center for Technology in Learning and Teaching (http://www.ctlt.iastate.edu) created an online masters program in "Curriculum and Instructional Technology." This graduate degree program was designed for teachers of kindergarten to 12th grade (K-12) who were widely spread across the large mainly rural state of Iowa. This graduate program is described in this presentation as a distance education exemplary case in the context of North America. This program uses a cohort approach to graduate education and employs innovative technologies for its design and delivery. Program features, requirements, timeline, courses and outcomes are discussed.

Keywords: Teacher education, learning management system, blended learning.

1 Distance Education in U.S. Higher Education

Public universities in the United States need to rely on their strengths as they develop distance education programs. Reputation, recognized programs and experienced faculty members are some of the market advantage factors for public universities. However, there also have been a few failed attempts in creating distance education programs. As Foster and Carnevale explain [1],

> *"A few years ago, universities were dumping their online spinoffs like rotten fish. Temple University and New York University shut theirs in 2001. Two years later, Columbia University closed down Fathom, its once-vaunted online venture. The spinoffs were never able to attract enough students to justify the millions of dollars invested in them."*

In an effort to create and sustain successful distance education programs in the future, public universities have to: (a) leverage strong and well-established programs, (b) train/use university professors to teach online, (c) focus upon full-time working students, and (d) recognize the need to develop high quality programs. The Iowa State

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University Online Masters of Education in Curriculum and Instructional Technology is described in this paper as a distance education exemplary case in the context of North America. This program uses a cohort approach to graduate education and employs innovative technologies for its design and delivery.

2 The Iowa State University Online Masters of Education in Curriculum and Instructional Technology

The department of Curriculum and Instruction at Iowa State University offers a leading residential program of information communication technology (ICT) in teacher education [2]. Based on the success of this program, in 2003 faculty members and instructional developers of Iowa State University Center for Technology in Learning and Teaching (http://www.ctlt.iastate.edu) created an online graduate program in "Curriculum and Instructional Technology". This graduate degree program was designed to meet the needs of K-12 teachers who were widely spread across the large mainly rural state of Iowa. This state located in the heart of the United States has a rural population of 1,337,000 out of a total of 2,982,000. With a size of 56,275 square miles, Iowa's economy relies on agriculture and farming activities especially corn, soybeans and hogs [3].

The Online Masters of Education in Curriculum and Instructional Technology (http://ctlt.iastate.edu/~citmed/) is a three-year program that consists of 32 credits and is offered in a learning community environment, supported by the learning management system WebCT. The program is organized around cohort groups. Each cohort group is created every two years, all students in one cohort take classes together, they form personal and professional relationships, and the size of the classes are limited to 15 to 20 students. Each course was planned to have between one to three meetings on campus to develop a strong cohort who would support one another to continue their degree to its completion. This graduate program started in August 2004 with an initial cohort of eight students. A second cohort of 14 students followed in 2006, and a third cohort of 17 students started in June 2008.

2.1 Admission Requirements

To ensure a high quality in the graduate program, the admission process is competitive and limited to the most qualified students. When applying to this graduate program, three types of information weigh heavily in the selection decision: academic performance (evaluated through undergraduate and graduate transcripts), letters of recommendation, and personal narratives/statements of intent. The latter lists the candidate's goal(s) and/or purpose for pursuing an advanced degree, reasons for selecting Iowa State University, professional background, special areas of interest in the field of education and long-term professional goals. The statement serves as an important indicator of the candidate ability to communicate effectively in writing.

2.2 Features of the Program

With a commitment to ensure that the online program is as strong (or stronger) as the traditional Masters program, the online courses are taught by full-time faculty in Curriculum and Instructional Technology. Having the full-time faculty teach the courses reinforces our strong commitment to quality. Furthermore, it affords the faculty the opportunity to know their students, both interpersonally and intellectually, in greater depth. This is essential for monitoring student growth and progress.

To create a supportive and collegial learning environment, students entering the program the same semester are grouped into cohorts. Cohorts have been used effectively in a wide variety of educational settings to foster learning [4]; cohorts are especially important for online students to quickly acclimate to being physically distant from their peers and instructors. Cohort grouping helps to develop and maintain group dynamics across individual classes throughout the program. But to prevent the phenomenon of “group think”, where everyone is so familiar with each other that new ideas and approaches are rarely introduced, explored, and accepted, 20-30% of students not in the cohort enroll in courses with the cohort students. That is to say, students who may be in the traditional face-to-face program or in other degree areas often enroll in courses with the online cohort students. This helps to keep new ideas and fresh perspectives flowing among the group.

The online Masters of Education program in Curriculum and Instructional Technology uses a blended instructional approach where 85% of the instruction is online and 15% is face to face. Generally, online Masters students enroll in one course per semester (completing the degree in 3 years.) Each course begins with a face-to face meeting (some courses have an additional face-to-face meeting during the semester). When feasible, students travel to the university. Those who cannot travel, participate via internet conferencing (e.g. Skype). The face-to-face meeting allows for students and instructors to see each other and get to know one another in a non-mediated forum. In these initial meetings participants review course expectations, receive essential instruction (best provided face-to-face) and observe and use the classroom and technology laboratory facilities of the Iowa State University Center for Technology in Learning and Teaching. We believe that the face-to-face meetings assist students and instructors in better knowing who they are working with online. Furthermore, meeting on campus, affirms for the online students the level of technology capacity, expertise, and commitment of the university.

Strong technical support for students at a distance is essential to the success of an online graduate program. In our program, technical support is provided by the instructional developer, who assists students in resolving technical problems, assists faculty in the design of online course materials, and serves as a communication liaison between faculty and students. Centralizing technical support for both students and instructors, decreases miscommunication and heightens program fluency.

The online Masters of Education in Curriculum and Instructional Technology is practitioner-focused in that its aim is to prepare students to couple contemporary pedagogical thinking and cutting-edge technologies for use in K-12 learning environments. Because students and instructors are physically apart, innovative and nonconventional learning experiences are used.

2.3 Timeline

Program timeline is detailed on Table 1.

Table 1. Program timeline

Year	Summer	Fall	Spring
1	Instructional Technology Seminar (1credit) Foundations of Instructional Technology (3credits)	Introduction to Using Technology in Learning and Teaching (3credits)	C I 507 - Principles and Practices of Distance Education (3credits)
2	Contemporary Curriculum Theory and Principles (3credits)	Theories of Designing Effective Learning and Teaching Environments (3credits)	C I 515 - Action Research in Education (3credits)
3	Technology Diffusion, Leadership and Change (3credits)	History of American Education (3credits)	C I 599B - Research Development Project (4credits)
Additional course work (3 credits) can be taken any time, preferably after the first year.			
Total Credits: 32			

3 Courses Offered

Curriculum and Instructional Technology full-time faculty members teach the courses offered in the program. In these courses, students examine emerging technology tools and their potential contributions to the learning environments in which the students teach. Course work emphasizes the integration of technologies into the teaching and learning process, and provides an exploratory focus where students develop and test learning experiences that incorporate cutting-edge technologies such as blogging, podcasting, digital storytelling, and social networking applications. A brief discussion of most of the courses is offered below.

3.1 Introduction to Using Technology in Learning and Teaching

The purpose of this course is to help students with both the why and the how of using technology in classrooms. The course content is firmly rooted in learning theory, and *How People Learn,* edited by John Bransford and his colleagues [5], is one of the textbooks for the class. One of the major themes of the course is applying contemporary principles of human learning to creating classroom technology applications.

A second and related major theme of the course is the exploration of Web 2.0 applications in the classroom. Will Richardson's book, *Blogs, Wikis and Podcasts* [6] is a second text used in the course.

The course is carefully structured with a weekly schedule of readings, assignments, and resources on the course learning system management, WebCT. Each week, Dr. Thompson records a short video that summarizes the topics and assignments for that week. Students begin each week watching the video and have an opportunity to define and address any questions they have about the week's activities at that time.

A variety of approaches to encouraging student/instructor interactions is used in the course. Additionally, Dr. Thompson maintains a blog (http://ci505fall2008.blogspot.com/) and encourages student comments on the blog. Dr. Thompson also has weekly online office hours so that students have an opportunity to interact synchronously. In addition, there are structured course discussions each week and both the students and instructor make extensive use of email messages. Student discussions are active throughout this class. The average student posted more than three messages each week and was online 1.2 times each day. In discussions, students relate course material to their professional lives and provide a rich set of examples and experiences.

Students complete weekly assignments that involve designing classroom lessons using various types of technology. As a final project for the course, students write a journal article that describes a technology application in their subject/grade area and prepare to submit this article to a journal for teachers/practitioners.

3.2 Contemporary Curriculum Theory and Principles

The online version of *Contemporary Curriculum Theory and Principles* was modeled after the on-campus course, which is required in the Curriculum & Instruction Ph.D. core and an option in the required core of all Curriculum & Instruction masters degrees. This course comes relatively early in the sequence for cohort students and serves in providing a theoretical base for the critical examination of U.S. educational systems and policies that impact the curricula and pedagogies prevalent in public schooling. As such, the course requires the use of critical theory as the analytical tool for this exploration and examination of K-12 schooling. In order to facilitate the learning and in-depth understanding of the views, perspectives, and writings of critical theorists, which many beginning and advanced students find challenging, this online version of the course employs extensive use of discussion groups and student discussion leadership. In addition, using PowerPoint with audio tracks, the course instructor, Dr. Leigh provides direct instruction through mini-lectures (5-10 minutes) on important and complex terms and constructs.

Reflective paper assignments require that students choose salient ideas, views, and perspectives found in all of the weekly readings for their written analysis. In these papers, students react and respond to the main ideas chosen for analysis, connect their written discussion to previous readings and online-discussions, and, when possible, connect the reading material to their personal experiences. For the final exam/project, students can choose to respond to a ‘take-home’ paper exam or design and complete a final paper or project that reflects their learning. Dr. Leigh believes that these pedagogical approaches, which are also reflected in her traditional on-campus graduate courses, have proven effective in the on-line environment.

3.3 Theories of Designing Effective Learning and Teaching Environments

Dr. Correia’s teaching philosophy and approach to the course emphasized two core types of activities – (a): working in real-world situations. People learn better when they are actively engaged in learning tasks that are directly related to their needs and interests. Most of the learning in this course occurred within the context of projects and situations similar to those that students were experiencing or would be likely to encounter in real-world contexts. And (b): working as a team member. In addition to introducing models and theories of instructional design, this course provided students with concepts, tools, and techniques to help them to work productively as a member of a design team. The course required that students be active members of their design teams as well as of the e-learning community formed by all of the participants in the course.

As the course instructor, Dr. Correia also wanted to work in partnership with her students. By constantly eliciting student input on course activities as they develop, instructors can tailor activities so that they truly meet learner expectations and inspire learner interest. One way to encourage students to work with real projects was to strongly support making their course project relevant to their current professional activity. This way they would feel that they were accomplishing more than a mere class project. Working in virtual teams is a growing demand in today's workplace and this course offered plenty of opportunities to practice that skill. Since most of the students were full-time professionals, they related to that need and embraced the opportunity.

The main learning activity for the course required students to work in a design team to develop an instructional experience that taught a specific topic to a particular audience [7]. Teams were encouraged to create an experience that either addressed a social need or connected in some way to their community, preferably targeting an underprivileged or underrepresented audience. In addition to the topic to be taught, teams were responsible for identifying the target audience (the learners) and a real-world context (the situation in which the learning would occur).

The skills necessary to carry out such a project included not only knowledge of instructional design models, processes, and techniques, but also competence in applying this knowledge to novel situations and the ability to work as part of a virtual design team. Students had to manage their projects to meet aggressive deadlines while figuring out the best ways to manage their teams, which mainly operated at a distance.

3.4 Action Research in Education

Action Research in Education examines the design of classroom-based educational research for practicing teachers. Action research is a specific process for problem solving, verification, and discovery. The course provides students with the knowledge and skills to use action research as a teaching and problem solving methodology in the classroom. Methods of conducting and communicating action research are introduced by Dr. Schmidt and used with the goal of improving teaching and learning. The course main objectives are: (a) investigate and improve teaching practice, (b) conduct research so effective decisions about (one's own) teaching will be made, (c) combine current research and theory on related areas to come to new and valid conclusions, (d) plan an action research project; gather data to analyze and make conclusions, and (e) identify types of data collection and analysis methods common to action research.

Textbooks used in class are Mills' book on *Action research: A guide for the teacher researcher* [8] and Sagor's book *Guiding school improvement with action research* [9]. Students are involved in a main project - "Practice" Action Research Project–which consists on conducting and using a literature review and knowledge gained in class to design an action research project. This project is an abbreviated task so that students can complete the necessary steps during a 14-week semester.

In a research context, students collect data, analyze the data and report the results. Along with a written report, students prepare a brief presentation to share with course members.

3.5 Technology Diffusion, Leadership and Change

The purpose of the *Technology Diffusion, Leadership and Change* course is to explore ways that information age technologies (broadly defined to include computers and related devices, as well as the Internet and other web-based tools and applications) have been integrated into schooling contexts. Dr. Niederhauser begins by exploring Everett Rogers' general model [10] that addresses how innovations are diffused and adopted. Rogers' work provides insights into ways that innovative ideas, practices, and tools are adopted (or not adopted) by a group or culture. Rogers stresses the role that individuals within the group, and outsiders who are promoting the innovation, can play in influencing group members to more readily adopt the innovation.

We then focus our attention more directly on how educational change occurs. Michael Fullan's *New Meaning of Educational Change* [11] provides insights into the unique issues associated with educational change and provides a model for promoting change as a social process. Finally, we will look at an example of how a particular innovation (use of computers) diffused into educational settings. Larry Cuban published *Oversold and Underused: Computers in the Classroom* [12] eight years ago and his lessons are still relevant.

Studying these three informative perspectives helps students better understand how technology integration is occurring in their personal contexts, and helps them consider ways to provide leadership to help make the integration process more efficient and effective.

4 What Do Students Say?

A very strong and significant learning community is formed as students go through the program. The faculty-student as well as student-student interactions are well established and seem to form lasting personal and professional relationships. One of the students who started the program in June 2008 wrote in Dr. Thompson's class blog: "I have found this to be much more engaging and meaningful than meeting in person in most of my undergrad courses. I really like being able to participate in a discussion, but having the time to really think through things before 'opening' my mouth, so to speak. Also, there is almost more accountability with a course likes this than with a traditional course." Another student from the same group posted: "I too like the format of this course. I am taking another 'distance education' course in economics and there aren't any discussions and about the only interactions with the professor is when she gives small housekeeping updates for the course. I really like the format of our courses, MUCH easier."

Students also commented on the amount of learning that takes place during the courses. The extensive research based on reading is directly connected with the technology-based activities that students explore and can be immediately applied to their own classrooms. A student from the 2006 cohort group wrote in her course evaluation: "I was surprised to find that I am learning a lot more in distance education classes than I would likely be learning in traditional courses, I am proud of the work that I am doing and feel I will be ready for new career challenge when I earn my degree." The opportunity to apply the skills as students go through the program is also acknowledged by another 2008 cohort student: "Like I said at office hours last night, there are all sorts of things I have been able to use from this course already. I thank you [the instructor] and the group for really motivating me to think outside the box a bit, and use technologies that I, personally, have been using for quite a while."

Finally, students appreciate the flexible schedule and the quality of degree they are earning. A quote from a student from 2004 cohort exemplifies that: "I have enjoyed my experiences with the cohort through Iowa State immensely. I am confident that I am earning a degree that will enhance my abilities as an educator, and that I have a great deal of respect for. This program and the flexibility of its scheduling is the only way I could have gone back to school, and I am grateful for the wonderful experiences if has afforded me."

5 Conclusions

The Online Masters of Education in Curriculum and Instructional Technology, described in this paper, resulted from making a high-quality, pedagogically sound, traditional on-campus program accessible online and to students at a distance. The theoretical underpinnings and pedagogical strategies and methods survived the transitions from face-to-face classrooms to Web-based learning environments and the use of other ICT tools. Members of the teaching faculty espouse various educational philosophies and learning theories that support student-centered approaches and are, thus, able to maintain high levels of student engagement. Student engagement and interaction was also supported by the supportive and active learning community formed with each cohort group. Students and faculty both report that such engagement contributed to student retention and success as well as instructors' growth as educators.

The overall successes of educational programs are often measured by student retention and graduation rates. This online masters program had a 88% persistence and graduation rate for its first cohort of students beginning in 2004, with 7 of the 8 students remaining in the program until the completion of all coursework and successfully graduating with a Masters of Education degree. The second cohort of students, who began in 2006, had a 92% persistence and graduation rate with 12 of the 13 students completing all coursework and graduating this past Spring 2009 semester. Based upon these statistics and the testimonies of both faculty and students, we view this online program as successful and we aim to continue this tradition with the upcoming student-cohorts.

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Part III

Informatics

CV-Muzar Using a Multiagent System for Group Formation

Ana Carolina Bertoletti De Marchi[1], Márcia Cristina Moraes[2], and Cristiane Durigon Testa[1]

[1] Universidade de Passo Fundo, Curso de Ciência da Computação. BR 285, Bairro São José, Passo Fundo, Brasil
[2] Pontifícia Universidade Católica do Rio Grande do Sul, Instituto de Informática. Av. Ipiranga, 6681 – prédio 50, Porto Alegre, Brazil
carolina@upf.br, mmoraes@inf.pucrs.br, cristiane_dt@yahoo.com.br

Abstract. The purpose of this paper is to present two agents' societies responsible for group formation (sub-communities) in CV-Muzar (Augusto Ruschi Zoobotanical Museum Virtual Community of the University of Passo Fundo). The first is a static society that intends to investigate the groups in the CV-Muzar. The second is a dynamical society that will analyze the existing groups and look for participants that have common subjects in order to constitute a sub-community. The formation of sub-communities is a new module within the CV-Muzar that intends to bring the participants together according to two scopes: similarity of interests and knowledge complementarities.

Keywords: Virtual learning communities, multi-agent systems, informal learning.

1 Introduction

Over the last years, we were able to notice people's increasing interest in making use of the available resources on the Internet to improve their knowledge and interact with others. The virtual learning communities have proved to be favorable environments for this practice, because their participants are related to the construction of knowledge common goals. According to Pallof and Pratt [1] the virtual learning communities are dynamical components that emerge when a group of people shares certain practices, they are interdependent, make joint decisions, identify themselves with something larger than the total sum of their individual relationships and establish a long term commitment with the well being of all participants.

Group formation inside virtual learning communities is interesting, because group learning aims to develop and to improve individual skills for the use of knowledge, to accept responsibilities for the individual and the group learning process; to develop the abilities of reflecting about its own suppositions expressing its ideas to the group and to develop social and group abilities.

This paper presents information about the formation of groups within the CV-Muzar (Augusto Ruschi Zoobotanical Museum Virtual Community of the University

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of Passo Fundo). The groups are called sub-communities and are formed from two concepts: interest similarity and knowledge complementarities.

Two agents' societies were used in order to automate the sub-communities construction. The first society is static, and intends to investigate descriptive information about groups in the CV-Muzar. The second society is a dynamical society that will analyze the existing groups and look for participants that have common subjects in order to constitute a sub-community.

The static society is based on search algorithms to collect information for the establishment of sub-communities. Such information includes the group profile, concentration area of content of the possible participants as well as their interest area.

The dynamical society is based on the Dependence-Based Coalition Model, established on the Social Reasoning Mechanism and Contractual Network, based on Sichman's Economic Market Theory [2].

The paper is organized in five sections. Following this introduction, the second section discusses concepts of virtual learning communities, especially the CV-Muzar. The third section presents the group formation proposal for CV-Muzar. The fourth section describes some initial tests and the fifth section describes some final considerations and future works.

2 Virtual Learning Communities and CV-Muzar

The virtual learning communities have proved, recently, to be complex environments, which require a development and proper tools to fulfill their needs.

These environments are characterized as informal learning environments as the CV-Muzar, where the online communication is the main form of knowledge exchange through the use of synchronous or non-synchronous tools. In CV-Muzar the informal learning is stimulated by the use of learning objects repositories, the use of communication tools and the production of learning objects by the visitors.

The CV-Muzar (*http://inf.upf.br/comunidade*) was developed with the main purpose of involving more the museum visitors, making them part of the experience, putting an end to the passive receiver of the expositive speech that was established unilaterally [3]. Besides that the museum aims to amplify the communication channels, offering the public access to a vast amount of information produced and kept by their staff.

For the environment development we made use of the concept of virtual communities to promote the exchanges among the visitors and the Learning Objects (LOs). The LOs favor the museum communicative expansion, once they enable the creation of simple and small didactic materials, which can easily be used outside the museum environment.

The environment has a vast collection of materials built over nearly three years of use. The available information is organized into learning objects (LOs) that comprise materials developed for the displays, materials kept in the museum and users' productions. Due to these productions, the environment is in ongoing update and growth.

To build the basic elements of the environment, we assume that the essence of a museum is informal learning. Our goal is to provide an environment that favors lifelong learning in a casual and spontaneous way, without the existence of a strict and curricular structure. The objective is to create stronger bonds among the participants, bringing them near.

In order to provide CV-Muzar participants with the possibility of deepening discussions related to specific subjects, this paper presents the module of sub-communities formation, which allows any participant to create a new group to deal with specific subjects.

To create the sub-communities the multiagent systems technology was used, through the creation and development of two societies: one static and the other dynamic. In the next section function of these societies will be explained in detail.

3 Sub-communities Formations Assisted by Multiagent Systems (MAS)

Over the years, we have seen an increase in the use of groups in the execution of the most varied kinds of activity. In the educational area, the interest in the group formation starts in the 1960's, however, the first works on the subject appeared in the forties, when researchers studied groups based on the behavior of their members. The use of groups got a stronger impulse from Vygotsky's [5] work, because his theories were based on the experience that through discussion there is a knowledge consolidation and the findings of new solutions.

Some important information that must be considered in the understanding of groups formation, are their objective and subjective limits [6]. The objective limits of a group can be, the size of the group and the duration and the space that will be reserved for the execution of an activity in the group. Some researchers believe that the minimum number of members should be three, in order to have some group behavior. The subjective limits can be exemplified by the boundaries of the activity that is being developed by the group, that is, what the group must or must not to do.

The sub-community term represents the formation of small groups within the CV-Muzar. In these groups discussions will take place about subjects of common interest among the participants. A sub-community can be created by any participant previously registered in the environment and its formation (constitution of its components) occurs considering two needs:

- interest similarity: groups are formed by participants that have similar profiles;
- knowledge complementarities: groups are formed by participants that are gathered to accomplish complex tasks which require the composition of abilities for solving problems.

The sub-communities formation is undertaken through a multiagent system, composed by two types of societies:

- static: aims to investigate the information about groups, and
- dynamic: aims to analyze the existing groups and try to look for participants that have similar content to participate.

The static society, named Investigating Society of Sub-Community (SIS-C), uses search algorithms and the dynamic society is developed based on the Dependence-Based

Coalition Model, founded on the Social Reasoning Mechanism and Contractual Network, based on Sichman's Economic Market Theory [2].

A MAS is a society formed by agents that coexist in the same environment and interact in order to accomplish a common goal [7]. The MAS area studies the behavior of an organized group of independent agents that cooperate in solving problems, which are beyond each individuals' capacities.

The next paragraphs explain how the Investigating Society of Sub-Community (SIS-C) and Investigating Society of Participants (SIP) work. Figure 1 shows the high level interaction between SIS-C and SIP.

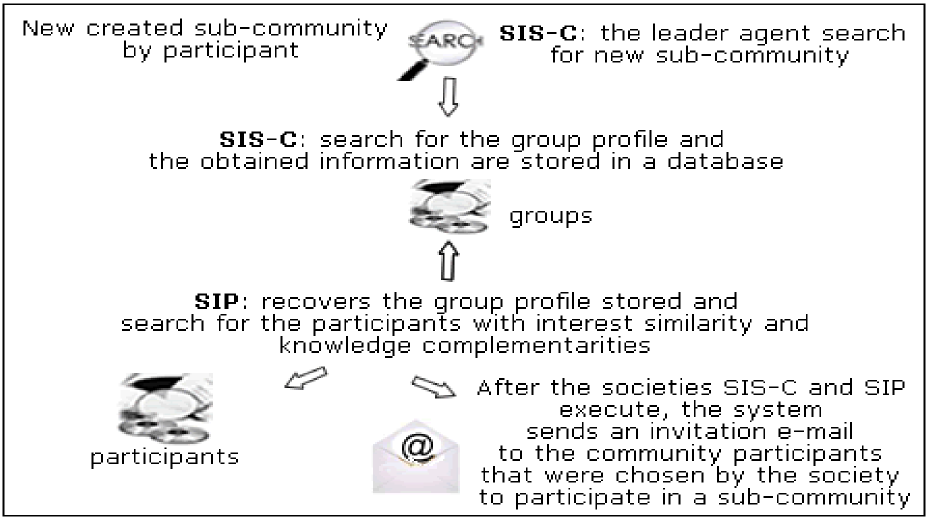

Fig. 1. High level interaction between SIS-C and SIP

The Investigating Society of Sub-Community (SIS-C) is characterized as a kind of static organization, because the roles that each agent will play within the society are already pre-defined like, for instance, the definition of each agent's role within the society. The roles that an agent can execute inside a society are a service provider agent and a leader agent. The service provider agent is the one responsible to provide service to others. The leader agent is responsible to find out which services agents can fulfill the necessary requirements to execute a task. Figure 2 illustrates the functioning of the SIS-C society and agents' communication. This functioning is illustrated through JADE platform.

As we can observe in figure 2, one of the society agents is defined as the leader agent, regardless of his knowledge. He is so-called because he will have the role to pass the required tasks by the environment to the other SIS-C society agents.

The leader agent gets information that a new group was created and he needs to investigate this group's profile in order to look for the participants who have interest in join the new group. At this moment, the process of tasks distribution is started. The leader agent checks a list of agents that have the capacity to fulfill the requirements of the search for the group profile, for instance, if agent A has the capacity to develop the proposed task “T1”. The leader agent asks agent A if he is available to fulfill the requirement. If so, there is a direct communication between the leader agent and the service deliverer.

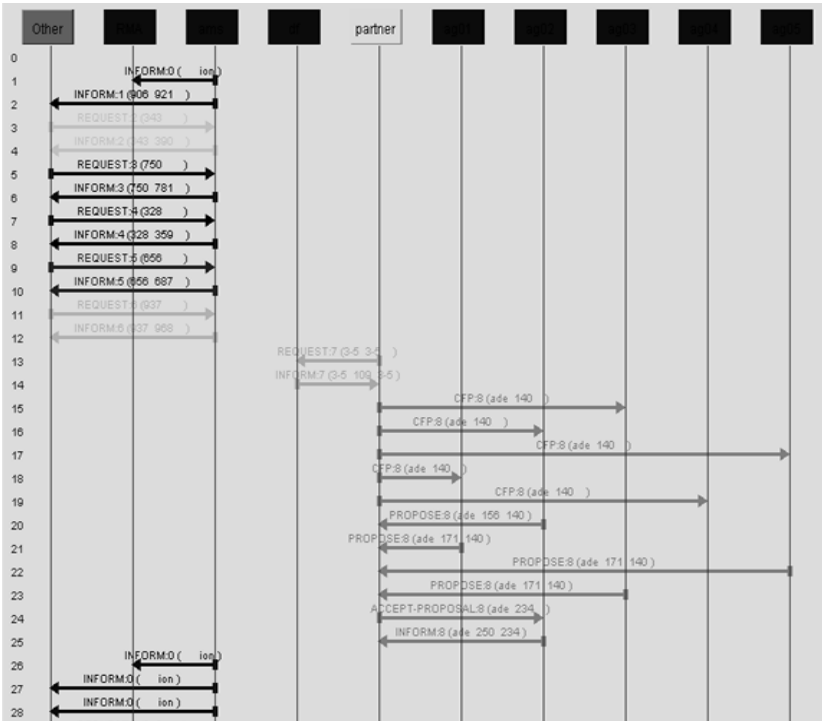

Fig. 2. Functioning of the SIS-C society presented through JADE platform

As mentioned before, the first task that will be accomplished by the SIS-C, specifically by the leader agent is the search for group profile. This search is composed by the following steps:

1. to verify all the information provided by the group coordinator. These information includes objectives, keywords, area of interest and communication tools used by the group;
2. to verify if the proposed profile is not similar to any other existing profile;
3. to verify the group’s central theme, if it is in accordance with the environment central idea that is natural sciences.

If all the listed requirements above are in accordance, the other activities are carried out; otherwise, the leader agent sends a message to the group coordinator advising him about the items that must be reviewed. The other activities are to search within the concentration area for the sub-communities and to search, within the interest area, for possible participants.

The option to use a leader agent enables the interoperability among the heterogeneous agents that are part of the society. After the communication cycle among the SIS-C society agents is over, the obtained information are stored in a database for a possible migration of some static society agents to the dynamical society. Thus, if it is necessary to migration, the coalition formation can occur for the search of participants that have profile similar to the group.

With the first part of information about the stored groups in a database, it is necessary to obtain information about the participants in order to accomplish the formation of the sub-communities. This task is carried out by the Investigating Society of Participants.

The Investigating Society of Participants is characterized as the dynamical type, because in this kind of organization there is the need of social interaction, that is, the agents must be able to gather and interact in order to achieve their local goals, whose combination occasionally results in the resolution of the community global goal.

The option to use the Dependence-Based Coalition model (DBC) for the dynamical organization is due to the fact that this is a model where there is cooperation and the communication between the agents is the main means for the accomplishment of the tasks. If the agent that integrates the society does not have the autonomy to carry out a certain activity, another member who can help is required. This way, over the time the agents improve their knowledge about other agents.

The formation of coalitions on the DBC model occurs in the following way: (the steps of the model are written in the form of an example of a procedure that occurs in the society):

1. Choice of a goal: an agent Ag1 chooses a certain goal to be achieved. In case there is no longer a goal, agent Ag1 does not try to form coalitions anymore. The choice of a goal can be the search for participants that have interest in discussing issues about “Environment Pollution”. The goal is always chosen based on the formed groups.
2. Choice of a plan: supposing that Ag1 chose the G1 goal, the next step is to choose a plan to accomplish it. As the agent can have more than one plan for the same goal, the choice of the plan is based on the notion of feasible plan. In case there are no more plans, step one is resumed. Based on the participants’ profile, agent Ag1 can have several plans for this objective and this way he chooses one that can be used. If Ag1 finds the plan worthwhile, he executes the analysis of the plan actions.
3. Analysis of the plan actions: once a plan is chosen, Ag1 analyses its objective situations concerning G1, in case the situation is independent or dependent. If the situation is independent, Ag1 is considered independent to accomplish that objective and this way does not need cooperation from any other agents. In this context, Ag1 can commence his activities to achieve his goal G1 with no need to form coalition. In the dependence situation, however, Ag1 cannot initiate the execution of his plan immediately, for he first needs to find an agent that accomplishes the action he does not know how to execute.
4. Choice of the partner: Through the social resolution mechanism, Ag1 considers his relationships and dependence situations with the other agents related to G1 and through the pre-established criterion, Ag1 chooses the

best possible partners. In case there are not possible partners for the actual action, Ag1 chooses a new plan to achieve G1 returning to step 2.

5. Coalition formation between the agents: once the best possible partner is chosen, here so-called Ag2, Ag1 will send it a coalition proposal, which can contain the following proposals:
   - Ag2 accepts the proposal and the coalition is formed. From this moment on, the works to solve G1 are started. At the end of this process, if the actions were accomplished correctly, G1 is considered concluded and an invitation is sent to the participants that have a profile similar to the group's to participate; and Ag1 can return to step 1;
   - Ag2 refuses the proposal and in this case Ag1 tries respectively to find another partner, returning to step 4. The proposal refusal by Ag2 can occur through the following factors:
     - Ag1 misunderstood Ag2, probably for having incorrect or incomplete information about Ag2. In this case, Ag2 informs such information to Ag1, and Ag1 can review his opinion about Ag2.
     - Ag2 did not find the proposal interesting for his goals.

The MAS uses the rules previously described to search for participants for a sub-community. Thus, the sub-community coordinator does not need to worry about finding partners for his group. He focuses on cheering up the group and encouraging the creation of discussions that enrich the knowledge.

The program code below shows the algorithm that will calculate the total number of messages in a society with *n* agents to establish presentation communication and to search for a partner, for a total number of cycles g. The algorithm is based on a previous analysis of the process within the CV-Muzar.

At each cycle, all the communication between the agents takes place through the messages exchanges. The active agent sends messages of coalition proposal until he finds a partner or until there are no possible partners. The possible partner always responds to the coalition proposal sending a message of acceptance or review. When the active agent gets an acceptance message, he sends a coalition message establishing the agreement with the partner agent. If no partner is found the coalition message is not sent. Thus, considering a society with *n* agents, where *m* agents can accomplish the desired action, and coalition proposal messages are sent to *k* agents (means that k – 1 agents sent messages of refusal or review), the total number of sent messages in each cycle is: Scycle = 2m in case it didn't find any partner; Scycle = 2k + 1, where 0 < k <= m and Scycle = 0 if the agent is independent.

Example of an algorithm that calculates the total number of messages in a society

```
depint(n,g)
Sap = n * (n-1); //calculates agents presentation
for i = 0 until i < g
 if Active.autonomous then start a new cycle;
 else
 m = Active.searchPartner(plan);
 //search and calculates the total of possible partners
 k = 0;
 //initiates the amount of proposals carried through
 findPartner = false;
```

```
 while (k <= m) or (not findPartner) do
          k = k + 1;
          If probably partner accepts proposal of col-
lation formation then
         findPartner = true;
         k = k + 1;
         end while
         Sc = Sc + k; //total of messages during coali-
tion formation
         end else
         Stot = Sap + Sc; //total of exchanges messages
end for
```

Now, considering a *g* cycles competition, the total number of exchanged messages between the agents after all the accomplished cycles (S_{DBC}) is:

$$S_{DBC} = S_{presentation} + \sum_{i=1}^{g} S_{cycle} = n(n-1) + \sum_{i=1}^{g} S_{cycle}, \tag{1}$$

where: Scycle = 2m in case it didn't find any partner; Scycle = 2k + 1, where 0 < k <= m; Scycle = 0 if the agent is independent.

These societies were implemented using the platform JADE and they were integrated to CV-Muzar, which is implemented in PHP. After the societies SIS-C and SIP execute, the system sends an invitation e-mail to the community participants that were chosen by the society to participate in a sub-community. The participants can accept the invitation or not.

4 Initial Tests

As a base of tests for the MAS, a simple experiment in the formation module of sub-communities within the CV-Muzar was carried out, with the participation of some trainees from Muzar. Fifteen people related to the museum were invited, trainees, professors and staff members. The participants were divided into two different groups. The first group received a small description of how they should fill out the individual profile and the subject nominations for the groups' formation. This first group was instructed on how they should create the groups, key words and the relationship with the Topic Maps present in the CV-Muzar.

The second group was random, they didn't have any help filling out the individual profile as well as creating the groups. These, in turn, could create their profile according to their interest area and create groups that had interest in forming centralized discussions. Over the two weeks' tests, the participants were invited, through messages sent by e-mail, to take part in the sub-communities created by two groups. In all simulations carried out with the two groups, the MAS nominated correctly the sub-communities related to the participant's profile. However, it will be necessary to optimize the processing time of the information exchange between the agents on the Dependence-Based Coalition model, because it took a long time sending the invitations.

5 Final Considerations and Future Works

As presented previously, the module for group formation is based on searches generated by the MAS, considering the Dependence-Based Coalition model In order to examine this model carefully and obtain a clearer analysis of the exchange flow when the dependence-based coalition process occurs, studies are being carried out to analyze the time that the society takes to process these data and send the message with the invitation to the participant. In this way, we chose to work with the Exchange Values theme, because in the Multiagent Systems area, more specifically in its applications to the social simulation, the matter of regulation of the interactions between the agents involved is quite important, since capturing the nature of the social relations depends, mostly, on the proper representation of the norms and social conventions.

The base for the interactions representation through the exchange values is Piaget's Sociological Theory [8], which states that the relationships among the individuals can be seen as services exchange among them, to which a range of exchange values are associated, being identified as social exchanges among the agents in a society.

For the application of the exchange values rule, the definition of an equation of exchange values is being studied, a mechanism of social reasoning and a set of internal structures to the agent for the storing and handling of these values.

For such procedure, Dimuro and Costa [9], present the proposal of creation of the exchange supervisor, a kind of leader agent as was defined in the Investigating Society of Participant, that is, a special agent capable of identifying the values involved in the exchanges accomplished by the agents and recommend them the accomplishment of new exchanges, with proper values so that the system has a balance.

On balance, socially speaking, it is understood that the system norms are followed. The agents, however, have their own personalities and, according to their goals, they can choose to follow the recommendations given by the supervisor or not. The mechanism used by the supervisor is shaped as a Markov's Decision Process (MDP), thus, at each instant he is able to recommend a set of exchanges, based on the current state of the values of the agents involved.

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The Development of Educational Games Supported by a Pedagogical Tutor Agent

Franciele da Silva Lewandowski and Adriana Soares Pereira

Centro Universitário Franciscano – UNIFRA, Brazil
fran.lewski@gmail.com, apereira@unifra.br

Abstract. New technologies of information provide facilities for the didactic means of education. This article presents the development of two educational games supported by agents that help students during their interaction with the games. The proposed agent is based on a pedagogical concept that seeks to respect students' individual development and learning. The educational games are: "Password Game", which stimulates logic reasoning; and "Math Space", which helps the basic learning of mathematics. They were developed in Flash programming, and were aimed at children from the first to the third years of Elementary School.

Keywords: Games, Tutor, Multimedia, Elementary School.

1 Introduction

The use of computers in education has fostered great changes through the development of Information and Communication Technologies (ICTs) in teaching and learning methodologies. This has occurred due to the widespread of information technologies in people's lives, which has caused transformations both in society and in teaching conditions.

Several studies and papers have been developed to show the efficacy of the use of information technology in teaching. Here we mention an article [1] that presents the importance of educational games for fostering motivation in students' learning, a paper [2] that shows the use of games to make learning more pleasant and interesting and a research [3] that presents the development of a pedagogical agent in Intelligent Tutoring Systems.

According to the Multiple Intelligences Theory [4], which considers intellectual capacity as a set of abilities whose learning are independent from one another, people are not given the same set of abilities, but each person can develop all intelligences naturally. Individuals can continue to develop any type of intelligence as long as they practice them and face challenges, reflecting upon what is learned. By using games, learners explore information around them and improve their mental capacity, developing and enriching their personality [5].

The objective of this study is to develop educational software in the form of games that help teachers to give their lessons using available computer technology. The games should cater to the objective of curricular activities, so as to guarantee individuals'

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formation and to motivate them for the new technological reality. The games should also be founded on a certain pedagogical structure, using reactive pedagogical agents which guide students' interaction and stimulus.

This article shows the development of the game called 'Password', which stimulates learners' logic reasoning. The game can be played either in pairs or with the computer. The other game whose development is presented in this article is 'Math Space', which explores the contents of basic mathematics, aiming at a more pleasant learning experience. The characters 'Dr. Burns' and 'Nani' are the agents that monitor students in their interaction with the activities, helping them in the task of learning by pointing out and suggesting alternatives, complimenting and helping students to understand the game.

The article is organized in seven sections. Section 2 gives a general view of the educational software; Section 3 briefly describes the pedagogical agents; Section 4 presents the environment that was developed; Section 5 shows the characteristics and the development of the agent; Section 6 offers the obtained results; and Section 7 presents the final considerations.

2 Pedagogical Agent

Artificial Intelligence (AI) is defined as the study in computer science that enables the development of perceiving, reasoning and acting [6]. In Education, AI is considered nowadays as a new methodology for improving knowledge.

In this artificial case, the agents are entities, and they can be defined as any entity (human or artificial) that is immersed or placed in an environment, perceives it through sensors and acts on it by means of actors. Agents act upon their own implicit or explicit objectives and, in order to achieve them, select their actions due to their perceptions.

The agents that perform an educational or pedagogical function that facilitates or improves student learning are called pedagogical agents. They can present characteristics of reactive agents, as they respond to changes in the environments where they are used.

According to [7], they can be classified as:

- Tutors: those that are aimed at students' directed teaching;
- Assistants (Friends): those that cooperate with students' learning;
- Web Agents: those that aim at employ the Internet to teaching;
- Mixed Agents: those that teach and learn.

The use of pedagogical agents in teaching becomes fundamentally important as they provide interactive and dynamic feedback between the environment and the student, and make the communication more persuasive, as they perform the role of a guide to the user.

According to [7], the introduction of agents in educational softwares allow for essential improvement in the pedagogical aspects of learning environments, once they provide more intense interactions as students approach the game.

3 Developed Environment

For the development of the educational games reported here the following technologies were used: JUDE Professional for UML modeling of the activities diagram with parallel behavior and Adobe Flash CS3, which is widely used in the development of educational games due to its flexibility, because it is an excellent authorship tool, because it has the ideal pedagogical character, and it offers resources and functionalities that developers need.

ActionScript Language was chosen for its resources and functionalities and because it is a consistent programming language aimed at objects.

The methodology used in the teaching-learning project through games is based on the performance of practical activities intended to improve curriculum activities, which brings teaching beyond the conventional classroom method.

3.1 Methodology

The need to think about a theme and define the objectives to be achieved allows for the adequate development of educational games.

To plan and model the environment, along with the proposed agent, a questionnaire with ten multiple-choice question and one dissertative question was designed and sent to four schools. The questionnaire was answered by fourteen Elementary School teachers. Some of the questions in the questionnaire were: How much do you know about computers? What teaching resources does the school have? Is there a frequently used computer lab in the school? Do you use computer resources to plan classes? Do you plan computer-based activities? In which area should emphasis be placed when computer resources are used? In which grades of Elementary School should computer-based activities be used?

The schools that participated in the research were:

- Escola Estadual de Ensino Médio Lilia Guimarães, in Uruguaiana, Rio Grande do Sul.
- Escola Nossa Senhora do Horto, in Uruguaiana, Rio Grande do Sul.
- Instituto Laura Vicuña, in Uruguaiana, Rio Grande do Sul.
- Escola Municipal de Educação Fundamental Centro de Atenção Integral à Criança Luizinho De Grandi, in Santa Maria, Rio Grande do Sul.

From the answers obtained in the fourteen questionnaires, graphs were produced to determine the profile of the games. The answers showed that the areas in Elementary School where the employment of computer resources was needed the most were mathematics (mentioned in 73.33% of the answers) and logic (mentioned in 86.66% of the answers). The games and their respective agents were created to cater to the target-audience and their needs. The activities for the games were selected with the aid of the teachers who participated in the research.

The use of the game was made possible because all schools have a laboratory with computers, and most teachers have knowledge of computers and use different methods for planning and performing classroom activities.

3.2 Properties of the Games Environment

One important effect of using computers in Education is the development of environments that foster learning. However, the creation of an environment that supports the learning process and that makes use of ICT needs applied planning.

The agents act with their “solutions” within task environment. But it is important to notice that the kind of environment directly affects the project that is adequate to the agent’s program [8]. During the first phase of the planning of an agent, all the aspects of the task environment must be individualized. These aspects define the appropriate project for the agent and its applicability.

In the acting of the developed agent, the environment must be accessible, that is, completely observable. The agent’s sensors must have access to the complete state of the environment, so as to detect essential aspects for the selection of its action. The agent is, thus, capable of knowing what action was performed by the student. The environment must also be episodic. Each activity (episode) that the student performs is based on the agent’s perception and action, and the chosen course of action depends only on the episode itself.

The agent’s task environment is considered small due to the number of perceptions and performed actions.

3.3 “Password Game”

“Password Game”, one of the games developed in this study, is the development of a computer-based version of an already existing board form of the game. The game stimulates students’ logic reasoning, which is important in helping students to think critically about the contents of all disciplines. The objective of the game is to discover a created or generated password in up to twelve attempts, following a checking chart of correct colors in correct places or correct colors in wrong places, with the agent’s aid. In this game, there can be repetition of colors, and the student must think of all possibilities.

Figure 1 presents the initial screen of “Password”. It is possible to create a password for another player to discover. This is done by clicking on the desired sequence of color buttons (yellow, blue, green and red). It is also possible to ask the program to generate a password. This is done by clicking on the “Generate Password” button. The student can also ask the program for help. In this case, the student clicks on the “Instructions” button to see the agent’s explanation.

Figure 2 shows the game steps screen. In this screen, the student attempts to discover the password by clicking on the desired color sequence. In the checking table the markers indicate whether or not the student correctly guessed the colors and their order. The black ball indicates the correct color in the correct place, and the gray ball marks the correct color in the wrong place.

Another screen shows the final result and the total of attempts made by the student, which can be evaluated by the teacher. During the game the student can click on the “Give Up” button to restart the game.

Fig. 1. Initial Screen

Fig. 2. Game Steps Screen

3.4 "Math Space"

"Math Space" explores two basic math activities, namely counting and subtraction, which are of fundamental importance in the initial years of Elementary School. The objective of the game is to perform the counting of stars that appear on the screen and, afterwards, their subtraction, which is informed through the numbers that are showed on the screen.

Figure 3 presents the initial screen of the game, where it is possible to set the number of questions to answer and to ask the agent for help. Figure 4 shows the screen of the first part of the game, where the learner must count the stars and give the correct amount by clicking on the numbers shown in the bottom part of the screen. The second part of the game shows only the remaining stars, and the student must provide the number of stars that are gone. Another screen indicates the result of correct and incorrect answers, and shows the possibility of printing the results, including the student's identification, which can be used by the teacher as an instrument of evaluation.

Fig. 3. Initial Screen

Fig. 4. Phase 1 Screen

4 The Developed Agents

During the building of the environment, several ideas came up for the development of the agent, and modeling provided the study with the definition of the actions. The agents are developed within the environment itself.

Because they perform tasks for the user, these agents have basic characteristics directly associated to their capacities, depending on their functionality. The developed agents perform periodic actions, have spontaneous execution and are static, that is, they are fixed in a certain location. They possess a low level of intelligence, and perform routine tasks that are triggered by external events. They perform a set of rules and do not adapt to changes. However, they use the knowledge base to reason upon monitored events.

The tasks performed by the agents are of gopher type, that is, they are simple tasks based on suppositions with pre-established rules. The acquisition of intelligence is of a reflexive/reactive sort, based on the mapping of situations and on associated responses. Thus, the agents are of reactive type, once they behave in a stimulus/response style.

4.1 Functions of the Agents

The pedagogical agents were developed as a tutoring tool during the structuring of students' knowledge along their interaction with the activities of the educational software.

These agents present a set of rules that determine the actions to be performed in the teaching activities. This is the base of the strategies to be used in ludic environments (games). This way, their objective is to help and monitor learners during their interactions in the environment, and not to teach.

Each pedagogical agent presents the following functions:

1. Ability to perceive students' errors and interact with them, stimulating them to explore the activities of the environment;
2. Following of students' actions during their interaction with the system;
3. Assisting students personally, performing tasks for them;
4. Motivating students to learn.

4.2 Architecture

A specific way to build agents is to have their architecture as a base. According to [8], the appropriate architecture depends on perceptions, actions, objectives and also on the environment. When the state of the environment is altered, the agent performs a corresponding action to cater to the new state. This is the stimulus/response style.

The Reactive Module is responsible for changes in the state of the agent during its interaction with students. The means of interaction that provide feedback are:

- Textual: activation of messages in balloons;
- Visual: facial expressions such as thoughtful, happy and unhappy.
- The base for the agent's internal knowledge is composed by:
- Base of visual resources: formed by elements that constitute the agent's appearance, such as body, balloons and others;
- Base of information: contains information on the content of the questions;
- Base of messages: consists of the phrases used in the interaction with students.

4.3 Visual Characteristics

In the establishing of the agent's physical characteristics, the following ideas were considered.

The agent should:

- Be similar to reality, having a whole body, being of feminine or masculine gender and being coherent to the style of the environment;
- Not interrupt users during their learning process;
- Interact with users, subtly changing their posture and face according to situations and actions;
- Use text balloons with phrases to communicate with users.

Besides the behavioral ideas presented above, the characters "Dr. Burns" and "Nani" were devised with friendly characteristics and with young features to get and keep users' attention. They should look like cartoons, as shown in Figures 5 and 6.

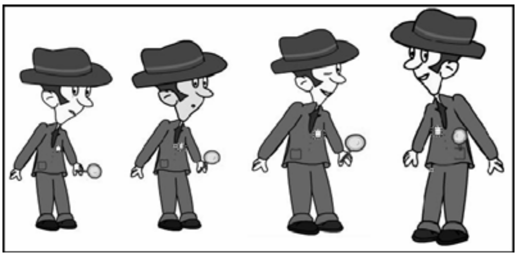

Fig. 5. Forms of Agent Dr. Burns in "Password Game"

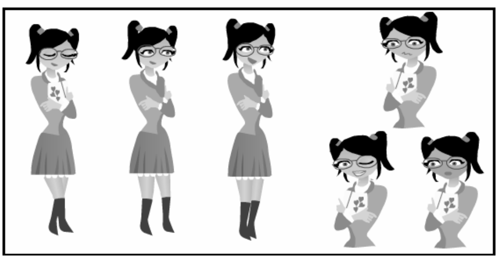

Fig. 6. Forms of Agent Nani in "Math Space"

5 Results

The validation of this study was done in the participating schools. As mentioned before, the study involved school students of the First and Third Grades of Elementary School.

In the test, the games were validated in six groups, with an average of fifteen students in each group. All the teachers received a new questionnaire with seven questions that evaluated the students' acceptance of the agents and their performance during the games. Some of the questions were: Do you consider the kind of game appropriate? Did the game offer improvement for the curriculum activities? Did the students show enhanced interest in learning through the game? Do you think that the presence of the agent brought contributions to students' interaction with the game? Did you like the agent's character?

Both the games and the agents proved to be successful and well-accepted by teachers and students.

New graphs were generated from the answers given in these questionnaires. These graphs show the feedback given by teachers on the use of the games. According to the results shown by the graphs, the games were considered adequate and they provided improvement for the curriculum activities, due to the interest and participation shown by students.

As for the objective of the pedagogical agent, it made the environment more motivating and interactive. During the validation of the study, students paid attention to the messages and the facial expressions presented by the agent and performed activities so as to "make it happy".

In the questionnaire, in the space provided for suggestions, the followed comments were written: "It's good to have a contribution to the classes. The pace is better" (teacher from Escola Municipal de Educação Fundamental Centro de Atenção Integral à Criança Luizinho De Grandi). "It's important to have different learning means as alternatives" (teacher from Escola Nossa Senhora do Horto). "It's an important work that must be continued, because it enriches the environment" (teacher from Escola Municipal de Educação Fundamental Centro de Atenção Integral à Criança Luizinho De Grandi).

This proposal was a differential in the schools that participated in the study, because some of the schools used games for leisure and as free time activities, but not for teaching.

It was also possible to verify the students' performance during the test. Some of them had difficulties to play "Password" because they could not progress in their logical reasoning at each attempt to discover the password. Some had difficulties in the subtraction phase in "Math Space" because they were not used to using computer resources that demanded greater need of concentration and reasoning.

6 Closing Thoughts

The emergence of educational technologies has allowed for changes in the pedagogical paradigm. Teachers have been opening doors for the use of resources that go beyond traditional teaching-learning methods. Thus, educational games are tools that complement the building and the consolidation of concepts to which students are exposed in the classroom.

The development of this study considered the phases of definition and modeling of the games "Password" and "Math Space", the development of the environment and the creation of the animated character that represent the agent that is embedded in the environment.

The final phase of the study was the validation of these games in the teaching environment of the schools that participated in the definition of the model of the games. The validation consisted in checking the benefits that the games provided and the inclusion of the agent, considering that the use of agents in educational games is not common.

It was possible to conclude that the introduction of computer technology in education is a rich tool that can be used as a new form of learning, as a novel pedagogical instrument that has much to contribute to students' building of knowledge.

This work contributes to a series of other studies about the use of computers in the classroom and its potentialities. Another point that is worth mentioning is the use of a pedagogical proposal to determine the activities and the work that the teacher can perform with the results that are obtained from students' interaction with the software.

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Applying Informatics Knowledge to Create 3D Worlds

Michael Weigend

Westfälische Wilhelms-Universität Münster, Fliednerstr. 21, 48149 Münster, Germany
michael.weigend@uni-muenster.de

Abstract. Designing three-dimensional models using a tool like Google SketchUp is an attractive and inspiring activity fostering spatial thinking and visual creativity. The basic functions of SketchUp are easy to learn (low threshold). But more demanding design projects require computational thinking. This paper discusses some informatics concepts 3D-desigers need to know to be able to use SketchUp efficiently.

Keywords: Algorithms, Computer Science, Modeling, Thinking, Didactics.

1 Introduction

Create the house of your dreams. Reconstruct a historic building that has been destroyed using verbal descriptions, old photos and plans. Design a city to be built on Mars.

Modeling three-dimensional worlds can be a thrilling and inspiring activity. Google SketchUp is an easy-to-learn modeling tool which enables even young students to construct complex surface-oriented 3D-models in a relatively short time. What makes the usage of SketchUp easy and efficient?

Perhaps, the secret of success is that you can use already existing everyday knowledge. Fischbein [4] and diSessa [3] use the term "intuition" for mental concepts, people feel certain about and which they have successfully used in many different domains (see also [13]. Sometimes intuitive concepts are subconscious, but still they influence our thinking and acting. For example, we all know what it means to move a thing, to pull a rubber band or to fold a sheet of paper. This is intuitive to us. Powerful and efficient geometric operations that can be performed with SketchUp rely on this kind of knowledge. But obviously specific concepts from the domain of geometry are helpful too. At least for some design tasks users need to know what points, circles, angles, tangents or irregular triangulated networks (TIN) are. What about informatics knowledge? Wing describes "computational thinking" as a "universally applicable attitude and skill set" that everybody should learn at school [14, p. 32]. Since it is claimed to be universally applicable, the question arises in what way computational thinking might be helpful for creating 3D worlds. This is the quest this paper deals with. Relevant concepts, which I am going to discuss include the notion of objects, being in a state, classes, aggregates, parameters of method calls and iterations over data collections. Such knowledge can be learned separately in computer science lessons or "just in time" during the work with SketchUp. But however, they should not remain in the dark. They should be explicated and 3D-designers should be aware of

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them. A similar discussion takes place in the context of other digital artifacts like word processors [1, 11].

2 Values and Mutable Objects Being in a State – Mathematical and Informatical Perspectives on Geometry

Fundamental concepts in geometrical modeling are lines and points. In geometry, a line is defined by its properties, for example the position of the two end points. If you change one of these, you have a different line - a different entity. Thus lines are immutable. Nevertheless, in a context like constructing a two-dimensional geometrical shape with pencil and paper, people use phrases like “I will make this line a bit longer”, thus indicating that they consider a line as a quasi-material entity. Its length is just a momentary state that can be changed. Furthermore, while designing geometry, people use colors and create blue and red lines. Of course the color is just decoration to make the geometry easier to perceive. When we make the distinction between the mathematical entity “line” and the visual entity that can be seen on the paper or the blackboard, we are entering the domain of informatics. The line segment we draw using paper an pencil or a software tool is an object, not *being* line segment but *representing* it in its state. Usually this object has additional – non-mathematical- properties like color, thickness, texture.

In dynamic geometry environments (DGE) like GeoGebra, GEONExT, and Geometer’s Sketchpad students can construct geometric shapes like quadrilaterals on the screen with the mouse [2, 8]. The user can drag points and watch the changes of dependent lines and points, thus discovering geometrical knowledge. Keith Jones’ analysis of math lessons with a DGE suggests that the notion of geometric figures being objects with changeable states is quite intriguing for teachers and students. For example, 12-years-old Karol said: “Our old math teacher used to call a rhombus a drunken square, because it’s like a square but sick.” [7, p.74]. Hölzl points out that students using DGSs must be aware of the behavior of the objects they manipulate on the screen. “And some of those characteristics may not at all lie in the realm of geometry” [6, p.171]. It might be helpful to distinguish clearly between the *view* on the screen representing a geometrical figure and the conceptual *model* underlying it. A similar distinction has been made in the “model-view-controller” pattern [10], which in software engineering is commonly used for the development of visual programs. For example, the model behind the view of a quadrilateral on the construction board is an aggregate of linked objects, which can execute certain operations like changing position. The object representing a line segment stores in its attributes references to its two end points. When we drag one of these point-objects, we change its state but not its identity. Thus this point is still the end point of the line segment it is connected to. In consequence the line segment looks different now although we did not execute an operation on it. When a student drags the four points of a quadrilateral to the same place, it looks like one point. In mathematical reasoning (which is intended when using a DGE) the student actually thinks of just *one* point (view). But on the model level there are still four points, which can easily be separated.

3 Creating and Using Components: Class and Instance

From DGEs back to 3D-modeling with SketchUp, which is not an educational tool but a professional editor used for construction. In complex design projects it is convenient to use components. A component defines a smaller 3D-entity which is a part of the whole model. The model of a table can be constructed as an aggregate consisting of one instance of a slab-component and four instances of a leg-component. Like a class in OOP a component can be considered as a template (representing a type of entities), which can be used to create instances. All the visual properties you define while creating a component can be regarded as class attributes. These attributes have the same values in all its instances. If you change a component, all instances will adopt the changes. Thus a new instance of a component, representing a *type* of entity, is something different then a copy of an existing entity. There are additional instance attributes (equivalent to object attributes in OOP) that belong to the individual instances of a component. These include the scale, visibility on screen and the material the surface looks like. There exist things in real life, which are similar to templates. For example, a potato stamp determinates how the printed entity looks like. But – in contrast to SketchUp-components – real life templates must be defined completely before creating instances. If you change a stamp after having printed with it, the modifications have no effect on already created entities. When you build several houses using one common plan and change the plan later, the houses still look the same. Such templates in real life are used to *create* and not to define. The set of *created* instances is not an Aristotelian extension of a category. But when you edit a SketchUp component, you observe on the screen that all instances are in a magical way connected to the component and change simultaneously. You can see that small changes can have a large effect on the world and you realize that a SketchUp component actually defines a set of entities. The tables in Figure 1 are aggregates consisting of one slab and four legs each. Changing the - one and only - leg-component affects the whole picture. Even the shadows look different.

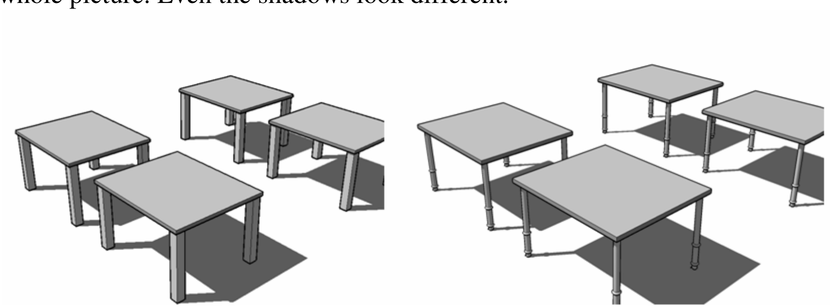

Fig. 1. Effects of editing a component representing a table leg

4 How to Put a Plate on the Table – Different Ways to Define Parameters

We are familiar with moving objects in our 3D reality. When Tom puts a plate on a table, he just takes it and moves it until it looks right. In the real world moving is a continuous process. This intuitive way to move things in space does not work in a 3D-modeling environment like SketchUp, since the user interface is two-dimensional.

In a 3D-modelling environment movement is one discrete operation. Consider a model consisting of instances of two components, one representing a plate and the other representing a table. To put the plate on the table Tom has to do three things: (1) select the move-tool, (2) specify the entity that is to be moved (plate-component) and (3) specify an Euclidian vector, which defines the shift (direction and length). To specify the entity and the operation (method) is easy. It is done by clicking on visual elements. The problem is how to define the vector. A quite elaborate way is this: Tom edits the plate-component and draws one or two lines underneath the plate to gain a point, which is exactly in the middle. Then he draws lines on the table top to indicate the target position of the plate. Note that drawing on an existing surface is easy in SketchUp. When you have selected the pencil tool and move the cursor over a surface, the system assumes that you want to put a line on it. With these two points on the bottom of the plate and on the table top Tom has (indirectly) defined the spatial vector for the move-operation. Since both points must be visible Tom changes the face-style to transparent. To execute the move-operation he selects the move-tool, clicks on the first point and then on the second on the table. The plate had followed the cursor movement and snapped to the target point after the second click. Finally Tom removes the lines he had used for the specification of the initial and terminal points of the vector. The beauty of this proceeding is that the parameter of the move-operation – the vector – is explicitly embedded in a meaningful context. The initial point of the vector is not just some triple of numbers but the center of the plate bottom. This relation to the plate defines the meaning of this point. In the same sense the second point on the table top is a meaningful entity. It indicates the future position of the plate which is on the table and not too close to an edge.

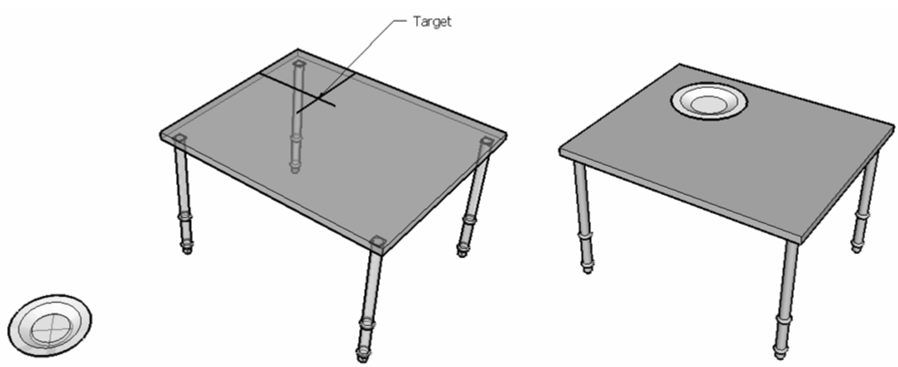

Fig. 2. Moving a geometry using a target point

Where is the connection to “computational thinking”? Computer programming includes embedding new knowledge in a context of existing knowledge, introducing new entities and constructing meaningful relationships between entities. Consider this Python program:

```
sequence = ["a", "b", "c"]
for index in range(length(sequence)):
        print index, sequence[index]
```

The term `range(length(sequence))` represents a list of numbers `[0, 1, 2]`. Instead of using explicit numbers, the programmer defines a list indirectly, using the already existing sequence. The term `range(length(sequence))` has a *meaning* within the algorithmic context of the program, but the list [0, 1, 2] has not.

A second way to put the plate on the table is to split the three-dimensional move into three moves along the three axes of the coordinate system. The first move could be in the direction of the vertical axis up to the height of the table. For this up-move-operation a vector is needed too. But it is specified in a different way – by its direction and length. Tom selects the move-tool, clicks on the plate and moves it in upwards-direction. But what does it mean to "move the plate"? When Tom moves the cursor, the plate is displayed at the current position of the cursor. When he strikes the escape-key, the plate jumps back to its original position. Only when he clicks the mouse, the plate remains at this position and stays there. In this moment – and not earlier - the atomic move-operation has been executed. The movements between the two mouse-clicks are anticipations of the future position of the to-be-moved entity. Generally speaking, Tom is specifying the parameter of an atomic move-operation by anticipating the future state of an entity. In the SketchUp environment his concept is additionally supported by a mechanism called inference. By touching the table top with the cursor Tom can specify a reference point. When he moves the plate along the vertical axis, and the present height happens to be the height of the table, a dotted line appears connecting the plate to the reference point (Fig. 3). Again, this means the future position of the plate has been specified within a meaningful context.

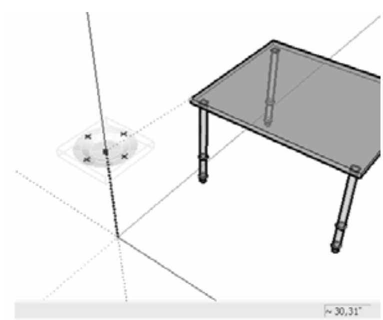

Fig. 3. Moving a plate-instance to the correct height using inference

Note that Toms did not use explicit data as parameters for the move operation. Of cause the system inferred the data from Tom's activity, but Tom himself used the concept of immaterial states. There still is another way to specify parameters: If Tom knows the exact height of the table, he can also enter the length of the move-vector in a small input field on the right side at the bottom of the window (Fig. 3). When he strikes the enter-key, the plate jumps to the corresponding position. This feature is called “accuracy” in the SketchUp world.

Let me sum up. I have described different ways to move an entity in a SketchUp model using concepts like anticipating a future state, embedding an entity in a meaningful context and inputting explicit data. When you see the move-operation through the eyes of a computer scientist, you are aware that this operation needs a spatial vector as parameter. The question is just how to tell the system the required data. Knowing a variety of activities, which all serve the same purpose – to specify a vector –, should make it easier to find an appropriate and efficient proceeding to perform the move in a given situation.

5 Iterations

In an iteration a certain activity is applied to each item of a collection like a set or sequence. In contrast to a while-statement, an iteration is not controlled by a condition but by a collection like a set or a sequence. The Latin word “iter” means “march” or “walk”. Metaphorically speaking, to execute an iteration is to walk through the items of a collection and do something with *each* of them. Collections are specifically designed for iterations. This aspect is emphasized in the syntax of the programming language Ruby. Collection objects have the method `each`, to specify some activity to be applied to each item (example see below).

In 3D modeling with SketchUp we use iterations when we want to apply an operation on several geometrical entities. Assume that Sarah intends to paint several parts of a model in the same color. First she specifies a collection of entities – using the selection tool – and then applies the material tool (paint bucket) on this collection. Note, that the selection tool is very efficient for defining collections. Sarah may create a “box” with the mouse, thus selecting all entities within the box. To exclude some of them she keeps the shift key pressed and clicks on those entities she does not want to paint. All selected entities are framed with yellow lines and are therefore easy to recognize as members of the collection.

The paint iteration can also be specified by a Ruby-program, which is to enter into the command line of the Ruby-console:

```
s = Sketchup.active_model.selection()
s.each {|entity| entity.material="blue"}
```

6 Attributes of Entities

Suppose you have an instance of a component consisting of two instances of another component representing a cubicle (Fig. 4). How to put some material (like wood, metal or color) on the surfaces of this geometry? It can be done this way: Select the material tool (paint bucket), select a material (for example wood), move the bucket onto the collection and click. The second picture of Fig. 4 shows the result.

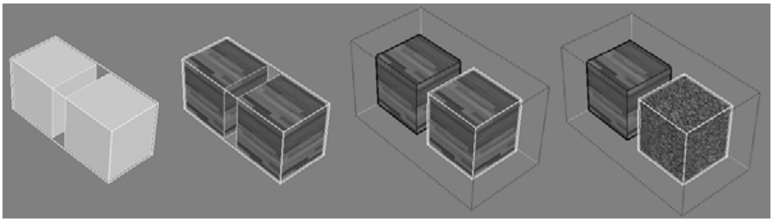

Fig. 4. Adding material to a Sketchup geometry

Now open the component and select one of the cubicles (third picture). Try to remove the material. This is not possible! But you can add a material to this entity, say a carpet, so that this cubicle looks different from the other (fourth picture).

This strange behavior can quite easily be understood by applying the concept of objects and attributes. The component instance representing two bricks is an aggregate consisting of two instances of a cubicle component (see UML object diagrams in Fig. 5). Each geometrical entity has an attribute named `material` defining the texture, shown on its surfaces. If this attribute has the value `nil`, the system uses the material specified in the aggregate-object for rendering. Thus the cubicle in our example, which is part of an aggregate and has no explicitly specified material, is shown with the material of the two-cubicle-component. And there is no way to change this by editing the properties of this individual cubicle. But it is possible to add a material to this cubicle and make it look different from the rest of the aggregate.

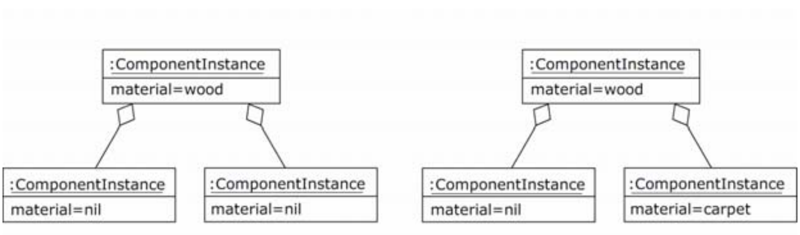

Fig. 5. UML object diagrams corresponding to the 2nd and 4th geometry of fig. 4

Note that this kind of construction does not happen in real life, where things are really *made of* material. In 3D-modelling the term material is just a metaphor for a property of a surface. Thus modeling using materials cannot be understood in a naïve way merely based on everyday experience. Formal informatics knowledge is required.

7 Conclusions and Pedagogical Perspectives

In this section I start with summing up the advantages of informatics knowledge for 3D modeling and then present a few ideas for teaching this knowledge.

SketchUp users should profit from informatics knowledge in several ways. Being aware of the underlying concepts increases the competence to communicate. Design plans and SketchUp system behavior are easier to understand and to explain to someone else, if you use proper informatics terminology (including terms like aggregate, object, attribute, operation, parameter etc.). This concerns teachers, supporting and scaffolding students working on 3D projects as well as students cooperating in a team.

Creating a complex geometry with SketchUp requires a deep understanding of model structures and the ability to combine operations to efficient design plans. If you do not know how to use iterations, collections and aggregates you are not able to create complex structures, just because you do not have enough time. In many cases it is necessary to construct auxiliary structures. For example, if you want to create a curved pipe, it is efficient to start with creating a box, which has nothing to do with a pipe, if you only consider geometry aspects. But if you have this box, you can easily create a curved line on the front faces of the box, then a circle on a side face, and then create the pipe using the follow-me tool and finally delete the delete the edges of the box. Such strategies are similar to the construction of class structures in OOP in order to manage cognitive complexity. 3D designers need to be creative not only in the domain of geometry and aesthetic but also in the field of informatics inventing efficient proceedings to implement their ideas.

Let us now consider the teaching perspective. Why should SketchUp be taught in informatics classes? Keep in mind that informatics concepts underlying 3D-modeling exist independent from 3D-modeling and might be taught respectively learned more efficiently in a completely different context. Perhaps it is easier for students to understand what iterations, operations and parameters are when they write and test programs using a universal programming language like Python. A teacher can introduce useful concepts like object and attribute applying the existing rich repertoire of media and class room activities. Metaphors from different domains might help to understand the interactive entities on the construction board. For example, a metaphor of a changeable line segment is a string, which can be connected to different things. The two end points of the string might change, but the string remains the same entity. In some respect a line on paper, drawn with pencil and ruler, is a worse metaphor of a SketchUp line segment.

There are basically two approaches to design instructive tasks to inspire computational thinking in the context of 3D-modeling. (1) A Task might focus on some functional features of SketchUp and stimulate to explore the computational structure of geometries. Example: “Create a triangular prism (Fig. 6 first picture) using only the

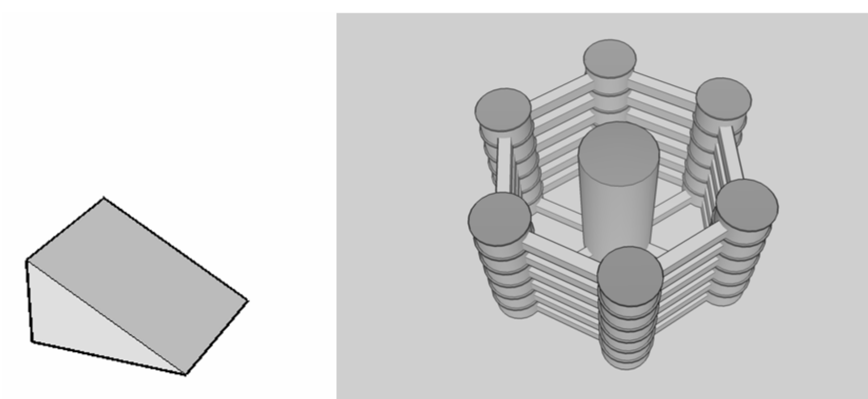

Fig. 6. Triangular prism (1) and a building with structured architecture (2)

following tools: rectangle, push-pull, select and move." To solve this task the student needs to find out how to use the move-tool to move an edge. She or he might discover that moving the edge implies changing adjacent edges and faces and that the aggregate-structure of the model has been modified tacitly (the number of entities has been reduced).

(2) 3D-modeling projects imply situated learning [9]. A task may be – on the surface – an architectural or artistic design challenge. Still, it might *indirectly* encourage deploying and developing computational knowledge. Example: "Create a building like the one in Figure 6 (second picture)". This can be done in minutes if you use components, the material- and the move-tool in a clever way. To construct it in a naïve way (line by line) is practically impossible.

And such experience might lead to an important insight: Informatics empowers you to create things.

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Part IV

Digital Solidarity

Ensuring Success and Quality through the Use of Standards in Team Projects: Students' Perceptions

Elsje Scott[1], Robert Brown[2], Jeffrey Pearce[3], and Peter Weimann[4]

[1] Senior Lecturer at the University of Cape Town, RSA
elsje.scott@uct.ac.za
[2] Business and Software Solutions Group, RSA
robobrown@gmail.com
[3] Business Analyst at White Wall Web, RSA
pearce.jp@gmail.com
[4] Professor at Beuth University of Applied Science Berlin,
Visiting Academic at the University of Cape Town, Germany/RSA
weimann@beuth-hochschule.de

Abstract. This paper reports on a study analyzing the factors that contribute to the success and quality of software development projects in an educational environment. Software development standards were reviewed to identify key project success factors, as well as measures of success and quality. Interviews with students then investigated the degree to which students implemented software development standards in their projects, and the perceived impact of these standards on project success and quality. Students generally viewed standards as the "proven" ways of doing something, and felt that the use of standards supported project success. The factors that were perceived to contribute most to the success and quality of their team projects were team composition, skills within the development team, and communication within the team.

Keywords: Project Success, Software Development, Quality Standards.

1 Introduction

Information Systems (IS) professionals are often involved in tailoring application technologies and developing systems or parts of systems to suit the requirements of an organization [1]. In preparation for this, students should gain experience in the application of information and technology-enabled business processes in such a way that the organizations will benefit and obtain a competitive advantage [2]. However, despite endeavors to effectively educate prospective IS professionals, one out of three Information Technology (IT) projects still fails more than 10 years after the famous 1995 Chaos Report of the Standish Group [3]. Projects that fail either miss the targets or they do not deliver the required business functionality [4]. The main aim of this study was therefore to determine the factors which contributed to the success and quality of software development projects in an educational environment.

The paper reports on an empirical research study conducted in 2006 at the University of Cape Town (UCT), South Africa, to investigate students' perceptions of the

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factors that contributed to the success and quality of the IS undergraduate system development projects. The paper briefly outlines success and quality as defined in the literature and the relevant factors contributing to success and quality. It comments on standards as determinants and measures of success and quality. The students' perceptions are then compared to those revealed in the literature, various themes are identified, and their relevance to the objectives of the study is discussed.

2 Success and Critical Success Factors

Many different and sometimes very diverse factors can contribute to the success or failure of software projects, making it difficult to define and measure their success [5]. The factors "on time", "within budget" and "to specification" have often been used to measure the success of projects in terms of their outcome [6, 7]. Even though Turner [8] argues that these three factors primarily represent the view of the contractor of a project, they remain the highest ranked factors in a number of different surveys [9, 10]. Other important factors that have been used to assess project success are:

- The fit between between project and organisation [10]
- The consequences of the project for the performance of the business [10]
- The quality levels met [9]
- The satisfaction of users and other stakeholders [11]

Baker, Murphy and Fisher [12] point out that a project can still be perceived as successful even if it has not met the timescale and budget requirements. This implies that the success of a project depends partly on the viewpoints of the different stakeholders [9]; and so project managers in particular cannot ignore what developers consider being important in terms of project success [13]. Furthermore, the success of a project can also be described in terms of how the project affected the team and its individual members with respect to the level of stress, overtime, conflict, satisfaction and the level of motivation [14].

The list of factors *influencing* the success of a project is as diverse as the set of factors *measuring* the success of a project. In a survey by White & Fortune [10] the most frequently mentioned criteria are: clear goals; support from senior management; adequate funds and resources; and realistic schedules. Other project success factors frequently mentioned are: end user commitment; clear communication channels; effective leadership/ conflict resolution; effective monitoring and feedback; flexible approach to change; taking into account past experiences; recognizing complexity; taking account of external influences; effective team building/motivation; and effective management of risk. These critical project success factors are in line with Belassi and Tukel, [15]; Magal, Carr and Watson [16] and Pinto and Slevin [11].

3 Quality and Factors Contributing to Quality

Software quality is an important determinant in the success of software projects [9]. It is therefore not surprising that it is recognized as one of the 10 knowledge areas of the Software Engineering discipline and pervasive in the Guide to the Software Engineering

Body of Knowledge (SWEBOK) [17]. Software quality has traditionally being defined as "fitness for use" [18]. According to the International Organization for Standardization (ISO) 9001 standard, software quality is "the degree to which a set of inherent characteristics fulfills requirements" [19].

The field of software quality is broken down into three subtopics, namely: Software Quality Fundamentals, Software Quality Management Processes and Practical Considerations [17]. Software Quality Fundamentals refer to the culture and ethics of software engineering, the value, costs and characteristics of quality as well as quality improvement processes. Software Quality Management (SQM) encompasses the different perspectives of software processes, products and resources whereas Practical Considerations refer to requirements, defect characterization, management techniques and measurements.

Software quality factors such as understandability, completeness, conciseness, portability, consistency, maintainability, testability, usability, reliability, structure, efficiency and security constitute non-functional requirements for a software program. In many cases, related attributes of these factors can be used as metrics, which allows subsequent measurement of how well the project goals have been achieved [17]. In addition to the technical qualities of software, the end user's perspective on the usability of a software product must also be considered.

4 Standards as a Requirement for Success and Quality

Moore [20] states that the sound engineering approaches provided by The Software Engineering Standards of the Institute of Electrical and Electronics Engineers (IEEE) Computer Society and their SWEBOK can be applied to increase the probability of success. According to Moore [20] a standard is a measure of comparison, a characterization to establish allowable tolerances or constraints for categories of items and a level of required excellence. All standards have limitations, and it is often not possible to comply only with one single standard when developing software [21]; because of this, the adoption of standards should not necessarily be viewed as mandatory.

The ISO 9000 family of standards represents an international consensus on good quality management practices that assist organizations to consistently deliver quality products and services across all industry sectors. The ISO/IEC 9126 standard of reference helps to stabilize the software process by providing a framework for the evaluation of software quality [22]. In part 1 of this standard a generic quality model is defined in terms of six quality characteristic, each with its own set of sub-characteristics. Part 2 describes external metrics that are applied to an executable software product in the later stages of developments or during the testing process. Internal metrics (part 3) are applied to a non executable software product in design or the early stages of coding.

The use of standards is also encouraged by the SWEBOK, which consists of ten knowledge areas that establish the appropriate set(s) of criteria and norms for software engineering practice upon which industrial decisions, professional certification and education can be based [17]. Other standards bodies such as the Software Engineering Institute (SEI), ISO, IEEE (SWEBOK), Object Management Group (OMG) and PMI (PMBOK), assist in providing a foundation for project success. These are incorporated in the CxOne quality standard document [23], which contains a number of sub-areas including project planning, process planning, testing and verification and validation.

At UCT a systems development group project is one of the major deliverables of the one year capstone course of the IS undergraduate curriculum. The course includes topics like requirements planning, software design, software construction and testing. Templates, checklist, patterns and guides are custom designed and support the creation of the relevant artifacts [24]. A comprehensive assessment strategy implements various instruments to accomplish formal summative assessment, formal continuous assessment and an informal formative assessment [25]. The course content adheres to international curriculum standards as specified in the IS Model Curriculum [2] and the Computing Curricula 2005 [1].

5 Research Methodology

The main aim of the study was to determine those factors contributing to the success and quality of the UCT 2005 IS systems development projects. A case study approach was used to unearth the factors and explore the question: "What are the students' perceptions on success and quality in software development projects in an educational environment?" Several authors agree that a case study approach provides an effective way to examine specific phenomena or to explore a question or an issue of concern in its own context e.g. [26]. According to Flyvbjerg [27] it fosters an in-depth understanding of the issue of concern, and Yin [28] concurs that it helps to link causes and effects. It thus seemed viable to investigate the students' perceived ideas of success and quality, before exploring which factors they thought contributed to the success and quality of their systems development project.

The data was collected in semi-structured interviews. The sample comprised a selection of 13 teams out of a total of 25 teams who completed the course in 2005. The selected teams were representative of teams in the upper, middle and lower mark brackets. In most cases the team leaders were approached for the interviews. In some cases other team members were interviewed as well, accounting for the 18 interviews conducted. The interview comprised three sections. The first was used to gain an understanding of the student's awareness of the role standards play in software development arena. It also provided some insight into the importance the students placed on the usage of standards in their projects. The second section of the interview attempted to identify the student's perception of the impact standards have on the success and quality of the systems development project. The third section was designed to establish the interviewee's awareness of the key areas of software development as revealed in the literature. The interviews were treated as confidential and conducted individually to guarantee anonymity of the interviewees at all stages. Notes were taken during the interview to assist in identifying themes. Additional questions were asked to aid in the understanding of the respondent's viewpoints. The interviews were recorded with the consent of the respondent and transcribed in a textual format to enable the researchers to identify themes guided by Ryan and Bernard [29]. Mind maps as a visual aid assisted to group the various themes into categories as described in the following section.

6 Findings

We grouped the themes that emerged in the data collection process into six categories namely: factors contributing to the success of projects; factors contributing to the quality of projects; tools and techniques; standards; focus areas; and the adherence to UCT course guidelines.

6.1 Success Factors

The most important factors contributing to the success of software development projects as mentioned in the interviews were:

Team roles: Healthy team dynamics and open communication in software development teams was a major theme raised by most respondents. It was also important that team members exhibited commitment and contributed to a good “mix” of skills and as one of the team members verbally confirmed: “Need to choose the right people, if you don’t have the right people, there is no way you can pass the project well.”

Good testing: Although only three teams claimed to have used formal testing methods, most respondents felt that proper testing is of major importance. This is consistent with the literature which claims that if software is tested properly and functions correctly it contributes to success and quality [18, 30]. Many teams only performed informal testing and did not execute formal testing methods due to poor time management.

Project sponsors: The respondents stated that the support given and relevant information obtained from the sponsor enabled them to build up a better system and therefore contributed to the success of the project. Project success was also dependant on meeting the sponsor’s requirements.

Good time management: “We wasted a lot of time, and were really crammed towards the end. I feel that if we had planned our time better we would have done better”. Most respondents agreed that should they have managed their times better, more tasks would have been completed successfully. It is clear that time management was another major theme that emerged from the interviews. Although compulsory, only ten out of the 13 teams interviewed constructed and used their Gantt charts effectively to assist them in task allocation.

Proper analysis: The majority of respondents admitted to using tools and techniques such as Use Case diagrams to assist in requirements planning, but only two teams felt that conducting thorough analysis was essential to the success of their projects.

Coding standards: Several respondents stated that better adherence to coding standards could have improved their final result.

From the above factors it is clear that the respondents felt that people as stakeholders of a project played an important role in the success of their projects. This is in line with the study of Procaccino et al. [13]. Although the respondents focused more on personal achievements such as their marks and the learning experiences as indicators of a successful project, they agreed that one of main factors for success was to effectively meet the sponsor’s requirements.

6.2 Quality Factors

During the interviews the researchers tried to group the responses on quality in software projects under the six different criteria for quality as depicted in the ISO 9126 standards [22]. Five of the six areas, listed below, were either directly or indirectly mentioned in the interviews.

Usability: Phrases like "easy to use", "user friendly", "user interface finish" and "value to end user" were mentioned as determinants of quality.

Functionality: Ten out of the 13 teams interviewed, mentioned that "meeting the sponsor requirements" is an important determinant of quality. Other responses reflecting the functionality aspect of quality were "fit for purpose", "innovation" and "value to end users".

Efficiency: The themes that emerged from the responses under this area were "speed of use" and "speed and efficiency".

Maintainability and reliability: A few respondents mentioned that they view "reliability" and "robustness" as valuable to enhance the quality of a system. One respondent focused strongly on the use of coding standard to make the system "maintainable".

The general perception of students towards quality was primarily that of usability, functionality and efficiency. They considered maintainability and reliability as secondary factors and no mention was made of portability. This could perhaps be contributed to the fact that students gain little experience in the implementation of the software products they develop. Other than this, the data collected regarding students' perceptions of quality correlated with the ISO 9126 standard on quality software [22].

6.3 Tools and Techniques

Several tools and techniques identified in the data collection process impacted directly or indirectly on the projects' success and quality. Respondents mentioned that adhering to the UCT coding standards provided them with useful patterns to create higher quality software products. Unified Modeling Language (UML) artifacts were used to improve requirements planning. Storyboarding and extended UML artifacts were used in the design phase. The project management section was supported by the use of Gantt charts; timesheets, risk analysis and estimation techniques. Testing emerged as a major theme, where respondents reported that test cases were used to perform more structured testing. "Testing to break" was applied more informally and unstructured, but contributed to the quality and success of the projects. A few respondents reported to have used "XP style testing", "acceptance testing" and "unit testing" which contributed to the success and quality of their projects.

6.4 Standards

The majority of respondents defined a standard as "something you need to achieve", whilst others thought that it was the "same way of doing something" or "something that is consistent and enables a predictable result". Seven of the respondents were of the opinion that standards were important as they provided guidelines, directions or a baseline for comparison. Their general perceptions of standards as an adherence to sound software engineering approaches, were close to the description of the standards in the literature [20]. Although students felt that using standards was a positive thing, they also felt that it might have limited their abilities within their teams. This is in agreement with Bennatan's [21] viewpoint that standards limit the freedom of developers. Moore [20] however, disagrees as he argues that the use of standards is completely voluntary.

6.5 Focus Areas

In the third section of the interview process the researchers attempted to gauge the respondent's awareness of the key areas of software development process as identified in the literature. Although the respondents did not list these areas directly, their responses could be categorized under the respective areas: project management, requirement planning, software design, coding and testing. Amongst others, aspects like time management, the overseeing of the project, controlling and organizing events as well as the managing of people and risks received special attention. The responses varied significantly, but comments relating to testing however showed some consistency. Barnett and Raja [18] state that many authors in the literature view testing as a means of achieving software quality. Comments like: "testing is a very, very crucial part of the systems development, and it should occur on a constant basis" and "include quality assurance and checking consistently" confirm that students agree with the view of testing being important to maintain quality and improve their final product.

6.6 UCT Guidelines

Throughout the project course clear guidelines were given to students in three major areas:

Project guidelines: The two top teams felt that their success was largely due to the fact that they followed these guidelines meticulously. The six project teams who obtained middle of the range marks also benefited from following these guidelines. Four of the five teams with very low marks confirmed that they did not follow the guidelines well.

Coding guidelines: Almost all the respondents used the UCT coding guidelines as a base for their coding structure and confirmed that it was a critical component of their project success. One team did not benefit from it. They however admitted that they had "no standard conventions" and "little coding experience". In an extreme case the top team used these guidelines as a base to develop their own "self built code generator", reducing the time to produce standardized code.

Assessment guidelines: The majority of the teams used the appropriate mark sheets and rubrics available when they produced deliverables throughout the year and when they planned their final presentations (code and project). These teams generally felt that it helped them to meet expectations and this contributed to their success. Three teams, who did not use the mark sheets in their preparation, did not do well.

In general it seemed that where project teams adhered to the UCT guidelines provided, they reaped the benefits by enhancing the quality of their system and achieving success.

7 Conclusion

The main focus of the IS Curriculum design is to provide students with sufficient experience in the application of information and technology-enabled business processes to be able to contribute to the competitive advantage of organizations [2]. Although the students' general perception of the success of projects focused more personal achievements such as the marks obtained and the learning experience of the project, they emphasized the importance of good communication and the correct mix of skills in a project. Their perception of standards as being "very important as they are best practices" and "providing a base", "gives us guidelines", or "give you direction for the future" adheres to Moore's [20] description of the role of standards [19, 22]. Testing was not always implemented in a formal manner in the student projects, but the general perception that it is a "very crucial part of the systems development" confirms the acute awareness of the importance of testing.

Through the "lived" experience of the project, students gained a better understanding of a number of different factors that contribute to the success and quality of systems development projects. Team composition, skills and communication within the teams were seen as major success factors, followed by the need to meet sponsor requirements. Student teams who adhered to the UCT guidelines consistently performed better than those who did not. In view of this finding, it is important to ensure that guidelines are aligned to industry standards and that an awareness of the benefits in using the standards is cultivated throughout the delivery of the course.

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Implementing and Sustaining Educational Change and ICT: A Case Study of a Taiwanese Primary School

Yih-Shyuan Chen and Ian Selwood

The University of Birmingham, UK
katycys@gmail.com, I.D.Selwood@bham.ac.uk

Abstract. This paper is a case study of a school in Taiwan. The School in this study has successfully implemented and sustained the integration of ICT across the curriculum to support teaching and learning, whilst other similar schools have failed to maintain the impetus of a national project. By using questionnaires, interviews and document analysis the leadership and management, organisational processes and decision-making, and ICT resources and technological adoption were analysed. The study highlights the importance of shared, collaborative leadership in implementing and sustaining the integrating of ICT into teaching and learning.

Keywords: ICT, educational change, leadership, teacher attitudes.

1 Introduction

The introduction and/or extension of the use of Information and Communications Technologies (ICT) in school settings has been of concern for some time, as is evidenced by studies of change management and ICT integration in school settings [10, 12, 14]. The significance and importance of ICT in education is widely acknowledged. Nevertheless, research has often highlighted barriers to ICT implementation in schools [5]. Studies by Kennewell et al. [6] and Tearle [14] examined factors which underpin successful ICT implementation in schools in the UK, identifying the key attributes of the ICT-capable schools: the headteacher's and senior managers' strong lead and active involvement in ICT development, collegiate work patterns amongst the staff, convenient access to ICT resources and support, and adequate staff ICT training. The above attributes were also verified by Sheppard [12] and Wong and Li [16] to be crucial for whole-school change and ICT integration in other educational contexts, including Canada and Hong Kong. Yet these researchers went further, concluding that shared leadership tended to be a radical driver for a collaborative culture which had a potential impact on sustaining school improvement in ICT development. Indeed in his studies, Selwood noted that the role of school leadership and management, particularly the headteacher's leading style, was the core of success in the widespread use of ICT in schools [11].

The ICT Seed School Project (ICT SSP) was a national ICT-related project announced by the Taiwanese Ministry of Education in 2002, that aimed to extend the

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use of new technologies in schools by integrating ICT into the curriculum. These ICT Seed Schools were given training and financial support to expand their use of ICT across the curriculum. They were then expected to support other schools with their ICT development. Some schools in the ICT SSP were very successful in implementing and sustaining the project, others less so.

Given the above context, the aim of the present research is to explore the effect of school leadership and management on educational change for ICT development. Centring on a specific rural primary school in Taiwan, this study examined the way in which the entire staff succeeded in transforming a traditional school with limited technological resources into an acknowledged ICT-capable school. Thus, the findings can possibly show the patterns of change management concerning ICT development in Taiwanese rural schools.

2 Theoretical Framework

The theoretical framework of this study was built on two areas of literature. The first of these concerns school change and improvement, with a focus on the issues of school leadership and management. Leithwood [7] examined the features of effective school management in various countries and identified three common principles of successful leadership practices: ‘setting directions’ – the development of a shared vision, consensus about school targets and high performance expectations for staff work; ‘developing people’ – enhancing teachers’ individualised and professional support, staff commitment, and important values for school development; ‘redesigning the organisation’ includes shaping a collaborative learning culture, motivating staff to participate in decision-making, and building the relationships with parents and the community.

The other area of work that influenced the design of this research was school staff’s responses to the introduction of new technologies in teaching practices. These intention-based theories are essential in bringing about an understanding of and an ability to predict individuals’ attitudes and reactions when new technologies intervene in school contexts [8, 13]. Therefore, the literature concerning intention-behaviour models, such as the Theory of Planned Behaviour constructed by Ajzen [1] and the studies of individuals’ acceptance of ICT adoption [2, 13], were used in this research to explore teachers’ reactions to ICT adoption.

3 Methodology

A case study approach is used in this research and as such the evidence used covers many sources, since multiple information is highly complementary [17]. Questionnaires, semi-structured interviews and document analyses were used for gathering both quantitative and qualitative data from the case study school. Purposeful sampling was applied to ensure the school selected for this study was an information-rich site in which the ICT Seed School Project (ICT SSP) was continuing at the time of the research.

The school selected for this research was a rural primary school in Taiwan and had 21 classes, with 578 pupils on roll, and 30 teaching staff plus the headteacher. Prior to being involved in the ICT SSP the target school was short of technological resources. However, it has become publicly acknowledged as an ICT-capable school and officially recognised by the Ministry of Education as a model for other schools, and its experiences in change management for ICT disseminated around many schools in Taiwan. In addition the school also provides training sessions in the use of ICT for parents and teachers from other schools. Furthermore, to confirm the school's status as a high achieving school the researchers carried out a measure of its "ICT maturity" using the tool developed by Underwood and Dillon [15] and the school showed a high level of ICT maturity.

Questionnaires were distributed to 28 school staff and responses were received from 25 (89%). Following an initial analysis of the data 22 members of staff were interviewed: 10 were from the ICT instructional team[1], 6 were teachers from outside this team, and another 6 were seen as key personnel (the ex- and current headteachers, ex- and current directors of academic affairs, the ICT coordinator and an ex-teacher). All the interviews were recorded and then transcribed. Data was also collected by analysing official school documents such as development plans, school policies and minutes of meetings.

4 Findings

The findings from this research were obtained by examining the staff's opinions on the following issues: leadership and management, organisational processes and decision-making, and ICT resources and technological adoption.

4.1 Leadership and Management

The research data showed that a large proportion of respondents (97% from the questionnaires and 100% from the interviews) were positive about the leadership and management approaches to ICT development in the school. The leadership style was seen as collaborative and supportive by all respondents and 92% of the questionnaire respondents felt that the school's aims and direction were clear when undertaking educational change resulting from central government initiatives.

Supporting the data from the questionnaires, all teachers who were interviewed confirmed that the headteacher's strong leadership, together with a clear school vision and strong support for educational innovations, encouraged them to accept the need to implement ICT innovations. When asked about their opinions on the governmental action on educational shift, 16 interviewees (73%) felt positively that change was essential for progress in all aspects of education. They also concluded that the staff generally welcomed educational change for school improvement and were prepared to take risks as part of the improvement process. For instance one teacher said:

> *"Of course, making change cannot always guarantee the desirable outcomes."*

[1] The ICT instructional team was an ICT-focused learning community within the school whose members were the headteacher, departmental directors, ICT coordinator and classroom teachers.

Delegation of responsibilities to the staff was also mentioned positively and repeatedly in the interviews. As the headteacher declared, he personally did not take a direct lead in ICT innovations in the school. Instead, it was his belief that delegating power to the teachers with ICT knowledge and great enthusiasm about school management was the way of strengthening their commitment to strive for excellence in ICT implementation. On this basis, he felt comfortable empowering the staff with ICT expertise to lead the school in making progress in implementing ICT. Indeed the headteacher contended that:

> *"Without the continuous and joint efforts of the ICT coordinator, director of academic affairs and classroom teachers in managing school-wide educational innovations, it would have been almost impossible for our school to launch and sustain ICT improvement."*

The headteacher's firmly-held belief in shared leadership and management may explain why all interviewees attributed their present level of ICT implementation not only to the strong lead from the headteacher, but also to the exceptional competence of both the ICT coordinator and director of academic affairs in guiding the school through the difficulties in integrating ICT.

For the ICT coordinator and director of academic affairs, it was the headteacher's great trust in their abilities and that they were able to have a strong sense of freedom in managing whole-school ICT improvements. The ICT coordinator also maintained that:

> *"We all understand that our headteacher is not specialised in new technologies…[Yet] whenever the government's funding is not sufficient enough for us to upgrade our ICT equipment, he [the headteacher] is sure to make efforts to solve the "money problems"…This is really helpful…He encourages us, helping us overcome the growing pains in the course of managing the ICT SSP."*

When explaining how staff collaborated in implementing ICT across the curriculum, 96% of the interviewees raised a common example as follows. In order to put the plan for ICT integration forward, the ICT coordinator and director of academic affairs invited classroom teachers, particularly those who were ICT competent, to constitute the ICT instructional team which offered instructional and technical assistance in meeting teachers' individualised demands for teaching with ICT.

Importantly, apart from the headteacher and other managers, teaching staff in the ICT instructional team were identified by many interviewees (77%) as teacher pioneers in extending the use of ICT in the school. This is mainly because before the start of school-wide technological adoption, the ICT instructional team worked together with the ICT coordinator in developing and experimenting with different modes of ICT-integrated curricula in selected classes. These trials, associated with action research, enabled the ICT instructional team to share their experiences of ICT integration, including suggesting strategies for overcoming challenges, with other teachers in advance. As a result, most teachers came to realise the ways of preparing themselves for confronting the educational innovations in teaching practices. Given this context, it may be unsurprising that 76% of the respondents to the questionnaires reflected that the staff as a whole were always ready to engage in educational change, and that the processes of change management in the school were generally acceptable. It could be said that not only the formal leaders and managers (i.e. the headteacher and directors), but also teachers from the ICT instructional team were the core in permeating the ICT culture throughout the school.

However, it would appear that the ethos of collaborative leadership had been rooted in the school before the current headteacher took up his post. For instance, in the interview with the ex-headteacher, he asserted that all teachers could be good leaders in their specialised areas if they were given suitable opportunities. Like the current headteacher, the ex-headteacher had also enabled school staff to feel free to exercise leadership practices in the school. As all teachers in the interviews contended, before undertaking the ICT SSP, the staff were frequently involved and participated in planning and decision making. Moreover, 86% of the interviewees pointed out that before commencing the ICT SSP, regular staff workshops for sharing individuals' experiences and new knowledge had already served as a solid foundation for constructing a positive atmosphere for staff teamwork. The interviewees specifically said that their previous experiences in implementing and managing government initiatives had taught them that mutual support within the staff assisted in overcoming difficulties. Hence, the staff accepted working and learning together with their colleagues as a natural part of the approach to dealing with educational change.

Notably, sharing responsibilities in leadership and management seemed to be a commonplace in the school, rather than being restricted to the area of ICT implementation. As the interviewees highlighted, distributed leadership was not restricted to ICT developments but applied to all areas of the school.

4.2 Organisational Processes and Decision-Making

Staff views on organisational processes and decision-making in the school were found to be generally very positive. All respondents believed that the staff at all levels were involved in decision-making and vested with adequate decision-making power, and that each of them took a defined role and responsibility in the organisational processes. Open debates and reflective evaluations were regarded by most respondents (96%) as the usual approach to assessing the overall organisational performance. An equally large number of respondents (96%) felt that staff communication was effective, and that they were kept well informed in respect of executive decisions and school policies. A considerable number of respondents (92%) recognised that sharing responsibilities and close collaboration between teachers and leaders/managers was commonplace, particularly when making school plans. The same proportion (92%) confirmed that leaders consulted teachers about decisions which would affect the whole school.

Further information from the interviews reflected that 91% of the staff enjoyed being involved in the decision-making processes. Although many admitted that contentious issues sometimes resulted in conflicting tensions, the interviewees claimed that with the prompt mediation of the headteacher and other senior managers, the conflicts turned into the constructive discussions, and this allowed them to consider deeply the issues under discussion, and this facilitated shaping shared values and developing a consensus before decisions were made.

One experienced teacher said:

> *"It doesn't matter which post you are holding, your voices are always respected. People in this school care about others' feelings and thoughts both at formal meetings and in informal discussion. Whilst it is inevitable that some proposed ideas incurred our criticism at the very start, we are still willing to try them out to see how they work for our school. This is how we do things here."*

While an inexperienced teacher noted:

> *"This school is like a family and the morale is very high… It was really heart-warming that everyone here tried making me feel accepted."*

4.3 ICT Resources and Technological Adoption

It is apparent that even with good leadership without technological equipment and technical support a school can not integrate ICT effectively. Thus staff were asked their opinions on these aspects. Responses to the questionnaire showed that staff believed - hardware matched their needs (100%), software met their needs (96%), technical support catered for their needs (96%), ICT resources were useful for their teaching (92%), application of ICT enhanced teaching effectiveness (92%), and ICT resources were always accessible to the staff (88%).

The questionnaire data revealed that generally speaking teachers were confident and competent users of ICT. All respondents showed their confidence in ICT adoption, claiming that they were competent users of ICT and that they applied ICT appropriately to support teaching and learning; 88% believed that ICT adoption reduced their workload, and the same percentage (88%) felt that the staff had been trained in all aspects of ICT necessary for their teaching. More importantly, nearly all respondents (96%) were satisfied with the long-term training for the ICT SSP.

As might be expected given teachers' positive responses to the questionnaire, the interview data reported the staff's high satisfaction with the access to ICT facilities and technical support in the school. The interviewees also stressed that the ICT training held in the school demonstrated the strategies for developing the ICT-integrated curriculum. Thus, staff members, including those who at the start of the ICT SSP had limited ICT skills, became clear about the ways and benefits of using new technologies in teaching and learning. More importantly, the ICT instructional team and the ICT coordinator conducted the regular audits of teachers' ICT skills and needs. Based on these audits, the school then provided differentiated training sessions to meet staff and school needs. In addition, knowledge sharing through staff meetings and informal discussions enabled teachers to understand the utility of ICT and procedures for integrating ICT. For the interviewees, formal ICT training and informal staff discussions were useful for improving understanding the concepts of ICT adoption into their teaching practices.

The questionnaire data revealed that sufficient equipment, timely technical support and suitable training sessions were the base for extending the use of ICT in the school. However, when, compared with the responses concerning leadership and organisation processes above, 94% of the teachers in the interviews rated the strong determination and high expectations of the headteacher and other senior managers in pursuing ICT improvement was most influential on their willingness to engage in instructional innovations with ICT. Interviewees also stressed the endeavours of the headteacher and other senior managers to lead the school in establishing good relationships with parents and the community so that this solid school-community connection facilitated the school obtaining financial support from parents and neighbouring colleges, particularly when technological resources were limited at the commencement of ICT implementation.

5 Discussion

Whilst generalisations are impossible from the results of one case study, interesting issues can emerge. With respect to school leadership and management, it was clear that the evidence reinforced the conclusions of recent studies that the supportive and proactive lead from the headteacher in educational change is critical for school-wide instructional innovations concerning ICT integration [11, 16]. Furthermore, it is apparent that the headteacher's comprehension of the staff's quality (i.e. skills and interests), together with his good appointment of the competent teachers as leaders and managers (i.e. the ICT coordinator and departmental directors), seemed to be essential for success in planning and initiating whole-school ICT developments. Moreover, school leadership for innovations in ICT was not limited to managers and ICT experts at the implementation stage of ICT development. The leadership of a group containing classroom teachers (the ICT instructional team) helped the entire implementation of ICT by providing prompt feedback and solution of staff's individual problems.

The above findings reflect that leading and managing in the school was not the domain of any individual, but devolved across many members of staff. Furthermore, it appears that the headteacher's delegation of leadership to specific staff with vision and passion about ICT development, in the very early stages of implementing ICT, was critical for the effective commencement and continuity of whole-school ICT improvement. Such findings support the international multi-case studies by Leithwood [7], who affirmed teachers' participation in school leadership as an important foundation for successful change in nearly all educational contexts. The findings also support Sheppard's work, which reported that schools succeeding in developing ICT had participative or shared leadership but had at least one key person who acted as a leader and champion of school change for ICT implementation [12].

There is no doubt that staff collaboration in leadership and management is instrumental in school change. The evidence gathered here demonstrates that staff's collegial interaction and applying shared leadership to managing school improvements were formed through a long-term process, and were not confined to a particular domain, but permeated all aspects of school improvement. Similar results were also shown in Tearle's studies of effective school change for ICT development [14].

In addition, teachers in the school seemed to readily accept new ideas and educational change. The staff's awareness of the necessity for school change underpinned their intentions to keep improving in ICT implementation even when challenges occurred. Indeed the literature of educational improvement notes that school staff are typically willing to undertake change and development when feeling a critical need for doing so [3, 4].

The findings related to organisational processes and decision-making made it evident that the school fostered high morale and a collaborative culture where collective plans and establishing a shared vision through open debates and reflective evaluations appeared to be deeply rooted in the staff working processes. This finding, that there is a strong link between shared leadership and a positive culture for school staff collaboration, has been well documented in other studies concerning successful ICT implementation [12, 14, 16].

The headteacher and senior managers not only respected the divergence of individuals' opinions, but also assisted in moving wide-ranging debates forward to constructive dialogues for reaching common values amongst the staff. More specifically, even without formal management duties, some classroom teachers voluntarily managed and strengthened social networks of colleagues, and this was considered by the staff as instrumental for dealing with school-wide change. Again, these finings could correspond to Leithwood's assertion of the basic features of effective school management [7]. In his work, Leithwood claimed that successful headteachers have capacities for developing teacher consensus about the issues under discussion. On the other hand, they are competent in encouraging teachers to spontaneously engage in instructional innovations by means of reflecting upon existing practices critically, questioning taken-for-granted assumptions and participating in organisational processes.

With reference to staff views on ICT resources and technological adoption, the evidence showed the importance of sufficient ICT equipment and staff training cannot be over emphasised. Similar findings were also reported in other studies [11]. The approach of frequently auditing staff skills and needs and differentiated training based on this is worthy of note.

Furthermore, both formal ICT training and knowledge sharing amongst staff members in an informal manner facilitated teachers in perceiving the advantages of ICT integration and assimilation of new pedagogies regarding ICT into their teaching strategies. It could be summarised from these findings that the teachers were willing to deal with challenges caused by technological adoption, as long as they felt that using ICT for teaching and learning were compatible with their present instructional experiences and matched their needs. The studies by Chau and Hu [2], who explored organisational members' acceptance of technological adoption outside the educational field, also found that compatibility was the primary factor which determined whether individuals accepted or resisted the use of new technologies.

A particularly interesting issue which emerged in this study was that teachers' commitment to ICT development seemed to highly depend on the perceptions of their colleagues' resolution to improve schooling. Indeed, the interviews showed the teachers were conscious of the efforts of the school leaders (i.e. the headteacher, directors and ICT coordinator) and ICT instructional team to transform the school into an ICT-capable school, and this raised the entire staff's determination to launch and sustain ICT developments. Therefore, even though the school was limited in ICT resources at the very start of the development process, the teaching staff still had a strong will to work together in managing school improvement for ICT integration.

6 Conclusion

The school's achievement in implementing and sustaining its use of ICT was not simply the result of the headteacher's strong leadership, but the joint and intense engagement of staff members in leadership and management. Although the factors which affected ICT implementation in the school were inter-related rather than discrete, it was evident that collaborative leadership played the key role in underpinning school change for ICT implementation. Indeed, the finding of this study may be parallel to Morrison's argument that 'change concerns people more than content' (p. 15) [9]. Finally, as with work of Sheppard [12], this case study highlights the essential link between leadership and successful implementation of ICT in schools.

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The Mexican National Programs on Teaching Mathematics and Science with Technology: The Legacy of a Decade of Experiences of Transformation of School Practices and Interactions

Ana Isabel Sacristán and Teresa Rojano

Center for Research and Advanced Studies (Cinvestav), Dept. of Mathematics Education,
Av. Instituto Politécnico Nacional 6058, D.F., Mexico
asacrist@cinvestav.mx, trojano@cinvestav.mx

Abstract. Here we give an overview of the Mexican experience of a national program, begun in 1997, of gradual implementation of computational tools in the lower secondary-school classrooms (children 12-15 years-old) for mathematics and science. This project illustrates, through the benefit of long-term hindsight, the successes and difficulties of large-scale massive implementation of technologies in schools. The key factors for success and for transforming school practices seem to be: adequate planning, gradual implementation, continuous training and support, and enough time (years) for assimilation and integration.

Keywords: Computers and technology in schools, national program, policy-making, teaching, mathematics, physics and science.

1 A Government Initiative for the Use of Computational Technologies in Mexican Classrooms

In 1997, the Mexican Ministry of Education (SEP) – in collaboration with several institutions such as the Latin-American Institute of Educational Communication (ILCE), the Center of Research and Advanced Studies (Cinvestav) and the National Autonomous University of Mexico (UNAM) — had the initiative to incorporate computational technologies to the primary and secondary (middle-school) levels. The aim was to 1) introduce in a gradual and systematic way the use of digital technologies into schools; 2) put into practice a meaningful use of those technologies using a pedagogical model that would improve and enrich curricular content; and 3) explore the use of technology for teaching to go beyond the curriculum and give early access to powerful ideas.

For secondary schools (children aged 12 to 15 years old) the initiative began with two parallel programs: "Teaching Mathematics with Technology" (EMAT) and "Teaching Physics with Technology" (EFIT). In a later phase, the project "Teaching Science through Mathematical Modeling" (ECAMM) was added, and EFIT evolved

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into the broader "Teaching Science with Technology" (ECIT) program to include Physics, Chemistry and Biology. (See [1] for a more comprehensive history of these programs).

These programs aimed to promote the use of new technologies, using a constructivist approach, to enrich and improve the current teaching and learning of mathematics and science in Mexico. A study [2] carried out in Mexico and England involving mathematical practices in science classes, revealed that few students were able to close the gap between the formal treatment of the curricular topics and their possible applications. This suggested that it was necessary to replace the formal approach of the then official curriculum in Mexico, with a "down-up" approach capable of fostering the students' explorative, manipulative, and communication skills.

Thus, a major part of these programs was to design activities and a pedagogical model for incorporating the use of technological tools to teaching that emphasized exploratory and collaborative learning. Technology and the computational instruments [3] are conceived as support tools mediating action [4] and students' construction of concepts. The principles characterizing the programs are summarized in the official documents (e.g. [5]) in the following way:

- A use of computer software or technological tools (e.g. calculators) that makes it possible to deal with concepts in a phenomenological way; provides representations of mathematical objects that can be directly manipulated; is related with a specific area of school knowledge content; e.g. for school mathematics: arithmetic, algebra, geometry, probability, etc.
- Specializes the users of the technology (teachers and students) in one or more pieces of software and/or tools so they become proficient in its use and are able to apply it for the teaching and learning of specific curricular topics.
- Puts into practice a collaborative model of learning: students work in pairs with one computer, thus promoting discussions and the exchange of ideas.
- Incorporates a pedagogical model where the teacher's role is that of promoting the exchange of ideas and collective discussion; at the same time, acting as mediator between the students and the technological tools (the computational environment), aiding the students in their work with the class activities and sharing with them the same expressive medium (tool).

The design of the pedagogical model, the choice of tools, and the activities was carefully carried out by researchers, both Mexican and international from top institutions in the world (who served as external international experts and advisors), taking into account results from studies in computer-based education for the practice in the "real world". For the pedagogical model, much of the philosophy and pedagogy underlying the design of mathematical microworlds [7] – which takes into account, not only the technical component, but the learner, the pedagogical and teacher components, as well as the contextual and social setting – was present in the design and recommendations for the EMAT and ECIT laboratories. Thus, emphasis was put on the changes in the classroom structure, such as the requirement of a different teaching approach and the way the classroom needs to be set up: from the physical set-up of the equipment, to the collaboration between students, to the role of the teacher, to the pedagogical tools (e.g. worksheets) [5]. In particular, the pedagogical model emphasizes a collaborative model of learning, with students working in pairs or teams for each computer (and the classroom computers set-up in a horseshoe fashion) for promoting discussions and the exchange of ideas.

The teacher's role is that of acting as a mediator between the students and the technological tools (the computational environment); guiding and aiding the students in their work with the class activities; intervening as necessary to ensure higher levels of conceptualization by students; promoting in students exploration, the formulation and validation of conjectures, the learning and analysis of mistakes, as well as the expression, exchange and collective debate of their ideas; and integrating the knowledge that is generated in the computational context with the more traditional mathematical knowledge.

The activities are organized through worksheets that aim to lead students to reflect on the work carried out with the technology and to synthesize it so that they can communicate it. The activities (piloted for over 3 years) of EMAT / ECIT are laid out in 16 books (most of them available for download at www.efit-emat.dgme.sep.gob.mx) that give a complete curricular development. The worksheets are intended to promote the model of collaborative work in the classroom. The sequences of activities were designed taking into account evolving lines in the different curriculum contents. For instance, for the mathematical activities: from arithmetic to algebra; from intuitive to exploratory dynamic geometry; from static descriptions to variation models; from solving closed problems to modeling.

Also, these worksheets, when filled-out, can give teachers information on students' work and the understandings of the concepts involved in a task.

EMAT and ECIT are designed to be carried out in a normal computer room, with a preference for software that allows open content (often shareware or freeware as well as software that is generally available in most computers – such as spreadsheets). ECIT also includes the use of simulators and sensors as well as interactive units for specific areas of the curriculum.

The gradual implementation of the EMAT and EFIT programs: From 1997-2000, the EMAT and EFIT programs were piloted in 14 states (out of 33) of Mexico, in 28 junior secondary schools. In the first year there were 33 participating teachers, which increased to 157 in the second year, and 905 in the third year. In this trial, we had the participation of national experts from the Center of Research and Advanced Studies (Cinvestav), the National Autonomous University of Mexico (UNAM), the Autonomous Technical Institute of Mexico (ITAM), and many state universities such as those of Coahuila, Durango, Colima, Morelos, San Luis Potosí, Aguascalientes, Michoacán e Hidalgo.

The programs were conceived to be expanded gradually in different ways, while preserving the quality of teacher training and of practice and implementation of the models in the classrooms. The ways of expansion were: 1) in the number of participating schools, teachers and students; 2) in regional coverage; 3) in the tools being used; 4) in curricular topics; 5) in school levels; and 6) in secondary school modalities (e.g. regular schools, technical schools, "tele-secondary" schools).

The expansion phase started in 2001. Adjustments were made that were derived from the results of the pilot phase, including adaptation of the tools being used. Implementation of the EMAT and ECIT programs expanded gradually and exponentially in the national public school system. Although we had conceived a gradual implementation everywhere, some states (such as Coahuila) decided to implement these models massively, and in those cases the support of local academic groups in universities was fundamental.

In terms of curricular expansion, the ECAMM (Teaching Science – Physics, Biology and Chemistry— through Mathematical Modeling) was developed as an extension to both EMAT and EFIT (although it follows naturally from EMAT), which uses mainly spreadsheet, graphing calculator and paper-and-pencil activities. Later, as mentioned above, EFIT was extended to include activities and materials for Chemistry and Biology, as well as Physics, becoming the ECIT (Teaching Science with Technology) program. Another extension was an attempt to adapt the models to the "Tele-secondary"[1] (*Telesecundaria*) school model.

In terms of teacher-training, during the pilot stages, teacher-training was undertaken directly by the national and international experts, and there was continuous support of the teachers. In the expansion phase, however, due to the immensity of the scale of the program, this was no longer possible. A cascading model was implemented: the experts trained trainers who in turn trained teachers and/or head-teachers, who in turn were supposed to support other teachers. This carried with it the problem of a "faulty line effect" where the quality of the training was diluted (particular in that which concerns the understanding of the pedagogical model); but this was an unavoidable problem. In this sense we observed that the support of local academic groups (e.g. from local universities) or of a local advisor was crucial: having a local structure for needed support and continuous training has been observed to make a huge difference on whether teachers and/or schools continue to use the models or not.

In 2007, a change in government meant that federal support for the EMAT, EFIT, ECAMM and ECIT programs was dropped, but these programs continue in many states supported by the local state governments; and in other parts of the country more and more teachers use the program materials often simply because they find them useful.

2 The EMAT Program

One of the most extensively developed and implemented educational technology programs in Mexico has been the EMAT program. It followed the principles outlined in sections above, including the pedagogical model. In terms of the software and tools used in the EMAT program, a main criterion for their choice was to be the open tools [5]; that is where the user can be in control and has the power of deciding how to use the software. This allows for the construction of learning environments where students are able to decide on how to proceed, as opposed to other types of computer software that direct the student and the activity. These open tools have to be flexible enough so that they can be used with different didactical objectives, such as those designed for the program.

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[1] The *Telesecundaria* School program –which began four decades ago, in the late sixties— is an educational model of the Ministry of Education for reaching the wider community (e.g. rural areas) that may not have access to regular lower secondary schools: in a Telesecundaria school, learning is mediated by a teacher-promoter for all subject areas, structured through learning guides, content guides, and television programs.

In its first phase (1997-2000), using a pilot group of approximately 99 teachers and 10526 students in 8 states, the project researched the use of spreadsheets, Cabri-Géomètre, SimCalc, Stella and the TI-92 calculator, all aiming at covering curricular topics such as arithmetic, pre-algebra, algebra, geometry, variation and modeling. In the first year, different technology was implemented in different sites; the first generation groups used different technological tools, except for the calculator that was used by all groups. Specifically, spreadsheets were used in 1st Grade (children 12-13 yrs-old); Cabri-Géomètre in second grade; and SimCalc in third grade; and the TI graphing calculator in all grades. In the following two years, the expansion was done gradually, by working with more teachers and grades in each school, thus giving the necessary training for each added tool. In this way, in the first three years, the participating teachers in that phase received training in at least three tools.

The conclusions derived from the experiences in this pilot phase were that it was easier for teachers to incorporate spreadsheets, the graphing calculator, and the dynamic geometry software into their practice. Thus, in the following expansion phase (2001-2006), these were the tools that were used, together with two added tools: Logo, and CAS (Computer Algebra System) activities with the calculator. The decision to add the Logo programming language was taken at the suggestion of both national and international advisors who evaluated the first phase and pointed out that there was still the need for more expressive tools and activities (such as programming), on the part of the students, and they suggested Logo. Logo had actually been considered since the beginning, but due to political factors, could not be included in the first phase. The addition of Logo proved to be very enriching in many schools, where often it became a students' favorite, but also enhanced and complemented the use of the other tools [6]. SimCalc and Stella were dropped because it was hard to fit these tools into the curriculum without a more extensive teacher-training that was hard to achieve. However, we are now reconsidering use of SimCalc, since the new curriculum implemented in 2007 includes elements of the mathematics of change and variation.

By the year 2003, the EMAT project had been implemented in 731 schools in 17 states, with 2283 participating teachers and close to 200,000 students (out of a population of over 5.7 million lower secondary school registered students); after that, many more states joined the program and teacher-training workshops were continuously held all over the country.

3 The EFIT/ECIT Programs

EFIT is the result of an adaptation to the Mexican school system of physics education, of the Canadian model: *Technology Enhanced Science Secondary Instruction* (TESSI). In EFIT, through activity guides, students explore physics concepts in four ways 1) through computer simulations; 2) through laboratory activities using sensors to collect data that is transferred to the computer; 3) carrying out experiments with computer software or multimedia equipment and 4) carrying out traditional physics laboratory experiments. These four approaches naturally give rise to "working stations" within a class session.

The main tools initially used in EFIT, besides traditional physics laboratory equipment, were: *Interactive Physics*, for simulating real-world situations and visualizing phenomena; sensors for measuring real phenomena (originally the Pasco Probes: Pasco Introductory Physics Bundle and Smart Pulley); *Nih Image*: for processing and analyzing images; Internet; multimedia and videos; MSOffice; as well as an NCS Optical Scanner, and the LXR Test V. 51, Scoring edition and Interactive extension for computer-aided assessment.

In the expansion phase, the EFIT program began using mainly the Interactive Physics model and a set of sensors (which were, in later years, custom-made for the program) because these are enough to cover the curricular content. In that phase new physics activities were also designed, as well as expanding the model to include Chemistry and Biology activities, thus giving rise to ECIT.

4 Results of the Evaluation and Assessment of the "Teaching with Technology" Programs

Over the past decade, various studies have attempted to evaluate the projects from different perspectives. We know that from a theoretical point of view, the complexities of evaluating innovative computational environments – especially when they aim to be systemic – are far from resolved, and so this is a difficult task. Research has been carried out using both global and local levels of assessments. The global level focuses on understanding the educational system as a complex model that includes teachers, headmasters, authorities and parents as essential elements, whose observations also form part of the assessment of the project's collective ways of thinking about itself [8]. On the other hand, the local level concentrates on the specific learning of students, and the use of the tools with respect to student profiles combining both quantitative and qualitative (e.g. longitudinal case studies) research methodologies[2]. On the local level, we have been trying to gather data from two different angles, each of which informs the other.

On the one hand, we are assessing the use and implementation of the project tools, materials and pedagogical model. For this we use a variety of quantitative and qualitative instruments: field observations, interviews and questionnaires both for teachers and students. On the other hand, we need to evaluate students' learning. Since this is such a large-scale study, the evaluation of student learning has relied mainly on traditional school-mathematics items and quantitative techniques (e.g. pre- and post-tests; academic scores). Thus, not surprisingly, many results related to students' learning have been inconsistent. But data from the local level of assessment (written questionnaires and pupil interviews) from samples of students in selected states, was also used to analyze the evolution of skills and specific knowledge within the mathematics curriculum, as is reported in [9].

In general, research has shown that the programs have had a positive impact on students. For EMAT, it has been found that, in general, the use of the computational tools has had a very strong positive impact on children's attitudes towards mathematics, although the impact on learning is more difficult to assess. For example, [10]

[2] This research was sponsored, in part, by the CONACYT research grants G26338-S (until 2003) and 44632-S; in part by ILCE; as well as by other sources and grants.

reports that there is a clear increase in students' enthusiasm and motivation; and although the impact is different for girls and for boys, the behavioral changes observed seem to lead to more gender equity.

The pilot phase (1997-2000), despite some difficulties, was groundbreaking in changing the role of the teacher and children: the changes in classroom dynamics modified the traditionally passive attitudes of children and empowered them, giving them a status almost equal (and sometimes even higher than the teacher) when involved in mathematical explorations with the tools [11]. The pilot phase thus created an irreversible change that seemed to indicate at the time, that it would allow for technologies to be incorporated, in an adequate way, into the Mexican school culture.

Despite these positive results, many issues and difficulties were detected. One finding is that the use of the technology made teachers aware of their deficiencies of their content knowledge, which had two types of consequences: in some cases this put teachers off wanting to work with technology; in other cases it motivated and helped teachers improve their content knowledge. We have also found that the teacher's attitudes and abilities towards the use of the technological tools and programs, have an impact on students' learning with the tools. Putting it bluntly, "good teachers" achieve good results: they are able to take advantage of the technological tools and their students benefit from those experiences; but less experienced, poorly trained teachers, or simply teachers who dislike the technological tools, do not do so well [9].

Other outstanding issues have been: lack of experience working with technology by both teachers and students; lack of adequate mathematical and content knowledge competency on the part of the teachers; difficulties in adapting to the proposed pedagogical model; teachers' lack of free time to prepare anything outside the established curriculum[3]; lack of adequate follow-up teacher training and support because of administrative issues; many other bureaucratic difficulties; and lack of communication between the different levels of authorities.

In relation to the first issue – the lack of experience working with technology—in the years since the programs were first put into practice, teachers and students are now, more and more, much more familiar with computers prior to working in the technology programs. This is a cultural change as computers become more prevalent in society. But we still find many teachers that have difficulties and lack technical ability and self-confidence in the use of both the computer and the tools.

As to the other issues, none of these have been fully resolved. What became apparent since that pilot phase is that factors not present in laboratory settings come into play, when implementing a project such as this one, "out in the real world". (See [1] for comprehensive reports on the results of the associated investigations to the technology programs).

5 The Technology Programs Ten Years Later, and Their Legacy

The EMAT program, as well as the ECIT program to a lesser degree, have been a model in our country (and even internationally) of massive educational innovation

[3] This had as consequence that the EMAT worksheets became a means to structure the activities, which in turn also became much more directed than originally planned.

whose main principle is that of using computational environments as a means for students to develop knowledge in new ways while opening paths of communication and social interaction in the classroom where meaningful discussions can take place between students and the teacher and amongst students. A decade of implementation of this program in secondary schools (children 12-15 yrs. old) in Mexico has left a wealth of experiences and results, which have been reported over the years and which we will attempt to synthesize and draw upon here. The characteristics of EMAT, in terms of its basic design principles; its implementation methodology; the diverse and extensive participating groups (researchers, software developers, educational authorities, teachers and students); its international background; and its close link with educational research, have implied that the decade of results and experiences that are derived from that program have had an extensive influence that surpasses its local experimental implementation. One area, in particular, that was influenced by EMAT is the curricular reform of the secondary school mathematics programs in Mexico and which has been an explicit reference for the use of technology in the curriculum of other countries.

Sadly, as mentioned above, in 2007, federal support for the EMAT/ECIT programs was dropped. However, the programs continue to thrive, particularly in some states such as Hidalgo, Durango, Morelos and Michoacán, where the programs were taken up by state authorities and/or by local university academic groups. In these states the programs have expanded gradually, with high-quality teacher-training plans and support groups led by local experts and teachers with long-term experience in the implementation of the EMAT/ECIT programs in schools. Some states, for example Hidalgo, have set-up a support and development structure with regional coordinators and head-teachers, as well as academic experts, who meet monthly and have developed an integrated syllabus with recommendations for the use of all the different tools, as well as new activities, according to the different areas and requirements of the curriculum. We consider this not only an important phase in the incorporation and development of the programs (where local groups take the initiative to enrich and complement the programs), but also an indicator of how the programs are appreciated and begin to be integrated into the broader school culture.

In another form of expansion, the programs and models have spread in other states, through teachers telling other teachers, who more and more demand support. This makes the lack of federal support a pity. We cannot keep track of how many teachers and/or schools have used the programs in this way, but we regularly get some information about this. Moreover, there are schools where teachers have become real enthusiasts of the program, using the different tools in an integrated way in their own activities and long-term school-projects (e.g. [12]), even achieving recognition for their work in technology-in-education events and fairs

Having teachers, schools, and states begin making the models and tools their own, incorporating them into their practices in an unforced manner, and complementing them with new activities is the long-term legacy of the programs. We feel that programs such as the ones discussed in this paper take a long time to properly take roots and develop. It is only now that we see these programs being assimilated into local educational systems in many parts of the country. But this is why we feel compelled to tell this story of a successful implementation program, as an example for researchers and policy-makers that the changes that can be brought about by the use of technology in schools can only happen adequately, through well thought-out programs, over long-terms of time and with adequate support. Those, we believe, are key factors: planning, gradual implementation (so that adjustments can be made), enough time (e.g. before expecting results) and continuous support.

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Trust and Conflicts in Distance Learning Higher Education Courses Tutor Teams

Aline Pereira Soares, Marina Keiko Nakayama, Ricardo Azambuja Silveira, Andressa Sasaki Vasques Pacheco, Patrícia de Sá Freire, and Kelly Benetti

Universidade Federal de Santa Catarina, UFSC, Programa de Pós Graduação em Engenharia e Gestão do Conhecimento – PPEGC/UFSC - Bairro Trindade - Florianópolis - Caixa-Postal: 476 - Santa Catarina - CEP 88040-970, Brazil
{Aline.Pereira.Soares,Marina.Keiko.Nakayama, Ricardo.Azambuja.Silveira,Andressa.Sasaki.Vasques.Pacheco, Patrícia.de.Sá.Freire,Kelly.Benetti}alinepsoares@yahoo.com.br

Abstract. This study reports on research carried out on 105 tutors working on distance graduate courses at the Federal University of Santa Catarina (UFSC) to assess the relationship between the level of trust and the conflict management in tutors of distance learning based graduate courses at UFSC on the AVEA - Virtual Environment of Learning. The research uses descriptive and quantitative methodology. It should be highlighted that the level of trust of the whole team prevails in the relationships, which explains the adoption of the Integration style, considered the most appropriate for creative solutions in moments of conflict.

Keywords: Distance Education, AVEA - Virtual Environment of Learning, Trust, Conflict, Tutors team.

1 Introduction

Modern organizations are faced with constantly-changing environments which cause significant alterations in the way in which they were, are and will be administered. The uncertainties provoked by the Information Revolution process, deregulation and the new management models, are the great challenge that individuals, organizations and society have to confront on a daily basis. Contact with phenomena such as information volatility and constant pressure, has been changing old paradigms set in place since the industrial society and which are modifying individual concepts and generating the constant feeling of anxiety, stress and conflicts.

From this line of thought, the models used to manage teams , competencies, work processes and organizational knowledge, need to be put in evidence and corrected so that conflicts becomes an opportunity for reorganization and adaptability of the system. It is also important to mention that the rise in new concepts for organizational climate improvement are increasingly dependent on the sharing of tacit knowledge among the people and its transformation into explicit knowledge, associated with the sustainability of the system.

In organizational environments, conflict is inevitable, specifically in Higher Education Institutions – IES - which implemented Distance Learning Education as a practice

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to promote a form of education accessible to many, and one which consequently faces processes of constant change. However, if organizational agents learn to identify and manage possible conflicts which may arise within this process and use these as matrices to solve problems [13], the managers can learn extensively about the system into which they have been placed. In addition to combining explicit knowledge – generally produced by the Higher Education Institutions – IES - and sent to the Centers; to the tacit [9] – the knowledge resulting from daily, regional experience of the on-site Centers.

This paper presents a empirical research with the tutors team of Brazilian Open University Project (Universidade Aberta do Brasil -UAB) in partnership with the Federal University of Santa Catarina (Universidade Federal de Santa Catarina (UFSC), which has been working with distance learning since 1995. The partnership between UFSC and the Open University of Brazil (UAB) was extended to all over the country. In February 2008, several graduate courses were set up with a big team called Distance Tutors (working at UFSC) and On-site Tutors (working at the attended towns). This team constitute the universe of this research.

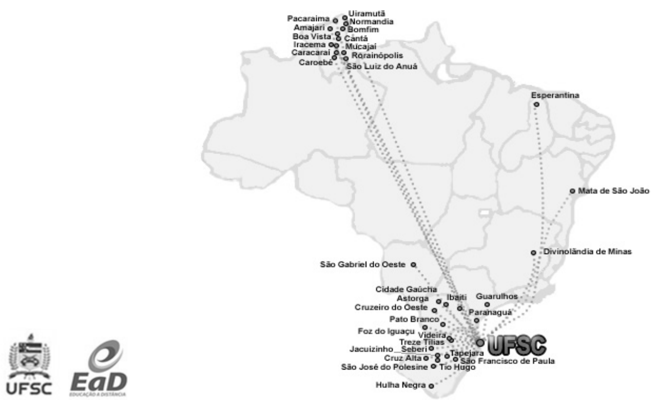

Fig. 1. UFSC sites: cities where the graduate distance learning courses are available

The Federal University of Santa Catarina offered graduate courses in Administration, Biology, Accountancy, Economic Science, Philosophy, Spanish, Portuguese, Physics, Mathematics and LIBRAS (Brazilian Signals Language), in more than 30 cities and towns in several Brazilian states, catering for approximately 6000 students and employing 130 teachers and 230 tutors. This includes those who work in the Centers (on-site) and those who work at UFSC (distance learning) The partnership with the UAB involves approximately 50 public, Brazilian, higher education institutions involved in about 200 courses in 300 centers. Fig 1 shows the cities where the graduate distance learning courses are available.

The managers of distance education graduate courses perceived the need to train the tutors' team to improve the use of the virtual environment of learning, and to make contact each other to improve their experience and the interaction of the whole team. Another objective was to provide greater contact with the Institution, i.e. acquire a deeper understanding about UFSC and what it represents to the country, in order to integrate the work of a team comprised of 105 people from different Brazilian states. It is important to highlight that this need emerged because all 105 participants were selected by the city council of the town where they live, and the course was the first formal direct contact with UFSC.

This study aims to present research carried out with this team of tutors from different Brazilian states to evaluate the level of trust and to identify the posture adopted by this public in the relationship and in situations where there are differences and conflicts with the UFSC team.

As has been emphasized, the integration of the team is an important factor for the coordinators of different universities, and equally important for the managers of the national project (UAB). With a view to these necessities, the study addresses the following research questions: What is the relation between trust and the posture adopted by the tutors when these find themselves in situations of differences (conflicts) between their own perspectives and those which are demanded by the directives of the distance graduate course at UFSC?

2 Background

2.1 Distance Education Team

The work process in Distance Education requires a multidisciplinary team with different competences: staff specialized in the areas of involvement such as the course, coordinators, specialized technicians, instructional designers, graphic designers, monitors, inspectors and tutors.

The Distance Tutor is an educator who coordinates the selection of content, discusses strategies and establishes a dialog with the student. He suggests, provokes thought and supports. This type of tutor is a virtual teacher who contributes to the development of the student. The tutor has the role of developing strategies which facilitate learning and which point the way towards enabling the student to learn in a collaborative and autonomous way and to reach his learning objectives.

According to Landim [6], the Distance Tutor should possess some basic qualities such as: authenticity, emotional stability and maturity, have a good character and a healthy sense of life, self knowledge, intelligence, mental, cultural and social agility, trust in others, cultural concern and broad interests, leadership, cordiality and the ability to listen.

Diverse concepts exist for the definition of a tutor’s duties but one for the tutor’s role would be to be understood as a global, guiding action, key to articulating instruction and education [6]. According to this author, the tutorial system involves a combination of educational actions which contribute to the development of the student’s basic abilities, guiding them in their intellectual growth and autonomy.

The local or On-site Tutor also plays an important part in the stimulation of the student`s learning process. Although he is not responsible for content decisions, he does have the responsibility to keep the student informed and motivated as he is the link between the Institution and the student. According to the Secretary of Distance Education [12], the role of the tutor in a local Center is that of an “academic guide, sufficiently qualified at higher level, responsible for providing assistance to the students at the Center, accompanying and guiding them in all their activities involved in the teaching-learning process". As the local tutor resides in the same city as the students, he should be in a position to better understand the student's needs and transmit this reality to the distance management team.

In corroboration with this statement, the Secretary of Distance Education The Ministry of Education [12] states that, through studies carried out, the local center makes the student's stay viable because it creates a link between the IES and the student, which favors regional customization of the course. In other words, tutoring is important in the orientation, direction and supervision of the teaching-learning process.

Tutoring can be divided into two or more categories according to the perspective provided by Fidalgo and Mill [4], as can be seen in Table 1:

Table 1. Tutor Categories Source: Fidalgo and Mill [4]

Virtual Tutors	Local or Presential Tutors
Responsible for the pedagogic accompaniment of a group of students and, or, a group of presential tutors, through virtual technology. This is a specialist in his subject area and is entirely subordinate to the subject coordinator.	rResponsible for the accompaniment of a group of course students (in all subjects). He is not, necessarily, a specialist in any subject area of the course and his role is slightly more than assisting the students in their contact with the virtual tutor and with the institution.

2.2 Trust and Conflicts

The theoretical review reports the subject "trust" under three basic references: reduction in "vulnerability" [3]; with a base in "positive expectation" generating "reciprocity" – reducing in this way the opportunism and vulnerability generated from interactions. For example, the understood probability of loss, when interpreted by a manager, is a key factor in the behavior of trust. This emphasizes an undeniable historical knowledge, which raises positive expectations about another team. Additionally, a strong collection of specialized books has highlighted the importance of positive interaction between teams, which raises the level of trust.

Despite the fact that the behavior of trust is a specific domain [15] and needs to be understood within an exact context, it is the result of a team's experiences in certain conditions which, despite not being confident on their own, help to build a base for the development of trust [7]. According to Kee and Knox [5], competence and incentives are the essential elements of trust. More recently, Butler [1] pointed out a scenario which comprises 10 basic elements important for the building of trust between teams. These are: availability, competence, consistency, discretion, impartiality, integrity, loyalty, openness, achievement and receptivity.

According to the survey conducted by Nakayama, Binotto and Pilla [8], the principal conditions for the building of trust between teams in organizational contexts can be listed as: reliable behavior, demonstration of ability, information sharing, demonstration of concern for others and, finally, demonstration of harmony. In other words, once these conditions are present the chances of conflict lessen. Concerns about issues including problems of communication, inadequate acceptance and poor administration can lead to conflict [11].

Reliable behavior affects the credibility of the person or system involved- systematic credibility is generated by the demonstration of a stable process and behavior. Thus, predictable and positive behavior becomes reliable. The demonstration of ability on the part of the team is directly proportional to their ability to be trusted [7], as demonstrating competence, power, ability and the knowledge to do what needs to be done, will instill security and trust in the mutual relationship [1]. However, the sharing of information among other meanings, indicates the willingness to be open and receptive mentally [1]. The demonstration of concern, according to Mayer [7] signifies the team's belief that the other group will not take advantage of them dishonestly, as it goes beyond unselfish behavior. It is to be genuinely interested and, first and foremost. to take the other's happiness into consideration. Moving on to the behavior of the demonstration of harmony which, according to Nakayama, Binotto and Pilla [8], means that, in the professional relationship, a mixture of feelings, interests, opinions, objectives and values exist which are balanced out and resemble each other, between belonging to one group or another.

The schools that study conflict management in organizations are divided into three views: the first refers to the Structuralist school (in the '30s and '40s) , the second is the school of Human relations ('40s until mid '70s) and the third is the Interactionist school (until the present day) [11].The oldest (and first) approach to conflict stems from the belief that all conflict is bad. It is seen and associated as a synonym for "violence, destruction and irrationality" [11] reinforcing the negative aspect. This is the view of the Structuralist school– that they are behaviors which reflect the behavior and events of the '30s and '40s. In this context, conflict was considered a disturbance resulting from the lack of trust, communication problems and lack of opportunity for discussion. Despite this being an "older" view, many companies currently treat conflict as something that should be avoided and even eliminable.

From the end of the '40s until the '70s, the Human Relations theory dominated the theories about conflict. It considered conflict as something inherent to any process of socialization and that, if managed correctly, can be of some benefit to the organization. In comparison to the School of Human Relations, the Interactionist school has a completely opposite view: conflict should be stimulated so that the organization does not become complacent, apathetic and unfavorable towards learning, creation and innovation. For this School, therefore, the role of leader is to maintain a minimum level of conflict in order to stimulate the group and maintain a level of self-criticism which is favorable to innovations. A group without conflict may be a sign of immobility in organizational results [2].

3 Methodological Procedures

The study can be characterized as descriptive, documental, bibliographical, theoretical and empirical, and the approach can be classified as predominantly quantitative. In this research the primary data were collected from the 105 local tutors during the training course held at UFSC. The questionnaire consisted of 10 closed questions (on conflict management) randomly arranged, with a scale of verbal evaluation and 1 open question on trust, thus totaling 11 questions.

Following data collection, there was a section on treatment. The data obtained from the closed questions were treated statistically through descriptive analysis with the use of measurements like frequency, average and standard deviation. The use of average descriptive unit was opted for using the Likert scale (1 to 5) for a comparison of the terms. This average, it should be stressed, has a minimum value of 1 (I totally disagree) and maximum value of 5 (I totally agree), therefore the higher the score/ value, the more the interviewee agreed with the statement.

The questionnaire used was based on the ROCI-II, Rahim Organizational Conflict Inventory – II, which was developed in 1983 by Rahim [10]. In accordance with the exposed theoretical foundation, the ROCI-II evaluates which type of conflict management is more adequate for a team: evasion, settling, integration, negotiation or domination. The original questionnaire in English has 28 statements. However, during the elaboration of the pilot, the number of questions was reduced (using the SPSS program when applying Pearson's Correlation Coefficient Test), during which the original questionnaire (pre test) was given to 35 tutors and very similar questions were verified in the Brazilian standard (resulting in the filling out becoming tiring). Consequently, the number of questions chosen was 10, in accordance with results from the Pearson's Correlation Coefficient Test.

3.1 Research Findings

The results from this research were analyzed in the way they are presented in Table 2, which shows the questionnaire results for the local tutors' perception of the posture adopted in situations of conflict – in which differences are perceived between what UFSC determines (explicit questions) and the values (tacit questions) of each presential tutor within their everyday reality. It is important to highlight that questions A and C correspond to the Integration style; questions B and G – the Evasion style; D and J – Settling style; E and I – the Domination style and F and H –the Negotiation style.

It can be seen that the predominant style adopted by the group is Integration (with an average of 4,8 and standard deviation of 4,7) and that the lowest numbers refer to the Domination style. That is, according to Thomas [14] and Rahim [10], the team wants theirs and the IES's demands to be met, as they demonstrate a concern for their own interests and for those of UFSC. The same authors also believe that the team is more inclined to come up with creative solutions especially in situations of long term planning, political and strategic objectives of UFSC.

In relation to the question of trust, the tutors were questioned on the evaluation of this among the UFSC group using AVEA, as shown in Table 3. Suggestions were sought for improvement in the relationship of trust. It can be seen that this was generally classified as good and great (25%). The other quotes refer to the relation between a good communication using AVEA and the high level of trust resulting from clear and continuous communication among the local tutors and managers of UFSC. Another point that stands out with 8.6% of the opinions is the importance of face to face meetings which, according to the interviewees, increase trust through direct contact.

Table 2. Identification of the type of Conflict Management by/ of tutors

Statements	Average	Standard deviation	1	2	3	4	5
I try to work with team colleagues to find solutions to problems that meet their expectations	**4,7**	0,63	1%	1,9%	1,9%	17,1%	78,1%
I usually give in to the consensus of the group I interact with	4,1	0,76	-	6,7%	6,7%	59%	27,7%
I negotiate with my work group in order to attain objectives	**4,8**	0,42	-	-	1%	19%	80%
I avoid confrontations with the people from the group I interact with	4,2	1,14	4,8%	7,6%	2,9%	31,4%	53,3%
I sometimes make use of my position to solve a situation in which there is competition	3,5	1,13	11,4%	12,4%	14,3%	36,2%	27,5%
I try to find an intermediary solution to solve an impasse	4,2	0,96	1,9%	8,6%	1,9%	37,1%	50,5%
In general, I accept the aspirations of the colleagues of the group with which I work.	4,2	0,66	-	3,8%	5,7%	51,4%	39%
I normally propose intermediary solutions to avoid obstacles in discussions	4,2	0,86	1%	6,7%	3,8%	45,7%	42,8%
I use my abilities techniques my favor in the decisions.	3,8	1,13	9,5%	10,4%	10,4%	33,3%	36,2%
I try to keep my disagreements with private people of the group to prevent conflicts.	3,8	1,29	9,5%	10,5%	5,7%	35,2%	39%

This is in line with Zand [15] and Butler [1] when they emphasize the importance of positive interaction among teams which consequently raises the level of trust. It can be seen that, according to Mayer et al. [7], the compatibility of beliefs and values (through the means of Integration when conflict can be minimized) are characteristics which suggest the presence of trust in the group studied. It should be highlighted that other suggestions were made, such as: the need to improve contact by using AVEA and the implementation of other tools (such as MSN, for example) and more contact with the teachers. The analysis of the Relation of Trust among the UFSC group through the virtual learning environment with the main quotes can be seen in Table 3.

Table 3. Relation of Trust through the virtual learning environment

Variable mentioned by the interviewees in the open question	Statements	Nº Absolute	%
Trust	Good	13	12,4%
	Great / Very good	13	12,4%
Virtual Learning Environment	Better communication by interaction with the use of AVEA – Trust should be absolute as the task of tutoring pelo AVEA requires good results / success in group communication AVEA / As much as possible, I try to re(transmit) information clearly. Improve through daily contact with the presential tutors and/ or coordinators /The tool is opening our visions up to a new world /In order to have trust, it is necessary to know the tools of the job!/ Motivating, interacting and communicating clearly always	15	14,3%
Communication	Good trust. Communication – could be improved through systemizations of chats per center./ Installing MSN to further help interaction / Trust is acquired through contact with the group. More contact with the professors is necessary to improve our work/ the distance is enormous, there should be more contact /what needs to improve is communication /I trust the group that interacts with AVEA. But I believe that we should explore this environment further,./it can be improved through knowledge and training of the tools available	15	14,3%
Live interaction and training courses meeting	Better communication by interaction from presential contact through training – frequent contact./ meetings allow for greater interaction (There is absolute trust, I have no doubt about this but to improve, it is only through these meetings as it is in these that questions arise through interaction among all the components /	9	8,6%
TOTAL number of interviewees		105	100%

In general, it can be seen that the relation between a good level of trust achieved through the information available and received from AVEA (main means of communication and communication between UFSC and the Presential Centers) and the positioning of the team of Tutors in relation to the positioning of Integration in the face of situations of conflict.

4 Conclusions and Recommendations

The educational process driven by the EAD is a reality which tends to increase specifically due to the size and geographical dispersal of the country. Thus, studies on team behavior become fundamental in order to potentialize IES strategies. As the research has shown, the relation of trust and positioning of interaction is very present in the team studied, since by using AVEA (and other technologies) the management of the course is able to transmit information and strategies in a way that the group of local tutors can trust and transmit to the students. It can also be concluded that participants emphasize the importance of local contact during training, since by understanding the whole structure of AVEA and UFSC better (and how they work), they can intensify the relationship of trust with the course. In accordance with the theoretical foundation presented, the reciprocity, positive expectation and predictability are fundamental concepts for the participants to feel security (and trust) with regard to the risk of negative consequences and vulnerability. The type of conflict management indentified– Integration – is also a consequence of the actions resulting from the trust among its members- what possibly favors this scenario is the adequate use of means of communication used by the graduate course of administration at UFSC. This is in addition to the Tutors perceiving the presential meeting as a strategy that drives such behaviors.

In this way, it can be seen that the style identified – Integration- as mentioned in Thomas' model [14], and Rahim [10], allows for better group collaboration as this positioning is fundamental for teams who work geographically apart. It can also propel the subject and the group to create innovative strategies and acquire more knowledge, conquering also the student's trust in the IES and in the EAD model, which can maximize student's stay on the course. With the aim of promoting greater integration and collaboration in situations of conflict, the group of local tutors balance their own interests with those of the Institution, especially because there are more chances of finding differentiated solutions which contribute so that planning, politics and strategic objectives can be attained.

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Part V

Learners and Life Long Learning

Bridging the Digital Divide, Aiming to Become Lifelong Learners

Annelise Kachelhoffer and Myint Swe Khine

Emirates College for Advanced Education, United Arab Emirates
{a.kachelhoffer,mskhine}@ecae.ac.ae

Abstract. Studies in the past documented that proper use of Information and Communication Technology (ICT) can positively impact learning. It has been shown that the use of ICT can help students develop inquiry and thinking skills, increase learning opportunities, enhance learning activities, and improve learning outcomes for students. While there are bright prospects, barriers still exist in certain areas, particularly the readiness of the teachers who will adopt the technology, administrative support and technology infrastructure in schools. This study reports the patterns of computer use and computer self-efficacy among students in a postgraduate degree in education program in the UAE. The survey from 91 students were analysed and found that most students have positive attitudes and beliefs in ICT, but lacking behind the use of such technologies. The authors suggest that it is necessary to create opportunities for them to use ICT in the classroom and further develop knowledge and skills in Web 2.0 technologies.

Keywords: Computer use, Computer Self-efficacy, ICT, Web 2.0, Classroom Teaching/Practice, Empowering, Integration of ICT, Teacher Training, Digital Divide, Teacher Education, Knowledge Society, Lifelong learning.

1 Introduction

Knowledge creation happens any where anytime. Educators and students use a variety of innovative and necessary tools in this process. Many of these tools were not initially aimed at education and took a while to become an essential tool in the teaching learning environment. For example, the Arpanet (the forerunner of today's Internet) was introduced in 1969 [1], but it didn't become an essential tool for worldwide business, communication, and entertainment or for education for another 25-30 years. Saariluoma [1] points out that once the structure became known and accepted, it provoked a wide variety of forms of usage, products, and services. She emphasized that this example points to a modern reality: "The faster new ideas find their routes into everyday life, the broader and deeper their impact on, for instance, social development can be" (p109).

In the knowledge society technological developments and new ideas not only impact on the society but also have an influence on the fabric of the culture of a specific society. Not all of these technological developments were initially aimed at the class room, but many like the Web 2.0 technologies, Facebook, Del.cio.us, podcasting and Weblogs (blogs) etcetera became part of the information and communication technologies (ICT) teachers use to ensure a richer learning experience for their students [2].

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There is empirical evidence that the proper use of Information and Communication Technology (ICT) can positively impact learning [3]. Major contributions of ICT have been documented in the literature and these suggest that the use of ICT can help students develop inquiry and thinking skills, increase learning opportunities, enhance learning activities, and improve learning outcomes for students. Studies in different countries show varying degrees of success in introducing ICT in schools [4][5]. While there are bright prospects, barriers still exist in certain areas, particularly the readiness of the teachers who will adopt the technology, administrative support and technology infrastructure in schools [6]. Web 2.0 is a relatively young technology and it is widely believed that it is a technology with profound potential for inducing change in the Higher Education sector, due to the catalytic effects of the Web 2.0 technologies [7]. The reality is that there are still students in the Higher Education systems in some parts of the world that are only starting to explore the value of technology on learning and teaching. This study attempts to explore the pattern of computer use and computer self- efficacy among students in the Post Graduate Diploma in Education (PGDE) at the Emirates College for Advanced Education in the United Arab Emirates.

2 Background to the Development of the UAE and Technology in the Country

The United Arab Emirates is a “young” nation. In 1971, six Trucial states of the Persian Gulf - Abu Dhabi, Ajman, Al Fujayrah, Sharja, Dubai, and Umm al Qaywayn - merged to form the United Arab Emirates (UAE). They were joined in 1972 by Ra’s al Khaymah.

The Education field developed in spurts over the last 50 years. In the early 1900’s three major schools were established by pearl merchants in Dubai, Abu Dhabi and Sharja but an economic crises forced closure of these schools between 1920 – 1930. In 1953 the first school that offered a comprehensive curriculum opened by the British in Sharja. In Abu Dhabi Mulla Darwish bin Karam taught children of Abu Dhabi at village religious schools during the mid 1950’s. The first school built in Abu Dhabi was in 1959. During 1962 the first oil left Das Island and the fabric of the country changed. Six schools were opened in Abu Dhabi between 1964 and 1965 and at the same time thirty one schools existed outside Abu Dhabi. The British School Al Khubairat opened in Abu Dhabi in 1971 the same year the federation of United Arab Emirates was proclaimed. During the early 1970 a remarkable expansion of public education facilities was seen and education became compulsory at primary level. The country’s first Higher Education institutions aimed at vocational training, the Higher Colleges of Technology, opened in 1988 and the UAE University opened in 1997 in Al Ain. During 1998 the country’s first university for females only Zayed University, was established. The Abu Dhabi Education Council (ADEC) was formed in 2006 and announced ambitious school reform plans. The Emirates College for Advanced Education opened in 2007 as an initiative of ADEC as the UAE’s first dedicated teacher training college.

The school reform plans announced in 2006 were very timely for the country. Mograby [8] alerted readers to the challenges the education system faced: “There is no doubt that the current education system is unable to sustain future development, cope with change, and realise desired national goals. The inability of the present curricula and structure to keep up with rapid technological developments, new demands of the labour market, modern communications and the information age poses a serious threat to the future of UAE society and economy." p. 302

The education reform announced by ADEC in 2006 is inter alia also looking at the provision of ICT in schools. It was reported in 2007 [9] that there was little ICT use in schools and that few schools used modern teaching and learning technology. In many cases computers are old and used for non-teaching purposes. The educational reform wants to address this digital divide [9].

The number of national teachers in the UAE currently teaching without any formal teacher education qualifications is not disclosed information, but taking the urgency in which the Federal Council and the Abu Dhabi Education Council are organizing professional development workshops for national and expat teachers, the number is estimated to be in the thousands. Students' enrolling for the Post Graduate Diploma in Education at the Emirates College for Advanced Education (ECAE) is a way for the country to address the problem.

It is accepted that some of the most innovative and promising practices in education involve technology [2] and through this research faculty at the ECAE wanted to establish the use and believes of a group of mature students who are doing a post graduate diploma to achieve a teaching qualification in the UAE. The ongoing professional development their lifelong learning skills.

2.1 Profile of the Postgraduate Students

The students enrolling for the PGDE profile as follows:

- Students are all nationals, meaning that the program is currently open to Emiratis only.
- The PGDE program is open to male and female students and the classes on Post Graduate level are mixed.
- Students come from a mixture of backgrounds. The majority are in-service teachers.
- Their undergraduate degrees are in the areas of Economics, English, Geography, History, Islamic Studies, Mathematics, Psychology, Science and Social Science.
- There is a number of retired military males in the group

3 Research Objectives

The study aims to explore how PGDE students are using computers and their attitudes towards the computers. The specific objectives of the study are to:

- Measure the extent of their experience in using computes
- Identify the familiarity of different types of software and applications and extent of their use
- Find out how the students might feel about computers, their beliefs and attitudes towards computers

3.1 Significance

Many studies have been conducted to identify the barriers that can affect teacher's adoption of technology in the classroom. These barriers can be summarized as (i) infrastructure and resources, (ii) knowledge and skills, (iii) organizational culture, (iv) attitudes and beliefs, (v) nature of assessments, and (vi) subject content [10]. These barriers seem to influence the successful integration of ICT in the classroom [11]. Among them knowledge and skills and attitudes and beliefs are critically important in the readiness of the ICT use. It is clear that teachers must be confident in using ICT and they must be equipped with necessary knowledge and skills in ICT in order to effectively use the technology. The results from this study will indicate the current state of ICT use and attitudes towards computers among PGDE students.

This study will further determine whether PGDE students enter their ICT studies with the belief that ICT can contribute to learning. The information obtained from this survey will be valuable in improving the existing ICT course and planning future ICT related courses as well as other professional development programs. The ICT course for the PGDE program aims to equip the teachers with the necessary knowledge and skills in and belief and attitudes about the use of ICT in schools in accordance with strategic directives of the Ministry of Education.

3.2 Method

Quantitative data were collected by using the following questionnaire.

(i) Computer use questionnaire
(ii) Attitudes towards computers

The computer use questionnaire was designed to find out current use of specific software and applications, the extent of usage among PDGE students and their belief regarding the contribution ICT can make in learning. This questionnaire was developed by the researchers of this project.

The second questionnaire deals with attitudes towards computers. The questionnaire was developed by Cassidy and Eachus [12] and consisted of 30 item statements.

The students were asked to provide their responses on a six-point Likert scale to indicate the extent of agreement to each statement. The internal reliability as measured by Cronbach's alpha for the instrument was reported as 0.94. Permission to use the instrument was obtained from the authors. The questionnaire was translated into Arabic language.

4 Results

In this study a total of 91 usable data sets was obtained from the total enrolment of 107 students. Among the useable data 42 (46.2%) are male and 49 (53.8%) are female. Students have different subject backgrounds and they are grouped into science, social science and business subjects. Out of the total number of students 42 students (46.2%) reported that they have science subject background, 45 students (49.5%) having humanities subject background and 4 students (4.4%) having business subject background.

Out of 91 students, only one student reported that he/she did not have any computer experience prior to this course. 11 students (12.1%) reported that they have limited experience; 44 students (48.4%) reported that they have some experience and 30 students (33.0%) with a lot of experience. Only 5 students (5.5%) indicated that they have extensive experience. A total of 81.4% of students indicated that they had some and a lot of computer experience. This shows that the students who come to the course had reasonable computer experience.

The data shows that 87 students (95.6%) had internet access at home and only 4 students (4.4%) did not have any internet at home. In terms of computer training 87 students (95.6%) indicated that they already had some form of computer training before and only 4 students (4.4%) indicated that they did not have prior computer training.

4.1 Software Used by the Participants

Participants were asked to provide to what extent they use the productivity software such as Microsoft Office suit. The extent of usage is shown in Table 1.

4.2 Application Program Used by the Participants (Web 2.0)

The students were also asked the extent of their usage of some of the common application programs such as blogs, wikis, podcasting, YouTube, FaceBook and TeacherTube. High numbers of students (78%) reported that they had never used a blog before. Similarly 76.9% reported that they had never used a wiki and an even higher number of students (83.5%) indicated that they had never used a podcast. The results on the use of other applications such as FaceBook and TeacherTube also show that high number of students never used these applications. In contrast to this trend at least 50% of students reported that they sometimes or always use YouTube. Table 2 summarises the extent of their usage.

Table 1. Software usage by students

Software	*Never*	*Seldom*	*Sometime*	*Always*
Internet Browser [Explorer]	4 (4.4%)	6 (6.6%)	18 (19.8%)	63 (69.2%)
Email [Outlook]	9 (9.9%)	12 (13.2%)	22 (24.2%)	48 (52.7%)
Word Processor [Word]	4 (4.4%)	8 (8.8%)	16 (17.6%)	62 (68.1%)
Spreadsheet [Excel]	25 (27.5%)	19 (20.9%)	28 (30.8%)	19 (20.9%)
Presentation [PowerPoint]	5 (5.5%)	9 (9.9%)	24 (26.4%)	52 (57.1%)
Desktop Publishing [Publisher]	47 (51.6%)	23 (25.3%)	10 (11.0%)	10 (11.0%)

4.3 Computer Self-efficacy Score

Computer self-efficacy score was measured by a translated Arabic version of Cassidy & Eachus's (2002) instrument on Computer User Self-Efficacy (CUSE). The survey consisted of 30 items and students answered to the extent of agreement for each statement by using 6-point Likert-type scale ranging from strongly disagree (1) to strongly agree (6). The original English version survey had reliability (Cronbach's Alpha) 0.94 and the Arabic version of the survey yielded Cronbach's Alpha of 0.908. The reliability of the Arabic version seems to be comparable with the original English version. This is evidence of homogenecity within the items and an average of correlation coefficients between scale item is approaching to a maximum coefficient of 1.

To establish the validity of the instrument a factor analysis was also conducted. Principal component analysis extraction method was used with varimax rotation. A total of 8 components were extracted from the data. Out of 30 items 24 items loaded on one scale with the factor loading ranging from 0.437 to 0.729. Keiser-Meyer-Olkin measure of sampling adequacy yielded a high value (.0800) and this indicates that the factor analysis may be useful and confirmed that the instrument has a single construct with high validity.

4.4 Gender Differences

The mean computer self-efficacy score for male students was 4.731 with the standard deviation of 0.620 and the score for female students was 4.538 with the standard deviation of 0.730. Although the self-efficacy score was higher in male students, the difference is statistically not significant. This means that female students are not far behind in computer efficacy. According to researchers having a high degree of computer self-efficacy has been identified as a significant factor in improving attitudes towards the use of computers.

Table 2. Application programs usage by students

Programs	*Never*	*Seldom*	*Sometime*	*Always*
Blog	71 (78.0%)	10 (11.0%)	8 (8.8%)	2 (2.2%)
Wiki	70 (76.9%)	5 (5.5%)	8 (8.8%)	8 (8.8%)
Podcast	76 (83.5%)	5 (5.5%)	6 (6.6%)	2 (2.2%)
YouTube	29 (31.9%)	16 (17.6%)	17 (18.7%)	29 (31.9%)
FaceBook	69 (75.8%)	8 (8.8%)	9 (9.9%)	5 (5.5%)
TeacherTube	68 (74.7%)	12 (13.2%)	8 (8.8%)	3 (3.3%)

4.5 Subject Background Differences

The results show that students with a science subject background had a computer self-efficacy score of 4.757 with a standard deviation of 0.654, and those with a humanities background had a score of 4.563 with a standard deviation of 0.696. This shows that self-efficacy of science students are higher than their counterparts with humanities subject background. The difference is statistically significant at $p>.05$ level. This may be due to the fact that science students tend to use more computers and there are many applications and examples available for science subjects.

4.6 Interscale Correlations with Background Variables

The Table 3 illustrates the correlation between computer self-efficacy score and background variables. As described above gender has no effect on the computer self-efficacy score. But subject background has a significant effect on the computer self-efficacy score and correlation is significant at p>0,05 level. Students with a science subject background had a higher computer self-efficacy score than those with humanities subject background.

Again the students' prior computer experience has some effect on computer self-efficacy score. Those who had more experience in using computers tend to score higher on efficacy.

Whether or not the students had internet access at home does not seem to have any effect on computer self-efficacy, but there is a significant correlation between computer training and computer experience. Students who had training tend to use more computers and gain more experience. The results also show that those who had computer training have internet at home.

Table 3. Interascale correlations

	Gender	*Subject background*	*Computer experience*	*Internet at home*	*Computer training*	*Computer self-efficacy score*
Gender		-0.097	0.152	-0.124	-0.124	-0.141
Subject background	-0.097		-0.162	-0.124	-0.124	-0.228*
Computer experience	0.152	-0.162		-0.013	-0.216*	0.500**
Internet at home	-0.124	-0.124	-0.013		0.477**	0.009
Computer training	-0.124	-0.124	-0.216*	0.477**		-0.106
Computer self-efficacy score	-0.124	-0.228*	0.500**	-0.009	-0.106	

4.7 Students' Belief in the Contribution of ICT

Students' belief in the contribution of ICT in teaching and learning was measured by 6 item Likert type scale. Students responded on a six-point scale from 1 (strongly disagree) to 6 (strongly agree). The sample questions are:

ICT can help students develop in critical thinking
ICT can help students engage in learning activities
ICT can help students increase their learning opportunities

The reliability of this 6-item questionnaire yielded Cronbach's Alpha of 0.90. Gender differences were computed to see whether there is any significant difference in beliefs among male and female students. The mean score of male students was 29.26 and females score 28.75. However this difference is statistically not significant. Similarly no statistical differences were detected between subject background, experience, internet at home, and computer training. It was found that there is a significant correlation between the computer self-efficacy score and students' belief in the contribution of ICT at $p>0.05$ level.

4.8 Implication Regarding Software and Application Use

The results of the questions asking about the use of software like Microsoft packages, (Table 1) and application software, like Web 2.0 technologies (Table 2) urged the faculty to develop a course for these students that –

- involves students developing and using their own Blogs as well as participating in the course blog,
- involves students to sign up and use wikis and
- introduces students to benefits and limitations of Facebook and TeacherTube in teaching.

The uptake of students using blogs is encouraging. Not only are they actively involved in the course blog, but they are using blogs now in their own teaching back in schools. Further research into this is currently underway.

5 Conclusion

The study shows that students are only using basic productivity tools such as word-processing and presentation software. The vast majority of the students are not using other productivity tools such as Excel and desktop publishing software. In terms of Web 2.0 technologies only small numbers of teachers (<10%) are found to be using Blogs, Wikis and Podcasts. Although YouTube seems to be popular among the students, it may only be for personal use rather than as an education application. The majority of them do not have experience in using a dedicated site like TeacherTube.

While they have positive attitudes and beliefs in the contribution of ICT, they are behind in actual usage of other productivity tools and technologies. This could be due to a lack of awareness, knowledge and skill in such technologies. In order to keep up with the technology, they need to be exposed to educational application of those technologies. The course on effective use of ICT has the aim to develop students' understanding, skills and curiosity for the use of ICT to encourage learning.

It is hoped that introducing ICT as productivity tool, tutoring tool and collaboration and communication tools will provide the students with knowledge, understanding and familiarity with the range of information and communication technologies. As reported in this paper (Implication regarding software and application use) this is already happening with in-service students taking this course. It is expected that the Abu Dhabi Education Council and Ministry of Education will continue develop and provide infrastructure and opportunity for the teachers to use such technologies in their teaching.

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Evolution of Information Systems Curriculum in an Australian University over the Last Twenty-Five Years

Arthur Tatnall[1] and Stephen Burgess[2]

[1] Graduate School of Business, Victoria University, Australia
Arthur.Tatnall@vu.edu.au
[2] School of Management and Information Systems, Victoria University, Australia
Stephen.Burgess@vu.edu.au

Abstract. Information Systems (IS) courses began in Australia's higher education institutions in the 1960, and have continued to evolve at a rapid rate since then. Beginning with a need by the Australian Commonwealth Government for a large number of computer professionals, Information Systems (or Business Computing) courses developed rapidly. The nature and content of these courses in the 1960s and 70s, however, was quite different to present courses and this paper traces this change and the reasons for it. After some brief discussion of the beginnings and the early days of Information Systems curriculum, we address in particular how these courses have evolved in one Australian university over the last 25 years. IS curriculum is seen to adapt, new materials are added and emphases changed as new technologies and new computing applications emerge. The paper offers a model of how curriculum change in Information Systems takes place.

Keywords: Information Systems, Business Computing, Curriculum, Change, History of Educational Computing, Higher Education.

1 The Beginnings of Business Computing

Fifty years ago a computer was something that few organisations could afford. The idea that many people would use their own computer at work and at home was unthinkable. Then in the 1970s, everything changed and computers began to become accessible and teaching about computers and their use became important [2]. This paper is concerned with the development of one type of computing course: Information Systems, however the boundaries between this and other aspects of computing are far from distinct. These courses could be described simply as "curricula designed primarily to educate people in the efficient and effective application of computer hardware, software, and systems to the solution of business and organisational problems" [2 :1].

Australia made its move into computing early with the CSIR Mk1 (CSIRAC), built by Pearcey and Beard in the late 1940s as Australia's first internally-stored-program computer. This is acknowledged to be the world's fifth [3]. Computer Science courses began in Australia's universities of the 1950s using machines like CSIRAC, but the

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universities were then only starting to come to grips with the issue of whether computing was a part of mathematics or should be considered as a new discipline [4].

In the late 1950s the Australian Commonwealth Government took the decision to computerise the operation of the Department of Defence and the Postmaster General's Department (PMG), creating a requirement for trained computing personnel, but soon found that there were no available computing professionals to be found either in Australia or overseas.

Courses in Business Computing commenced in the 1960s due to the requirement of the Commonwealth Government for computing professionals to fulfil these growing administrative needs [5] when the Australian Commonwealth Government Public Service Board set up its own *Programmer-in-Training* (PIT) course. The first twelve months long PIT course ran in 1965, drawing upon the Defence Department staff's experiences with both computerised and existing non-computerised, administrative systems. The forty-six week PIT course covered the following formal topics: Introduction to the Course and Public Service, Computer Equipment and Techniques-1 & 2, Computer Mathematics-1 & 2 (Statistics), Programming-1 & 2, Systems Analysis and Design-1 & 2. There were also 24 weeks of on-the-job training. PIT courses continued, under the Commonwealth Public Service Board until late in the 1960s when responsibility was transferred to the Higher Education sector [5]. These courses set the style for many of the courses later offered in Higher Education in Australia [6]. On the significance of the Commonwealth's initiatives to Higher Education, Pearcey notes that:

> *In many of these institutions, teaching in computing started as a result of the staffing crisis that arose first from the Defence and PMG's projects.* [7 :120]

2 Modelling Computing Curriculum Development

During the period from the late 1960s until the mid 1980s, Information Systems curriculum could be considered to have passed through a number of different phases as new technologies developed: one such change was the move from punch-cards to mini-computer terminals and then to the PC. A major change was due to growth in the use of computers in business and the development of many new business applications. In the early days of computing there was not much that you could do with a computer if you did not know how to program it. Even before Information Systems became popular as a discipline in its own right, some business courses taught computer skills and programming. One of the most popular languages was the third generation language BASIC, which (for example) was offered by a number of universities on punched card' that were then sent to Monash University for overnight processing on their *Monecs* computer – with the results of the program's processing returned to the institution the next morning. The production of new application software, typically running on personal computers, however, began to change all of this and Information Systems curriculum needed to adapt to all of these changes.

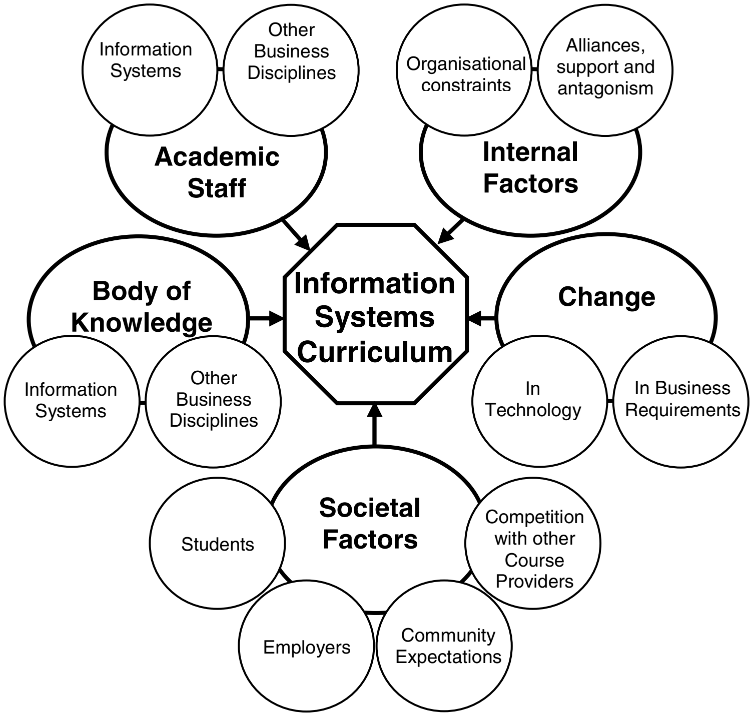

Fig. 1. Factors Influencing the Development of Information Systems Curriculum (adapted from Tatnall [1])

The mission of a university Department of Information Systems is quite clear: it must research, investigate and teach how businesses, and other organisations, can make the best use of computers and Information Technology (IT) to further their business and organisational aims [2]. By its very nature, Information Systems (IS) is an applied discipline that is closely related to the use of information technology in business applications. Many factors influence the direction of Information Systems curriculum development as we have indicated in the model above (Figure 1). What is more, these factors do not act singly but in combination, making a holistic view of their influence essential [8]. Information Systems, as a discipline in its own right, is seen to be separate from Computer Science in that it concentrates upon the socio-technical aspects surrounding the implementation and use of ICT in organisations rather than the technical side of systems development. This does not mean that the more technical aspects of Computer Science do not have a place in Information Systems as the disciplines do overlap and those boundaries are often blurred.

Layton [9] has developed a three-stage model for the evolution of *school subjects* in nineteenth century England. While Layton's model has been shown to be useful in examining slow subject evolution, it has also been shown to be of *limited* use in describing the rapid emergence and evolution of curricula in Information Systems [5]. Layton has argued that for new subjects:

1. The new subject area is justified on grounds of pertinence and utility. Learners are attracted because it bears on matters of concern to them. Teachers are rarely trained specialists, but bring the "missionary enthusiasms of pioneers" to their task.
2. Next a tradition of scholarly work emerges and teachers become trained specialists. Students are attracted "as much by its reputation and growing academic status as by its relevance to their own problems and concerns".
3. Finally, the teachers move to constitute a professional body with established rules and values, and subject matter is selected on the "judgements and practices of the specialist scholars who lead inquiries in the field".[9]

In the remainder of this paper we will consider the evolution of Information Systems at Victoria University in Melbourne, Australia. Victoria University (VU) is a relatively new institution formed in 1991 by the merger of two Colleges of Advanced Education (CAE): Footscray Institute of Technology (FIT) and Western Institute (WI). We will begin by considering events at Footscray Institute of Technology in the mid 1980s.

3 Information Systems Curriculum at Footscray Institute in the 1970s and Early 1980s

In the early 1980s FIT updated its Associate Diploma in Secretarial Practice to include a substantial computing component: word processing, office automation, use of computer technology and electronic mail. In 1984 the new Bachelor of Business in Information Management and Communication took its first students.

The course was pioneering at the time in that it attempted to stress that "information is a critical organisational resource that must be managed effectively and efficiently", rather than one concentrating on 'pure computing' where a study of the technology involved was seen as the priority. As well as a major in Information Management, the course had a compulsory minor in more traditional computing – programming, systems analysis and systems development. Students were, however, encouraged to do a double major of both Information Management and Computing. At that stage the term 'Information Management' referred to recognition that the *information* that flowed into, out of and within an organisation was a resource that needed to be managed. The earlier office automation focus thus needed to be updated as the notion of information as a resource had become a major focus. The updated area became known as Information Management.

Around this time, traditional *Business Computing* (later *Information Systems*) curricular was beginning to develop and most courses had a core of similar topics which were typically based around subjects related to systems analysis and design, database design, business programming (which at that stage was typically done using third generation such as BASIC, COBOL or Pascal) and systems implementation. Many of these courses at the time also had an introductory computer networking unit which was probably the most technical and close to the discipline of Computer Science. The subjects handling computer architecture were probably well into the realm of Computer Science and were often electives.

By the late 1980s, there was growing support for the development of a computing course and the *Bachelor of Business (Information Technology)* was launched with two strands: Information Management and Computing (Systems Development). Students were again encouraged to take subjects from both strands.

4 Information Systems Curriculum at Victoria University from the Early 1990s – 2000

At the start of this period the two CAEs were in the process of merging their courses to form a single university. While FIT had concentrated on Information Management, WI had taken a more traditional line in business computing. These streams needed to merge, and in the process several new areas emerged.

4.1 Information Management

As already mentioned in the late 1980s and early 1990s a number of courses were being developed around the notion of Information Management. At the time, [10] suggested that such courses should not be limited to one discipline, should prepare students with skills for tomorrow and should not be technology bound – their argument being that technological obsolescence occurred too quickly. Garrison [11] also noted that Information Management courses were emerging out of many disciplines such as the Library and Information Science, Business and Computer Science (in addition to Office Automation).

In discussing what should be included in these courses Laverty and Sorg [12] identified three levels of computer-related knowledge and skills they considered should be possessed by people charged with the task of managing the acquisition and use of IT and/or the management of information resources:

- Basic skills allowing use of the computer
- Ability to manage technology as an organisational resource
- Ability to implement IT policy: its promotion, implications of its use and an understanding of its impact on economic, political and the social climate.

It is thus clear that the links between the management of information as a resource and the use of IT to do this were being established. In its first incarnation (after evolving from an office automation degree), the Information Management subjects primarily addressed the use of IT within the organisation, the role of knowledge workers (another term coined at this time), methods for storage and retrieval of information within the organisation (using IT and more traditional means such as paper records), and other phases of the *information life cycle* (creation, processing, dissemination and disposal of information). A subject related to Information Systems Management was also introduced.

4.2 Skills of Information Professionals

One important notion that emerged during this time was the need for a new brand of professional: the Information Professional. These professionals would have skills that spanned a number of fields: some of the technical skills of traditional computing personnel, an understanding of the concept of information as a resource to be managed within the organisation, an understanding of the strategic role that IT was beginning to play in the organisation, the ability to communicate (both orally and in written form) with other professionals within the organisation and with senior managers, and an appreciation of their own role as professionals. These last two areas in particular highlighted a greater appreciation of the importance of IT and Information Management within the organisation and recognition of the importance of the roles of those who performed in these arenas [13]. To this end a subject was introduced (and still exists within current undergraduate and postgraduate degrees) known as The Information Professional, which highlighted the development of interpersonal skills, an understanding of the role of the information (now IT) professional and an appreciation of the importance and role that professional organisations play in promoting good practice and awareness in the IT profession [13].

4.3 IT Project Management

While most IS professionals spend much of their time in the implementation or management of projects, the curriculum of university IS courses does not always reflect this [14]. Although there had been some awareness of the need to include materials related to the management of IT projects in the curricula [13] this did not occur until 1994 with the introduced of a new undergraduate final year subject: 'Systems Implementation'. The initial motivation for this was use, by two IS academics [15], of Microsoft Project software in planning an academic conference the year before. Seeing the value of this software they then worked out a way to introduce it into the curriculum for the degree course. A postgraduate subject in 'IT Project Management' was introduced several years later.

4.4 Visual Programming Languages

Although the standard business computing curricula had included programming with third generation languages for a number of years, new forms of programming (based around personal computer databases) meant that the ability to build applications was becoming the domain of PC users in organisations, and not just the IT experts. It was necessary to reflect this in the curriculum. As well as IT project management, the content of 'Systems Implementation' included database programming (in dBase IV) and the use of Visual Basic (VB) to create information system front-ends. One of the authors, along with a colleague from another university, had recently discovered Visual Basic and were impressed by the ease with which simple, but powerful and good looking applications could be built up [16, 17]. VB was chosen as environments of this type were beginning to be quite widely used in organisational settings involving client-server systems and Visual Basic was able to easily extract data from a variety of external sources.

5 Information Systems Curriculum at Victoria University from 2000 – The Present

In this period two significant new curriculum areas emerged, mainly due to the efforts of a small number of academic staff. The way that each of these areas came into being closely parallels the first two stages of Layton's [9] model.

5.1 Electronic Commerce

Towards the end of the 1990s the Head of the School of Information Systems decided to introduce an undergraduate electronic commerce degree after being asked by senior management to identify *new growth* areas for the university, and academic staff were charged with developing this. It was decided to proceed along traditional IS lines with 'e' versions of database, systems analysis, systems design, programming and even networking subjects. It was initially decided to offer the course only at one of the university's outer campuses and this was not popular with students. New enrolments were encouraging without ever being significant. Not long after the time of the 'dot-com' crash a decision was made to move the course to another campus but then (as with many other e-commerce courses in the country), student numbers began to drop and the course was discontinued in 2008. Compounding this decision was the fact that, as with e-commerce in industry, many of the 'e' aspects of Information Systems had by then become mainstream (and thus part of the main curricula) over time.

The approach to postgraduate e-commerce offerings was more conservative. Several new postgraduate e-commerce subjects were introduced in 2000 for the MBA and Master of Business (Information Systems), in response to what we, and a number of our colleagues, saw as the growth in business importance of this topic [18, 19].

- **'Internet Commerce'** – the introductory subject provided an overview of how business is conducted over the Internet. It looked at technological and infrastructure requirements and business and management issues.
- **'Internet Technologies in Business'** – examined ways that business could use these technologies for communication and business research, as well as technologies such as intranets and firewalls to improve its own business processes and store business documents.
- **'Building Internet Commerce Systems'** – explored the use of HTML and other mark-up languages, design issues, scripting and programming for the Internet, Web databases, implementation options, and Internet design.
- **'Executive and Mobile Computing'** introduced technologies that support managerial work / decision making, particularly for the business executive away from the office and on the move, but needing to always keep in touch.
- **'Small Business Information and Internet Systems'** covered a broad range of topics relating to the use of the Internet by small business, with students building small business systems using recorded macros, along with Visual Basic for Applications (VBA) programs [20, 21].

Some of these subjects also served as electives for the university's MBA program. A few years into the new millennium these subjects were combined with others to form combined marketing/e-business and standalone e-business programs masters programs. The reduction in demand for e-business programs and a rationalisation of programs within the university meant that these were also discontinued in 2008.

5.2 Enterprise Resource Planning (ERP)

Around 2000 one of the School's academic staff developed an interest in SAP's Enterprise Resource Planning software. He soon managed to convince a number of his colleagues that ERP would be a worthwhile addition to the curriculum, and began agitating for this. It was first necessary, however, to have access to the software so he used his contacts to convince SAP (a German software company) to set up an agreement with the university to make use of SAP software in its new ERP courses, which spanned both the IS and management areas. ERP is now thriving at both undergraduate and postgraduate levels.

6 Modelling the Evolution of IS Curriculum at VU

While the various IS Model Curricula [22-24] are often seen as the drivers for curriculum development, this has not been the case at VU. While they were certainly examined, new subject initiatives came, in each instance, from one or two academics who had developed an interest in the area and enthusiastically promoted it. This is in line with Layton's first stage of new subject development.

Once a subject area has entered the curriculum, however, it is not assured of remaining there for ever. For example, by 2008 not much visual programming was taught as emphasis in IS course moved away from the teaching of programming of any type. Speaking of masters level courses in business containing some component of e-commerce, Melymuka [25 :48] notes that these all have several things in common: "They've been cobbled together in record time, they're evolving by the minute, they're wildly popular with students, and they will probably disappear in five years." What we have seen at VU tends to supports this view as much of the material presented in these e-commerce subjects has now disappeared into the background of traditional subjects.

It is doubtful whether many Information Systems subjects will ever move fully into Layton's third stage as this would amount to stagnation, and this is certainly not an area where there is any immediate danger of this happening.

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Secondary School Students' English Writing Aided by Spelling and Grammar Checkers

Odette Radi

La Trobe University, Australia

Abstract. This paper presents phase one of a study aimed at investigating how and why secondary school students use computer tools, such as spelling and grammar checkers, to aid them in their English writing and how their patterns of use relate to their English literacy. The study was prompted through close observations over many years, on how students use computers to support their writing. The observation indicated that while some students make a lot of use of computers, they still struggle to read and write in English. The research involved testing and surveying sixty-five Year 8 students. The test results obtained are compared with students' responses to the survey. The survey questionnaire contained open ended questions for the students to respond reflectively and to evaluate their uses of computer tools.

Keywords: Students, computer use, spelling and grammar checkers, literacy, secondary education, cognition, curriculum, social demands and practices.

1 Introduction

The study consisted of two phases: Phase one was screening procedures and Phase two involved participation of six case studies. This paper presents phase one of the study which began with a sample of sixty-five Year 8 students, aged 13 to 14 years old in a co-educational, intermediate metropolitan school in Victoria, Australia. The study began by measuring the students' use of computers at home and at school as well as gathering data on their performances on selected standardised English literacy tests. In analysing these results, no other factors have been compared with or looked at such as cultural background, family life, screen time, sports activities, background history, nor were any comparisons made to other studies in the same community.

The paper compares the Australian Council for Educational Research (ACER) [1] tests results to the students' survey responses and their use of computer tools in their domestic and school environments. The findings will examine whether the increased use of computer tools has any influence/impact on the students' development in language literacy skills.

2 Purpose of the Study

The focus of the study has stemmed from personal observation over the years as a classroom teacher in the areas of Computer Studies and Humanities. With the

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increased use of computers in both domestic and school environments, students have displayed more interest in the use of computers. There has been a shift in emphasis from reading the traditional printed text to include the use of the microelectronic medium. This shift had a bearing on the development of literacy (vocabulary, comprehension and writing) skills that for some students now reflect a decrease in the influence of the printed texts and conventions.

The transformation of educational activities into the electronic medium has sometimes been overwhelming to the young, their families and policy makers. "What has stimulated policy change has been the beliefs about average education levels in the labour force and the claimed effect of these on economic performance" [2, p. 87]. Computers in the education and domestic environments have become a common place for both teaching and learning. What is needed is detailed attention to the ways in which computers are used by individuals and their acquisition of computer and language literacy skills.

3 Acquiring Computer and Language Literacy Skills

Acquiring computer and language literacy skills differ in their concepts, cognition, attainment and learning development. For example, language literacy acquisition is a life long learning skills which begins from birth and requires proficiency and input from the individual's surroundings. While, the computer literacy skills are acquired in a much less time than its counterpart. The same skills repetitively applied when the users operate the computer and its components as well as the ability to manipulate data using the required software applications. However, both literacy skills are equally important in contemporary society.

3.1 Acquiring Computer Literacy Skills

Computer literacy skills are basically acquired, in a less specialised level, by learning how to turn on a computer, start and stop simple software applications, to save and print documents. As computers advanced over the years, the skills acquired are the use of the alphanumeric keyboard and mouse handling, in conjunction with other computer components such as the scanner, iPod, digital camera and projector, CD-ROM, DVD and the explosion in software available for use, including Internet [3].

3.2 Acquiring Language Literacy Skills

Language literacy acquisition determines the relationship between cognitive skills (perception and memory) and reading skills (decoding and comprehension) and writing skills. The Literacy Dictionary [4, p. 282-283] defines both word recognition and word identification as "the process of determining the pronunciation and some degree of meaning of an unknown word". Thus, language literacy can range from "word identification, word recognition" and decoding to understanding the intent of the person who wrote the passage or influencing readers when the definition is applied to writing [5].

3.2.1 Computers as Cognitive Tools

In order to use computers as cognitive tools effectively in classrooms, it is necessary to change the curriculum, especially at the secondary level. It is readily apparent that there is considerable disagreement concerning the scale and pace of change that is liable to be associated with computers and language literacy acquisitions [6]. Computers have their benefits in areas like the workplace and the industry for mass production, fast communication and profits, but the employees still require the ability to read and write in order to function effectively and proficiently in their job. This proficiency needs to develop in school age students if they are to eventually attain the necessary skills in the language literacy.

3.3 Literature Review – Similar Studies

Studies were conducted and shown that the increased use of computers in both education system and domestic environment have had negative implications on language literacy development for school age children. Fuchs' and Wößmann's studies reported that "the computer availability and use at home … [revealed] … a negative relationship between home computers availability and student achievement". Their results suggest "having a computer at home and using it at school will almost certainly raise some computer skills at the expense of other skills" which negatively related to student performance in math and reading [7, p. 17-18]. Similar findings have been reported by Leino et al [8] whose study examined both traditional printed reading and Internet activities based on the data collected by the Programme for International Student Assessment (PISA) 2000 study. They reported that;

> *Active traditional reading with a strong engagement in fiction is associated with a high level of reading literacy proficiency. … In contrast, the lowest performance level was attained by the group of heavy digital readers, who typically almost never read traditional fiction or non-fiction. This suggests that if students tend to read electronic texts only, they will not reach a very high level of literacy – at least when assessed by using traditional texts and methods [8, p. 272].*

By contrast to Leino el al's report, Ljungdahl and March stated that "[C]omputer tools [spell and grammar checkers] improve spelling and grammar accuracies. If the original work has been word-processed, errors picked up may be simple typographical (e.g. computers tend to correct *hte* to *the* automatically)," students should be encouraged "to take note of which spelling errors they make and why they might have made them" [9, p. 272].

4 Research Methodology

Quantitative method was used to correlate the results by testing and surveying Year 8 students and collecting data to eliminate some phenomena/ assumptions about students' computer use and English writing [10]. The number of students who consented to participate in the study was 65 out of 135. There was a gender imbalance at Year 8 level in 2005; 80 boys and 55 girls. The number of boys at this level exceeded the number of girls. Consistent with this were 40 boys and 25 girls who returned the consent forms, sat the tests and answered the questionnaire.

The data for this paper was gathered by administering (1) ACER tests: Progressive Achievement Tests in Reading: Vocabulary and Comprehension (PAT – R) [1] and Developmental Assessment Resource for Teachers (DART – English) writing test [11]; and (2) a self-developed questionnaire that explored patterns of educational and domestic computer use, by Year 8 students. The research issue was whether there was a relationship between performance on standardized tests of English literacy and patterns of use of computer tools, spelling and grammar checkers.

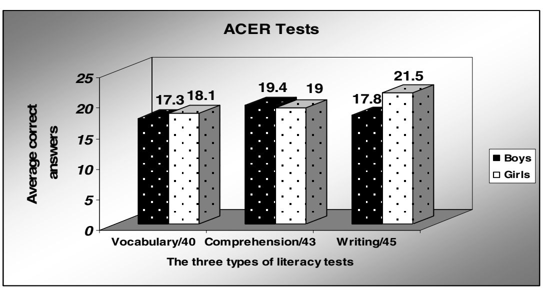
5 Results of the Study

The ACER tests results consisted of word knowledge, literal and inferential comprehension of prose material and three pieces of writing. The graphs below display the results of the boys' and girls' performance on the three tests; reading vocabulary, reading comprehension and writing. The final analyses below are based on the performance of each gender.

5.1 ACER Tests Results

The overall average results are shown in Graph 1 below.

Graph 1. Average performance of boys and girls in Vocabulary, Comprehension and Writing tests

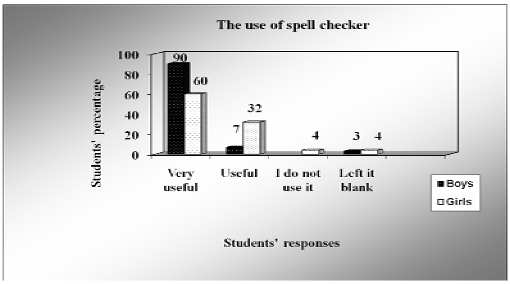


From examining Graph 1, the group performed differently on the vocabulary and writing tests. However, when independent group T-test was applied there was no statistical difference in the test results for vocabulary and comprehension between the boys and the girls. On the other hand, the writing test results showed the T-test for equality of means on the 2-tailed significant difference was .039 which was significant at 95% confidence interval that the girls did perform significantly better than the boys. In the next section, Graph 1's average tests results will be compared with the students' survey responses.

5.2 Use of Spell Checker

Data in Graphs 2 and 3 summarise the students' responses on how useful they find the spell and grammar checkers while they are composing their English writing pieces on the computer. Table 1 will also demonstrate later how the students apply their strategies and experiences with the use of computer tools.

Graph 2. The use of spell checker



The majority of students indicated that they find the spell checker very useful. Graph 2 illustrates their responses of 97% of boys find the spell checker very useful to useful compared to 92% of the girls. Some of their general comments were: "When I am typing in Microsoft Word, the incorrect spellings are underlined with red squiggly lines which indicate that there are spelling errors". "The spell checker will help me correct them." "I do not have to worry about it". "I do not have to remember how to spell it correctly because next time it happened I will do the same thing by using the spell checker." Obviously, the pupils are aware of the computer prompts and its operational functions. They have no difficulty interacting with the tools in order to enhance the quality of their English writing.

5.2.1 Computer-Pupil Interactions

Computer-pupil interactions are often characterised as progressive. However, we do not have an understanding of how children use computer tools and how they apply their strategies and experiences to aid them in their language literacy skills. Consequently, the implications of using computers as cognitive tools will place the emphasis of learning on the mastery of certain thinking skills as mentioned by the participants.

5.3 Spell Checker and Strategy for Word Replacement

One of the open-ended questions in the survey asked students about how they go about choosing the right word from the spell checker's list to replace the underlined word(s) with red squiggly lines. Their responses are grouped in reflective and non-reflective [12] responses in order to understand their strategies. The students' responses are shown in Table 1.

Table 1. Spell checker and strategy for word replacement

Spell checker and strategy for word replacement	Boys %	Girls%
Reflective response		
Look it up in the dictionary – look for the meaning	10	32
Ask parents/someone	11	8
By using the thesaurus as well	3	12
From memory/general knowledge	7	
The word that makes sense	7	
You pronounce the word to see if it is right	3	4
Recognise word	3	
I read it	3	
Subtotal	**47**	**56**
Non-reflective response		
You click on the first one in the list	18	16
Left it blank	14	8
Take a guess	12	12
I click ignore	3	4
I do not know	3	4
If it looks rite I will choose it	3	
Subtotal	**53**	**44**

The purpose of Table 1 is to show that the students understand what the spell checker does. The majority of students find the spell checker very useful to useful (refer to Graph 2). The strategies they engage with in regards to the computer prompts differ in their reflective and non-reflective responses. Table 1 shows slightly more (girls) or less than half (boys) of the responses to the cue take on a reflective attempt to correct the underlined word with red squiggly lines.

5.3.1 Reflective Group of Responses

The way the reflective group responded was that 32% of girls and 10% of boys put into actions reflective and thoughtful strategies such as “look it up in the dictionary”; and 8% of girls and 11% of boys seek or “ask parents/someone” for help.

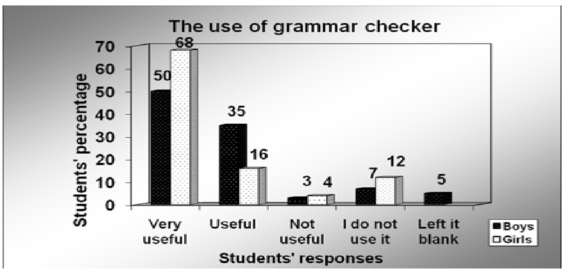
5.3.2 Non-reflective Group of Responses

The non-reflective group of students responded that they understand the computer prompts (e.g. the red and green squiggly lines when they appear on the screen), but they randomly choose different strategies to get rid of the lines. For example, 18% of boys and 16% of girls choose to “click on the first one in the list” without giving a thought about whether the word replacement is correct or not. Equal 12% of boys and girls responded with “take a guess”. This indicates that they are not quite sure of the correct word replacement/spelling. A small percentage responded “click ignore”, “I do not know” and “if it looks *rite* I will choose it”. This demonstrates that the students know how to use the computer tools but they do not know how to apply that experience into more general language literacy context.

5.4 Use of Grammar Checker

Graph 3 illustrates that students are also relying on the use of the grammar checker. The data indicate that 85% of boys find it very useful to useful compared to 84% of girls. Graphs 2 and 3 indicate that the students are frequently using the computer tools when they are composing their English writing pieces. All students have the same access to computer equipment at school and in their domestic environment. They are comfortable in the use of the hardware, as well as the software applications. They find that the grammar checker suggests alternative sentence structures to enhance their writing. Students' reflection on the use of computers was that "we use the computer tools to correct the mistakes after we access the information that we need for our assignments, from the Internet and the compact disk". Obviously, the students understand how to use the microelectronic medium, how "to access the information, manipulate it, transform it and exchange it" [14, p. 34].

Graph 3. The use of grammar checker



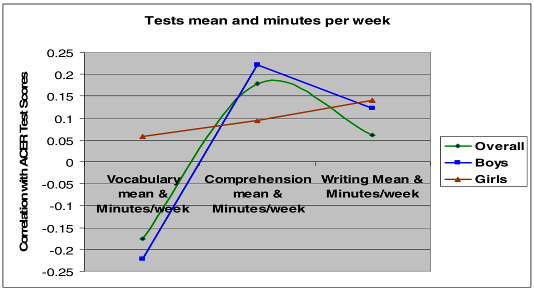
The ACER tests, the average results in Graph 1, revealed students performed below average in the three literacy tests. The average scores are 17 – 18/40 for vocabulary, equal 19/43 for comprehension and 17 – 21/ 45 for writing. The tests were based on traditional printed texts. Their responses to the survey on the usefulness of the spell (with autocorrect option) and grammar checkers (Graphs 2 and 3) may imply (including the estimated time spent using the computer) that the students are spending their time being as digital readers and composers [8, p. 262] and [9 p. 272]. The obvious question remains unanswered; if the students performed the literacy tests on the computer, would the results be different? The next section will look at the usefulness of the computer tools (spell and grammar checkers) as claimed by the participants, and its effect on the traditional printed literacy tests.

5.5 ACER Test Results Mean and Minutes Per Week

The results were compared to show whether the final results revealed any differences between the boys' and the girls' performance in the tests. Then the correlation coefficient distribution was used to measure the correlation outcomes between the students' responses of their estimated time (in minutes per week) spent using computers at home against the results of the ACER tests. The results of the correlation distribution are presented in Graph 4.

The results are not entirely consistent, but the dominant relationship is positive. For comprehension and writing, for both boys and girls and overall there is a positive relationship between minutes per week of computer use and scores on the tests. In other words, boys and girls who spend longer on the computer perform better on reading comprehension and writing.

Graph 4. Boys and Girls overall test results mean and minutes per week



This pattern does not hold in its entirety for vocabulary. Here the results for the boys and girls are quite different. The results for the girls are the same as for comprehension and writing. Girls who spend longer on the computer performed better on the vocabulary test. However, there was a negative correlation for boys of -0.22. More extensive use of computers by boys correlated negatively with vocabulary scores leading to an overall correlation for the whole cohort of boys and girls to be negative (-0.16). Since the overall performance of both boys and girls on the tests was at less than pass levels. Clearly, something was contributing to the overall low performance as shown in Graph 1 for both boys and girls, but these results suggest that for these particular students, with the exception of vocabulary for boys, greater use of computers correlated with better test scores.

6 Conclusion

The results of the study showed that the students are engaged with the use of computer tools (spell and grammar checkers) in both education and domestic environments. This emphasises that there has been a shift from traditional language literacy to computer-based literacy. This study has found that there is an indication of both positive and negative relationships between the two literacies.

The study showed that the students' responses indicated an extensive use of computers. Nevertheless, this is not fulfilling the functions of connecting the computer tools to the wider language literacy skills. The results in Graph 1 (literacy tests) compared to students' perception in Graphs 2 and 3 (spell and grammar checkers) indicate that the regular use of computer tools at Year 8 level has implications on the development of their language literacy skills. As demonstrated in Table 1, 53% of boys and 44% of girls responded with non-reflective strategies when selecting the correct vocabulary word replacement from the spell checker's list while composing their English writing. Meanwhile, Graph 4 shows positive and negative outcomes in the correlation coefficient distribution between the results of the ACER tests results and the estimated time spent on computers per week at home. More extensive use of computers by boys correlated negatively in the vocabulary scores. The collected data from the survey also revealed that 50% of boys compared to 34% of girls use their personal computer for amusement purposes. The games played as indicated in the questionnaire include non-educational ones like racing cars, soccer, football and simulated arcade games. For them to become part of the same literate community of practice, they will need to be able to make use of computer tools to attain their spelling and grammar skills.

The primary and junior secondary students are still in the process of developing mentally and physically. If schools do not adapt to meet the needs in reading and writing, a growing number of parents could feel alienated by the inadequacies of schooling. Goss [15, p.15] states that "the issue is not computers versus literacy on the basis that the increased use of microelectronic tools still requires adequate literacy skills to enable students and others to interpret the messages, look for several possible meanings and also fully participate in reading and writing". My data is consistent with this. Some students reported strategies that showed them reflecting on the literacy choices that the computer prompted them. However, almost as many students reported a non-reflective response. The issue appears to be more than one of how reflection is brought into computer use rather than how computers damage literacy skills.

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Learning Design for Creating a Lifelong Learning Organization

Ulla Widmark and Eeva Koroma

Stockholm University, Teacher Education, Sweden

Abstract. Our learning design for lifelong learning has been developed during the past ten years at the Teacher Education unit at Stockholm University. The same design but with different content has been used to higher the competence of different target groups; teachers in the field, policemen, medical personal, headmasters etc. As an example we will present our learning design for the course "Steps for Skills" which was a government appointed, multi-year national initiative to support municipalities' long-term quality and skills development in health and social care for older people. The purpose of the Steps for Skills was to improve the internal quality of health and social care. This was to be achieved by developing the skills of the staff working close to older people.

Keywords: Learning design, lifelong learning, blended learning, collaborative learning, Communication, Learning Dialogue.

1 Courses at Stockholm University

During the year 2006 two courses for the "Steps of skills" initiative were implemented at the Teacher Education unit in collaboration with Ministry of Health and Social Affairs national investment on skill development within the geriatric care. The participants were recruited from those six municipalities that participated in Steps of Skills pilot course. Tutor education during the spring of 2006 had 23 participants. The course during the autumn had 43 participants.

There were four different staff categories within geriatric care that were involved in our course:

- tutors, a new role with educational responsibilities (mostly assistant nurses)
- operating chiefs with responsibilities for the organizations and local units
- elected union representatives with focus on the staff's working situation and the skill development of the staff
- teachers – with the assignment to develop the geriatric care's pedagogy and with responsibilities for learning and validating.

The courses' common aims were to give the participants:

- deepened knowledge about a workplace as a learning organization
- knowledge about the educational content in College Coaching and the Learning Dialogue

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- resources to develop the geriatric care's organization and individuals and groups in it
- to become familiar with net based learning environment.

The content in the courses connect with the experiences the participants have from their work within the geriatric care and from current research and literature. The content was also concerned about the staff's needs for competence and skill development. It concerned the production teams' need of education and the participants' individual needs. It included also analysis of intentions, visions and action plans but the participants would also learn about the importance of digital technology for learning and work. We linked the practical experiences of Learning Dialogue to pedagogical literature about leadership, colleague tutoring and activity development. A very important element in the education was to implement a project activity on your own working unit with your stuff members. By doing a project the participants got experiences of how to build up and develop learning activities at work.

The courses were carried out both through physical and digital meetings. Between the campus seminars the participants met on web seminars. Thus the courses were built on two different learning environments; one physical and one digital. During the physical meetings, the educational methods were the same as during the digital meetings.

A detailed study plan for the entire course was prepared. It shows with clarity how the course is built-up and what educational methods are to foster the skill development. The aim was that the participants not only would have theoretical and methodical knowledge. They would also need to be able to use the new educational role that they were to become familiar with. The course included elements of educational ICT i.e. knowledge about how electronic tools can be used for the learning activity.

During the course's time and after the completed course, the work was evaluated with an electronic tool in aim to develop and to improve the shapes and the methods for the skill development.

The participants have continuously been examined. After each web seminar both common and individual contributions documented on our virtual platform were presented. We wanted thereby to emphasize the importance of learning processes, not only the end product. During the ultimate campus seminar the participants presented both orally and in written reports what they had learned. They presented various proposals for improvements in skill development. Our experience told us, as does the collaborative theory about learning, that the link between physical and social activities and the digital presence has had importance for interaction.

The educational tools on our virtual platform were exchanges of experience, literature analyses, written contributions, responses and discussions. The communication on the platform was flexible i.e. independent of time and place. The communication moved forward through participants' own questioning where argumentation and responses were included. The documents on the web were preserved and developed over the time. During the course's time, the participants had mutual access to each others' communication, documentation and learning. The platform enables text, picture, sound and multimedia presentations to be published.

An important learning resource during the studies was the participants' own practice experience. It meant that the participants actively worked with analyzing their practice experience and other participants' experiences in the light of educational/didactic theory. We organized study groups heterogeneously so that different experiences were represented in the groups. The participants in the study groups shared the responsibility for learning and interaction. The task to lead and to summarize a group's work rotated among the members.

The meaning of the course was that the studies were to be anchored in the occupational role i.e. the professional thinking and acting. Educational research of learning that focuses on practice communities has quickly won territory. Jean Lave and Etienne Wenger presented a model for the situated learning where they emphasize that learning can be linked to participation in what they call practice communities which can to be both institutional and spontaneous.

From a course evaluation we can read following participant's comment concerning the task to summarize a discussion:

> *"In my group we have been precise with the fact that we should all the time return to the issue we had chosen to discuss although we have given ourselves time to" fly out". To summarize and to speculate on if the issue is responded to or not, to write comments on the discussion is very important to learn in order to see the whole picture, to learn to have a global approach."*

According to theory about Computer Supported Collaborative Learning the participant is considered as an individual with potentials, perfectible capabilities and knowledge. An education on the basis of this perspective of learning and learners requires a practical exercise, activities of various kinds. Knowledge builds on the relation between the thought and the activity, between to learn and to do, between theory and practice.

2 The Learning Dialogue Method

The educational method, the Learning Dialogue, is one now well-known method for tutoring and coaching. The aim of the method is to, in a structural way, formulate questions around a professional activity, to lift up the resemblances and differences for discussion, thus not primarily in order to find solutions or just to complete the tasks. The answers and the solutions are more associated with the implementation of practical experiments. The Learning Dialogue is characterized as a dialogical approach on learning than one of defending a thesis. The dialogue is carried out in a group where everyone takes part in the conversation and all the ideas and thoughts become visible i.e. they all contribute to mutual learning and everyone involved shares the responsibility to ensure the dialogue.

The dialogue is to alternate between different levels on learning; activities, experiences, values and theories. The aim is that the group is enhanced a common attitude to its professional role. From a perspective more characterized of authenticity, anchored in reality, the learners' practical experiences and even the attitude to change, development and hopefully improvement develops.

An educational method for learning requires tools. The tools for the Learning Dialogue are: listening, asking, structuring in levels and different perspectives of organizations. Reflection is of great importance as is the documentation of the participants' reflections. Participation in the dialogue is central. Everyone in the group is to present their thoughts.

3 The Participants' Reflections on Education

We choose here to show some glimpses of the course for tutors where the participants in their final report present their view on "The Steps of Skills" education. The quotations are selected on the basis of the description we did around the method of learning dialogue that the participants learned to apply in their working practise where their task have been to develop the skills of the geriatric care's personnel.

> *"This course has meant hugely for me, I have developed as a person. Through all these meetings with different people, through knowledge that I have achieved, through literature and above all through the Learning Dialogue. All this has got me to see people, situations and events with new eyes and from other perspectives. My focus, awareness has increased, my self-confidence has grown and I have become a safer person. I have now a greater desire to learn and to acquire knowledge."*

This quotation is representative for how the participants describe their personal and professional development. The course has built up their self-confidence in the new role as a tutor and the perspectives on working practice has been stimulating and motivating. The participants have both recognized and developed their own base of experience. They have felt that they have been part of an important phase of development in the geriatric care and their own working role has been reflected in other persons' experiences.

Learning Dialogue with its experience and practice based content, where everyone shares their learning with each other and thereby are participating in a developing process, has created strong motivation. It has simply been exciting to attend a course. Particularly exciting has been the keeping of the log where the week's work becomes an object for reflection. The digital study room and its openness in what has been documented means that the course becomes a meeting place for learning and developing of the tutor role.

The digital rooms are not the course's only meeting places. Many of the participants also describe physical meetings with managers, with colleagues and with teachers i.e. persons that have importance for how their work will be planned, to be implemented and to be evaluated, as very important. One of the participants writes this way about her future role in a big system of roles:

> *"As a tutor, my role is to complement teacher's work through, among other things, Learning Dialogues, support students in different situations in their practical activities and make space for reflection in and around the experience. I will also try to attract my fellow-workers to this investment and to get them to share of their knowledge, thoughts and ideas. There is an extremely big silent knowledge that should be*

lifted forward and to be used in the work. It is a part of my work to stay up and to question which actions I should take. How will I act in order to function as a good tutor?"

The link between education and activity on work contributes to the fact that the course is experienced as worthwhile, stimulating and meaningful. Someone writes that she became aware about her own attitude and thereby now can better influence her own understanding and her actions.

The participants have detected how the road to understanding goes through practical actions. Therefore, the course task, to implement the Learning Dialogue method in a working team on their own unit is an important aspect in acquiring knowledge about the role of the tutor.

4 Analysis of Collaborative Learning

Learning Dialogue and College Coaching are educational methods that permeate our campus meetings, the distance learning and the practical part of the education. The findings we here present and that also illustrate the education's results are seen from the participants' perspectives. The flexibility in time and place, that the distance learning makes possible, is one of many factors that influenced the result. Participation is not scheduled or connected to a certain room, adaptable conditions make it possible for the participants to choose when they want to carry out their studies. The flexibility is characterized also in the fact that the communication in this education is horizontal. The course's structure is adapted to the participants' professional situation and their individual needs and it is characterized in equal relationships between participants where hopefully each and everyone become visible.

During the education different organizations/working units with different needs and conditions meet and that makes it possible for dissemination of alternative forms of education within the care of the elderly as regards contents and arrangement. This flexible structure on the education has in a clear way contributed to the fact that different forms of skill development were disseminated and were compared with each other.

The documentation is one of the corner pillars in the course. It has clearly been exciting to follow the process shaped in the fellow participants' writing. Unlike the printed word in the literature, writing in the course been written over the time and been accumulated gradually.

We designed courses in order to carry out the learning activities on three levels:

- an individual level
- an interactive level and
- a practical activity level.

4.1 The Individual Activity

During three seminar periods students have been activate in various way. They have been diligent participants as they did what they been expected to: written work logs during the entire course, did literature tasks, responded to questions, participated in discussions, gave response on each others' contributions etc. This level reminds one of the traditional individual learning that permeate all education from basic level to academic level. Our assessment is that at distance learning it is important to have a clear and surely well thought-out methodical approach. This is essentially a crucial level so that the participants in the course get started, becomes participating and do their tasks. A person's absence is easily detected by an empty file.

4.2 The Interactive Level, Learning Networks

The interactive level has created motivation, been exciting and instructive. The participants have pursued a row of deepening discussions on the course themes, the tutor role and the Learning Dialogue. That has given new knowledge and new experiences.

Notable is that several discussions are on simultaneously and that the participants go back in order to see what has happened over the time in this interactive group learning. Compared with traditional education with seminars and literature studies this becomes an entirely new educational environment. The participants take part in each others' education for an extended period of time not only during a limited time available as in a campus course.

4.3 The Practical Activity Level

During the course the participants have had the task to plan, to implement and to reflect over a project based on their professional work. They have with curiosity and encouragement in a constructive way followed each others' project works. They have not only had an opportunity to take part in a final presentation but they have even been able to follow an entire process and moreover support each other in this process. The "reality near" content has given the studies its legitimacy, credibility and usefulness. There has been a feeling of recognition but at the same time a questioning of this recognition.

5 Support for Learning

The three levels for learning have markedly contributed to an analysis of the geriatric care's activity and to development and renewal. The digital technology in itself has made it possible for learning meetings between participants and the use of the asynchronous communication has strengthened the mutual learning.

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Open Virtual Worlds as Pedagogical Research Tools: Learning from the Schome Park Programme

Peter Twining[1] and Anna Peachey[2]

[1] The Centre for Research in Education & Educational Technology (CREET), The Open University, UK
P.Twining@open.ac.uk
[2] The Open University, UK
A.Peachey@open.ac.uk

Abstract. This paper introduces the term Open Virtual Worlds and argues that they are 'unclaimed educational spaces', which provide a valuable tool for researching pedagogy. Having explored these claims the way in which Teen Second Life® virtual world was used for pedagogical experimentation in the initial phases of the Schome Park Programme is described. Four sets of pedagogical dimensions that emerged are presented and illustrated with examples from the Schome Park Programme.

Keywords: Research, Teen Second Life® virtual world, dimensions of practice, Schome, pedagogy.

1 Introduction

Virtual worlds provide simulated online environments where users, often called residents, interact through text or voice using two or three dimensional representations of themselves known as avatars. Many are driven by an imposed narrative that sets a goal or purpose to the environment, for example acquiring a set of skills or achieving a particular rank or increased social status. Some of these worlds enable content creation and avatar personalization within limits pre-defined by the environment's designers. For example, a user may be able to create a range of (pre-defined) swords; the user is in effect revealing existing swords rather them creating them. Open Virtual Worlds (OVRs) enable free activity alongside genuine content creation, scripting, and avatar personalization; the only limitations are based on the quality of the building and scripting tools provided and the users' ability to operate them. It is the multidimensional qualities of OVRs, such as Linden Lab's Second Life® virtual world (SL), which hold the most significant potential for rich, immersive teaching and learning activities, providing semi-authentic contexts for simulation, role play and experiential learning.

Whilst there is significant information to be drawn from a wider context of teaching and learning online and/or with virtual reality, our knowledge and understanding of teaching and learning in OVRs is very much in its infancy. For example the Open University (UK), as an 'early adopter' [1], has only been teaching in Second Life since 2006.

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Castronova [2] compared virtual worlds with the Wild West, claiming they provided new frontiers for people to explore. Gee [3] talked about the principles and patterns that are deemed to be appropriate in different social systems, which he called the 'design grammar' of the social system. He argued that virtual worlds entail new and different design grammars, which users have to learn or indeed co-create through their interactions. Twining [4] similarly claimed that OVRs represent 'unclaimed educational spaces'. This chapter will briefly explore the basis for that claim before going on to suggest that this makes OVRs powerful tools for researching pedagogy. The chapter will illustrate the ways in which OVRs have been used to support pedagogical experimentation within the Schome Park Programme (SPP), leading to the development of a set of dimensions of practice, some of which will be described.

2 Open Virtual Worlds, 'Unclaimed Educational Spaces' and Pedagogical Exploration

There are a number of features of OVRs that underpin our lack of understanding of their design grammars:

- *The chance to explore that which would be difficult, expensive, dangerous or impossible to do in the physical world – both literally and pragmatically.* Pragmatically it would be more difficult and expensive to set up a new learning community in the physical world than in a virtual world. Literally, there are things you can do in virtual worlds that are not possible in the physical world, such as flying like a bird or breathing without assistance underwater.
- *The meaning of space is different because the constraints of the environment are different.* Buildings are not needed to keep you warm and dry or to hold up pictures/displays, and you can travel huge virtual distances in an instant, so proximity is different to the definition in the physical world.
- *The opportunity to work together with the minimum of contextual hierarchy.* The influences of physical aspects of appearance such as gender, age, dress, etc. are significant in physical world educational settings. From this perspective, 'equality' over the age range in the SPP, and in virtual worlds in general, is easily achieved as interaction is mediated through avatars. Thomas [5] has observed that it is actually not the case that all avatars are 'equal' even in appearance; for example the degree to which each person has customised their avatar may be indicative of differences in power in relation to expertise, economic resource, etc. Nevertheless, the physical characterisation of the avatars does allow them to escape from the usually fixed differentials of physical world educational interactions [6].
- *The lack of established social norms in OVRs means that actors have space to experiment.* For example, during early contacts in Schome Park students would fly in and out of chat range apparently at random and/or would edit their appearance (sometimes quite drastically) during conversations. Socialisation defines the process by which individuals develop the habits, ideas, values and attitudes through which they learn to inhabit their culture or community: '… it prepares the individual for the roles he is to play, providing him with the necessary repertoire of habits, beliefs, and values, the appropriate patterns of emotional response and the

modes of perception, the requisite skills and knowledge …' [7]. The lack of established culture in virtual worlds requires users to establish the design grammars for their communities allowing for new models of socialisation.

The majority of children in the industrialised world start school by the age of around 5 years old. Their experience of primary, secondary and often tertiary education is overwhelmingly one of learning in a classroom with walls, floor, ceiling, tables and chairs, a black or whiteboard and a teacher. It is difficult therefore to conceive of a radically new model of education when we are each loaded with the social context and conceptual grammar of our own experience within existing education systems, where school is the dominant model. Engeström et al [8] submitted that it is 'very difficult for school communities to collectively analyse and redesign their practice'. From a situated socio-cultural perspective, where knowledge cannot be separated from the activity and situation in which it is produced, we accept that learning is the product of negotiation rather than 'individual construction' [9]. One solution to this burden of partiality would be to provide the opportunity for a radically different 'lived experience' of an alternative education system – precisely the opportunity for pedagogical experimentation afforded by the 'unknownness' of OVRs. Whilst people may have prejudices grounded in the media portrayal of virtual worlds, self-evaluation of their own computing skills, and expectations of computer 'games', most actors have little or no bias about definitions of education in OVRs.

The many education and training islands in Second Life adult and teen grids range from photorealistic reproductions of the physical world, where avatars use lecture theatres, sitting in rows to view slides delivered on virtual presentation screens, to fantastical spaces that stretch the metaphors beyond the known and familiar, challenging students to step free of any physical world contexts. See Figure 1 for illustration. Arguments are made for both as valid learning contexts with high potential for innovation, from challenging learners within their comfort zone to creating a truly unique perspective. It is precisely the lack of rules and accepted wisdom about working in this environment that holds significant appeal for anyone wishing to explore models of pedagogy.

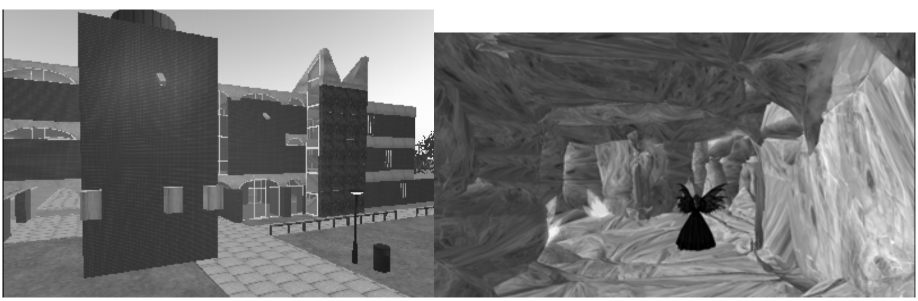

Fig. 1. Details from Sussex University Campus Island and Schome Park Beta *The Sussex in-world campus comprises replica real life buildings complete with security cameras (Sussex also has an island where students are creating their own content with very few restrictions). In contrast Schome Park Beta includes rivers of lava and an underground crystal cavern.*

Table 1. Summary of key aspects of the first three phases of the SPP

<table>
<tr><th>Aspect</th><th>Phase 1
(March to April 07)</th><th>Phase 2
(June to Dec 07)</th><th>Phase 3a
(Jan to Mar 08)</th><th>Phase 3b
(Apr to May 08)</th></tr>
<tr><td>Our focus (Aims)</td><td>To explore the educational potential of virtual worlds (with a particular focus on developing Second Life skills and ‘Knowledge Age Skills’). To build a community of learners.</td><td>To enhance ‘Knowledge Age Skills’. To increase student control and responsibility for the environment, the curriculum and support. To widen the community (not just gifted and talented).</td><td colspan="2">To enhance ‘Knowledge Age Skills’. To balance control and responsibility for the environment, the curriculum and support. To widen the community and increase its size. To explore the co-existence of the Schome ethos with school culture.</td></tr>
<tr><td rowspan="2">Environment</td><td>Island divided into six areas: Physics; Ethics & philosophy; Archaeology; Scho-op (generic support); Shared meeting areas; Sandbox.</td><td>Island as naturalistic and attractive environment with some core generic areas – student control of planning/building.</td><td>Two islands: One student controlled + one staff controlled. Immersive game theme for new island.</td><td>Two islands. Project teams allocated plots of land with full controls (e.g. terraforming)</td></tr>
<tr><td colspan="4">Island, wiki and forum available 24/7/365</td></tr>
<tr><td rowspan="2">Actors</td><td rowspan="2">149 students aged 13 to 17 from National Association of Gifted and Talented Youth (NAGTY). Staff from four universities and the National Physical Laboratory; PhD students; Consultants.</td><td>Ongoing students from Phase 1
New 13 to 17 year old students from range of sources (inc. USA).</td><td colspan="2">Ongoing students from Phase 2
New 13 to 17 year old students from range of sources, including: South East Grid for Learning (broadband consortium), ‘School groups’ from UK and USA.</td></tr>
<tr><td colspan="3">Staff from two universities; PhD students; Consultants; Teachers; Parents</td></tr>
<tr><td>Curriculum</td><td>Three strands of formal activity (Physics, Ethics and Philosophy, Archaeology) + discrete ‘taught sessions’ (e.g. research methods) + student led activity</td><td>Student led activity (inc continuation of formal strands from Phase 1) + Machinima creation + discrete ‘staff led’ sessions (e.g. Sudoku)</td><td>Student led activity (inc continuation of Phase 2 strands and new strands such as Time Travelers) + new strands led by staff (e.g. Maths)</td><td>Major focus on projects (led by students and/or staff)</td></tr>
<tr><td rowspan="2">Support</td><td>Staff scheduled sessions for each formal curriculum area</td><td>Staff available to provide support in Schome Park</td><td>Greater staff support for strands of activity (e.g. Maths) and for student led activity</td><td>Staff support focused on projects</td></tr>
<tr><td colspan="4">Peer – peer support; Information in wiki; Discussion in forum; Emergency help button to summon staff</td></tr>
</table>

3 Pedagogical Experimentation in the Schome Park Programme

The Schome Park Programme (SPP) set out to explore the potential of virtual worlds, considering their capacity to act as spaces in which visions of future practices and pedagogies can be built and experienced, making it "possible to construct, investigate and interrogate hypothetical worlds" [10]. In late 2006 the SPP chose Teen Second Life® virtual world (TSL), in conjunction with a wiki and forum, to give participants in the programme a 'lived experience' of radically different approaches to education. The first three phases of the SPP are summarised in Table 1 (overleaf). For more detailed information and reports about the Schome Park Programme see http://www.schome.ac.uk/

Analysis of the activities that the students and staff engaged in between March 07 and May 08 led to the development of a number of dimensions of practice which highlight key pedagogical issues relevant to any learning context, four sets of which are explored here.

4 Emerging Dimensions of Practice

4.1 Playfulness

We have already suggested that one of the most powerful and intriguing features of OVRs is that they encourage experimentation and rule testing. Warburton [11] suggested that there was a tension between playfulness and professionalism and that this inhibited innovation in virtual worlds. This could be seen as being reflected in the variation in the extent to which participants within the SPP experimented with building over the three Phases of the SPP, which is summarized in Table 2.

Table 2. Summary of building activity across the phases

<table>
<tr><th></th><th>Amount of building</th><th>Rules about building</th><th>Overall</th></tr>
<tr><td>Phase 1</td><td>A vast amount – most students involved to some degree</td><td>Students could build anywhere above 250 metres (and in the sandbox)</td><td>Very few rules. Focus on the process of learning how to build.</td></tr>
<tr><td>Phase 2</td><td rowspan="2">Much more limited both in terms of number of builds and numbers of students involved in building.</td><td>All builds required planning permission (via the forum).</td><td rowspan="2">Lots of (student-imposed) regulations and red tape around building. Increased focus on the quality of the buildings.</td></tr>
<tr><td>Phase 3a</td><td>Larger sandbox created. Builds outside the sandbox required planning permission.</td></tr>
<tr><td>Phase 3b</td><td>An increase in building involving more students (though still not as much as in Phase 1)</td><td>Sandbox increased in size.
Plots of land allocated to projects (with full controls such as terraforming).</td><td>Reduction in rules and red tape (compared with Phases 2 and 3a). Focus on developing builds to support projects.</td></tr>
</table>

The introduction of planning regulations, which could be seen as a greater professionalization of the community, meant that students had to plan their builds and persuade other people to support their applications before they could commence building (except in the sandbox). This was not only a slow process that required the use of the forum, but it also placed an emphasis on the building itself. Thus there was a shift away from the process of building towards the quality and appropriateness of the final product. The differences suggested two dimensions that impact on the degree of experimentation in building: regulation and product-process focus. These are shown in Figure 2, and it is suggested that they impact on the overall level of experimentation or playfulness.

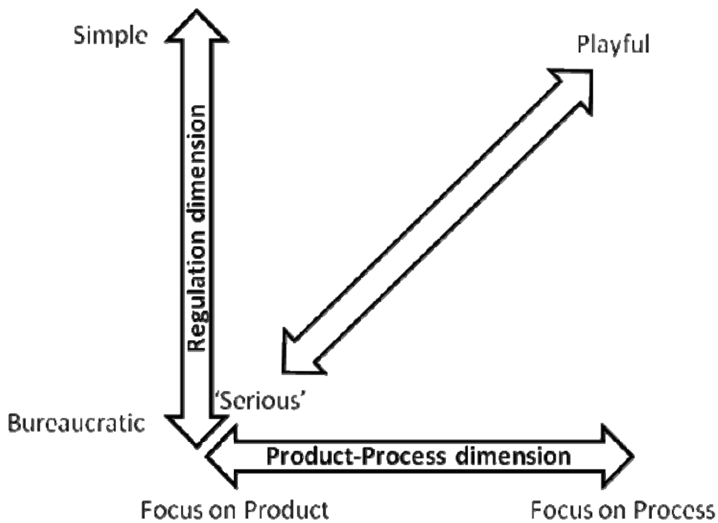

Fig. 2. Dimensions of playfulness

These dimensions may help to explain why OVRs encourage pedagogical exploration: initially people do not understand the 'design grammar' for the virtual space and are thus unconstrained by norms/rules of the community. They start to experiment and learn to operate in the environment, which inevitably involves a focus on what they can do (i.e. process). As people become more established in a virtual community rules become established, as they did in Schome Park, and the focus shifts from what is possible to the quality of production, thus restricting the degree of experimentation that is acceptable.

4.2 Pedagogy

Within Schome Park the nature of the activities varied along what we have called the pedagogy dimension, which is illustrated in Figure 3. Within the SPP students engaged in an archaeology session which involved researching topics on the web (learning about) and they then created artifacts in-world (learning by doing). At other times students organised in-world weddings and the trial of an avatar accused of murdering another avatar (learning through role play). Learning by becoming was evidenced by the Schome Park regattas, where students actually were sailors and race officers, and by the governance group where students took on the responsibility of planning officers for the community, creating rules and subsequently enforcing them.

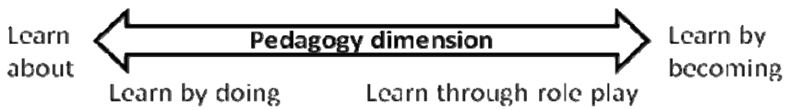

Fig. 3. The Pedagogy Dimension

4.3 Theoretical Stance

The predominant theories of learning/development underpinning formal education (at least in the industrialised world) are based on the premise that learning is an epistemological problem involving individual psychological processes that lead to the acquisition of knowledge [12]. Thus, an individual constructivist view sees learners as active agents who construct knowledge, in the form of their own internal model of 'the world', as the result of interactions within it. This perspective sees knowledge as being a commodity that an individual can acquire. The pedagogical focus therefore is on the individual, and assessment concentrates on what an individual knows, which will be reflected in the things that an individual can do (without support).

The Schome Park Programme is underpinned by a sociocultural view of learning, in which knowledge is seen as a social practice rather than a commodity. Hence knowledge moves from being something you acquire to being an ability to act within a community of practice. Thus there was a focus within Schome Park on each individual's participation and ability to act within the community. Figure 4 illustrates these differences in perspective.

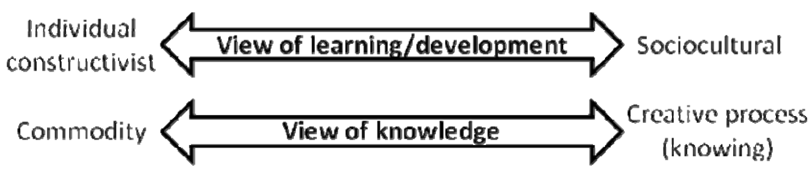

Fig. 4. Theoretical stance

The tension between a traditional school theoretical stance and the Schome Park stance was highlighted very clearly just after a group of students and their teacher joined Phase 3 of the Programme. The teacher had set the children some homework, which was to find the answers to some questions about the Schome Park Programme. Her intention was that the students would search for information in the wiki and explore Schome Park itself in order to find the answers to these questions. One of her students (SchomerE), having first tried to find the answers for himself, posted a message in the forum asking if anyone knew the answers to 23 of the questions. This almost immediately provoked a challenge from one of his classmates who seemed to be questioning the validity of this approach to doing the homework. Within 3.5

minutes of the original message a reply had been posted by an established student member of the community (SchomerG) providing the answers to 20 of the questions. Twelve minutes later another experienced student posted a message that provided answers to the remaining three questions and corrected a couple of the answers that had been provided by SchomerG. A couple of hours later an established member of staff posted a message congratulating SchomerE on taking advantage of the knowledge of the community:

> Lateral thinking - SchomerE is going to do well in Schome
> Now that the community has collaborated on SchomerE's homework - has anyone else got any we can help with?
>
> SParker4 16-Jan-08 @ 19.49

A discussion ensued about whether or not SchomerE had cheated. There was a clear divide in perspective between the new students and the existing ones. The class teacher, who was in the difficult position of being constrained by her school context whilst also trying to fit in with the Schome Park ethos, diplomatically explained that she felt that SchomerE had undermined what she had intended he would learn from the homework. SchomerE subsequently reported that "it doesn't look like I'm in TOO much trouble" (Forum 18-Jan-08). Underpinning this episode was a difference in theoretical stance, with most of the new students (and teacher) adopting a traditional (individual constructivist) perspective and the established members of Schome Park adopting a sociocultural one.

4.4 Curriculum Dimensions

A vast range of different activities took place on Schome Park, some of which seemed to be more effective (as vehicles to support learning) than others. The nature of the activities differed in many ways, but two dimensions which seemed to be particularly relevant when thinking about the educational potential of activities related to who specified what the activity would be (in effect who defined the curriculum) and how much choice students had about taking part in the activities or not (curriculum choice). Figure 5 shows how 'Traditional school' and a number of the Schome Park activities map onto these two inter-related dimensions. The shaded area illustrates the region that our experiences in Schome Park seem to suggest provide the most productive contexts for learning.

Traditional school (which was not a feature of the SPP) typically gives learners no choice about whether or not to participate because they are required to go to school (i.e. is imposed), and it has an externally defined curriculum (i.e. not defined by the learner).

Chosen projects relates to work that a group of students from a school who were working in Schome Park engaged in. The students were given a choice about whether they wished to take part in the SPP or some other activity; they had to choose from the available options, hence their curriculum choice was imposed choice. Having decided to engage with the SPP the students were taken through some taught sessions (not shown in the figure) which included the homework mentioned in the previous section. They were then allowed to choose a partner and come up with any project that they wished to pursue within Schome Park. Thus at this stage they were able to freely negotiate the content of the curriculum.

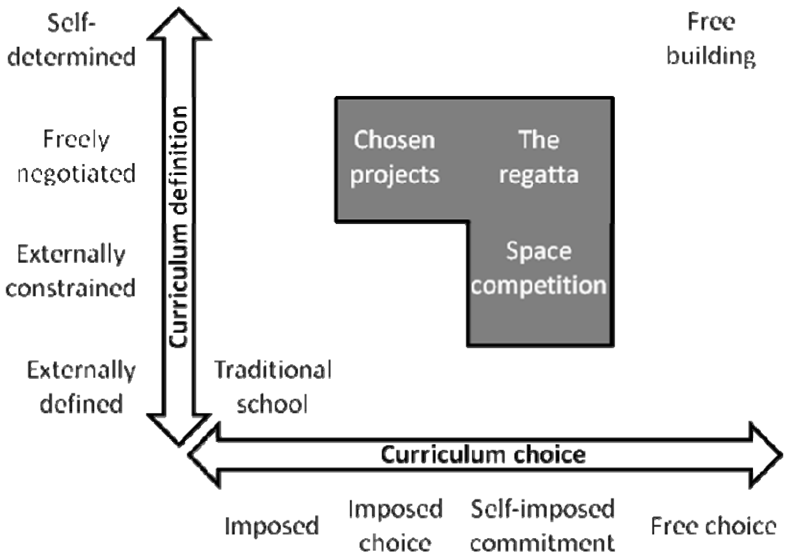

Fig. 5. Curriculum Dimensions

The regatta involved students in all aspects of preparing for and running a series of boat races around Schome Park. The students came up with the initial idea for the activity, but having decided to do it and advertised it to the community, they had imposed a commitment on themselves to see the activity through (self-imposed commitment). What the activity involved was also something that the students were free to decide, but they did have to agree amongst themselves what was going to happen (and indeed who was going to do which things). This was free negotiation (on the curriculum content dimension) in that it was negotiation between peers.

A member of staff suggested to the students that they enter *the space competition*, which involved designing an experiment that could be carried out from a satellite orbiting in space. The prize was to have your experiment actually implemented. The students had free choice about whether to take part in the competition (though not everyone who wanted to was able to in the end), but having signed up to take part they were committed to seeing through the whole project, which lasted several months (self-imposed commitment). The curriculum was externally constrained, in as much as the rules of the competition and judging criteria set limits on what your entry to the competition needed to focus on. However, within those constraints the students had a great deal of freedom to design any experiment that they wished.

Free building is used here to describe the sort of unconstrained building activity that took place in Phase 1 of the SPP, when students were allowed to build anywhere they wished above 250m. The students had total choice about whether to build or not (free choice on the Curriculum choice dimension) and about what to build and whether to add scripts to enhance their builds (self-determined on the Curriculum definition dimension).

5 Conclusions

The Schome Park Programme used the power of OVRs, as unclaimed spaces that encourage pedagogical exploration, to explore dimensions of practice in order to inform our thinking about schome (the optimal education system for the learning age). The dimensions of practice that emerged from this early work on the SPP help to distinguish between key aspects of practice within Schome Park, and would appear to have relevance across any educational context. However, there is a long way to go before we have a clear understanding of what schome (the optimal education system for the learning age) should be like. It also remains to be seen whether or not OVRs will retain their strength as pedagogical playgrounds, and if they do, then what impact (if any) will practices emerging within virtual worlds have on practice in the physical world?

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Technology Mentoring: Research Results across Seven Campuses

Rachel A. Boulay[1] and Catherine P. Fulford[2]

[1] John A. Burns School of Medicine, University of Hawaii, USA
rachel.boulay@hawaii.edu
[2] Educational Technology, University of Hawaii at Manoa, USA
fulford@hawaii.edu

Abstract. Representatives from seven community college campuses throughout Hawaii were designated to coordinate the creation of Technology Intensive (TI) courses using a model developed at the University of Hawaii at Manoa. Data collection focused on qualitative measures: written narratives, pre and post surveys, and samples of technology products and curriculum changes. This approach allowed for the detection of subtle changes in faculty growth with regard to technology. Findings suggest that a strong mentoring program promoted substantial progress among study participants to model technology for students. Many faculty members quickly incorporated technologies into courses and promoted student use of technology in a short period of time. Participants transferred the technologies they learned with their mentor into classroom instruction and modeled the use of these technologies for their students. Technology mentoring transformed faculty into able technology users, diversifying their use of technology to accomplish specific teaching objectives.

Keywords: Institutional change, modelling, personalized learning, teacher education.

1 Introduction

Proposing changes in teacher education programs is a formidable task and one that educational researchers would demand to be approached in an appropriate, systematic, and informed manner. Professional development programs are tasked with trying to speed individuals through various stages of progress, as quickly as possible, while preserving the quality of instruction and the long-term adoption of a technology. Different strategies have been proposed and utilized in professional development. Arguably, certain strategies may be more effective at certain stages of development or for certain groups. However, despite the proliferation of technology-introducing strategies offered for faculty, there is not a clear understanding of such programs and their success. While a decisive answer is not currently within grasp, “mentoring” has been proposed to be a promising strategy. While this strategy may be a natural progression, our understanding of the unique qualities of mentoring programs aimed at fostering technology integration is not sufficient. The purpose of this study is to provide one

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step towards more rigorous investigation of the outcomes of mentoring programs that encourage faculty to incorporate technology into curricula.

Mentoring means to "facilitate, guide, and encourage continuous innovation, learning, and growth to prepare for the future" [1, p.13]. Thus far, the mentoring described in education has targeted professional development, while simultaneously providing social support. In this study, the mentoring relationships are characterized as skilled, progress-focused, short-term associations. The participants of this study participated in formal mentoring relationships resulting from a structured mentoring program. Mentors acted as facilitators aiming to increase the knowledge, skills, and independence of their mentees to learn and use technologies. The roles of mentors changed to respond to the needs of the mentee [2]. The literature on mentoring is clear that mentoring relationships should be systematic and planned [1], [3], [4]. Training and support for mentors is recommended. More productive and successful mentoring relationships tend to be reciprocal, where both mentee and mentor gain from the experience. Finally, the understanding of mentoring relationships suggests relationships develop in four stages: Relationship-building, Goal and expectation formation, Teaching and learning, and Reflecting and redefining roles. Programs that aim at promoting mentoring, as a form of professional development should consider these recommendations in their design and implementation, as this study did.

Recent work examines the "mentoring" that has occurred in some technology mentoring programs for faculty. Chuang, Thompson, and Schmidt [5] summarized major trends in the literature on faculty technology mentoring programs. To date, studies have predominantly relied on self-reported accounts and attitudes. Data is typically in the form of surveys or interviews. Mentoring programs have sprouted up to provide faculty professional development to incorporate newer technologies into their teaching. However, the contexts within which these programs work are very diverse. Mentoring rarely operates in a vacuum without other resources and opportunities. To begin to develop an understanding of mentoring programs, their effectiveness and complexity, detailed descriptions of the programs studied, such as has been provided in recent work [6], [7] must be provided first.

At the University of Hawaii (UH), the Department of Educational Technology (ETEC) led the College of Education (COE) in responding to the national concerns related to integrating technology into preservice teacher education. The Learning Enhancements through Innovation (LEI) Aloha Project began in 1996 and matured into a viable model for technology integration. Fulford and Ho [8] developed a model of institutional change for technology integration based on faculty mentoring. The Technology Intensive (TI) Courses Model used graduate students as "technology mentors" to assist COE faculty with technology integration [9]. The approach was based on the philosophy that teachers teach the way they are taught. Therefore, COE faculty needed to model effective technology use in their own teaching and require their students to use technology in their academic work and research.

The TI model used a systematic approach for faculty recruitment, course redesign, and evaluation to assess the integration technology into courses. A three-tiered approach was developed to meet the challenge of faculty reluctant to use technology. This method allowed faculty to work progressively towards full TI courses. The Technology Enhanced level allowed them to experience success without making great changes in their current methods. In Technology Applied Courses, faculty add the use of technology to the current course structure encouraging students to use technology. In Technology Intensive Courses, the faculty must follow the TI Standards and Guidelines to improve technology literacy while continuing to emphasize course content. Students have a high level of involvement and faculty serve as role models using technology.

LEI Aloha then expanded its mission so that a continuum of technology-integrated courses would be provided from the time students enter the university until they have completed their field-based student-teaching experience. At the beginning of the continuum, community college (CC) faculty members often provide prerequisite courses. They have considerable influence on how students shape their view of teaching and learning. Though the COE developed and refined a successful model, no single model can work for every institution so it needed to be modified to fit the individual differences. This paper addresses a summary of the research results that emerged across the multi-institutional initiative, given each campus' unique approaches, resources, and faculty. Inherent in the project was the idea of building a bridge between the UH CC pre-education program and the COE teacher preparation program [10], [11].

2 Data Collection

A total of 78 faculty participants were selected across seven unique, two-year college institutions.

2.1 Participants

The only public institution for higher education in the State, the University of Hawaii (UH) is a ten-campus system that includes three universities and seven CCs. Four of the CCs are on Oahu, the most populated island; the other three are on other islands of Hawaii. Approximately 24,000 students are enrolled at the system's CC degree programs. UH has a diverse student population: 49% Asian, 22% Caucasian, 18% Hawaiian/Pacific Islander, and 11% other. Some faculty from every CC in Hawaii participated. The 78 faculty members (28 male, 50 female) in this study were mentored in order to increase their technology skills and their integration of technology into their courses. The females, representing two-thirds of the sample, completed 202 of the 307 total technology projects. Males completed 105 of the 307 total projects. The participants taught across a broad range of subject areas. The largest group taught English (35%), followed Social Sciences (18%) and Business (15%). The other subject areas of Language, Math, Science, Medical & Health, or Arts & Humanities attracted 4 to 6 faculty.

2.2 Procedures

At the beginning of the mentoring relationship, mentors and mentees defined expectations, helped foster conversation, and clarify roles. The mentor and mentee negotiated practical issues, such as, creating a schedule and signing a contract. During early sessions, they discussed the content of the courses mentees taught and options in redesigning their curriculum. Mentors often demonstrated samples of technology curriculum samples and teaching practices. Together they would develop goals for learning and using technology. Goals ranged from creating an online course or class website to learning how to use a piece of equipment in their classroom or how to use specific software. Each software or hardware a faculty chose to learn was called a technology project. Multiple technology projects may have been necessary to accomplish a broader goal, such as teaching online. The pair met at least one hour a week usually in the mentee's office. During sessions, mentors helped mentees to revise course objectives, student requirements, class projects, teaching strategies, classroom activities, and instructional materials. In some cases they addressed using new mediums, such as online environments. Mentors located training materials and resources, then, designed incremental learning steps for their mentees to practice and gain confidence.

Prior to, or shortly after mentoring began, the project collected written descriptions of faculty members' technology skills and the use of technology in their courses. In most cases, the faculty member's mentor wrote these narrative descriptions. Some faculty took a pre-mentoring survey measuring their confidence on specific technologies. To corroborate this data, the project also collected course artifacts that demonstrated the faculty member's beginning technology skill level. As mentoring progressed, new or revised course artifacts were submitted that demonstrated the progress a faculty member was making on a given project. Course artifacts often included screen shots of online course pages or websites, newly created digital presentations, syllabi or handouts, student assignments, scanned work, or PDF versions of documents. These artifacts painted the picture of what of the faculty member was working on, what they were creating, and how they were revising their course. After mentoring, another written description of the faculty member's newly acquired technology skill level and the use of technology in their course were submitted. In addition, faculty completed a retrospective, self-report survey that measured their perceived increase in confidence on certain technologies using a Likert scale. The resulting data provided a plethora of information detailing a faculty member's growth on multiple technologies over time. The project received sufficient data from 78 faculty members from seven unique campuses over a period of two years. The participating faculty members primarily received either one or two semesters of mentoring during the two-year period.

3 Analysis

Data analysis for this qualitative research study was approached through multiple strategies [10].

3.1 Constant Comparative Method and Triangulation

The data was examined and reexamined to identify patterns and themes. The qualitative comparative method of data analysis [12] was used to construct categories and themes that captured the recurring patterns that emerged from comments relating to technology. The analysis was cyclical, consisting of initial coding, reflecting, and rereading, then sorting and sifting through the codes to discover patterns and themes. These methods were used to triangulate the evidence of the data [13]. Triangulation is a process that can guard against the possibility that a study's findings are simply an artifact of a single method, a single source, or a single investigator's biases by checking findings against other sources and perspectives [14]. In this study, methods triangulation involved validating information obtained through self-reports and narratives by checking course artifacts, examples, and documents that could corroborate what the participants reported. Using a triangulation of sources method, the data sources were compared and cross-checked to determine the consistency of different data sources within the same method. For example, multiple course artifacts, including numerous sets of instructional materials, were reviewed for each participant. The third kind of triangulation, analyst triangulation, using multiple analysts to review findings was conducted. Two individuals rated all artifacts; then, the ratings were shared with technology mentors, to provide useful member checks of the findings. By combining multiple analysts, methods, and data sources, this study provides a robust design.

3.2 Development of Coding Instrument

Given the naturalistic inquiry and open-ended approach to data collection, the data sources submitted for each faculty participant varied significantly. An additional strategy for data analysis was needed to strengthen the aim of a cross-institutional comparison with some reliability among multiple coders. The project developed a system for coding and synthesizing this information. Coders recorded on a form each unique technology in which a faculty member was mentored. Then, for this specific technology a notation was made of: (a) why the technology was learned, (b) what the faculty member's skill level was before and after mentoring, and, (c) whether any visible changes would be evident to students in their courses.

Unlike a limited one to five Likert scale measure, a key component was using one of the following seven descriptive categories to rate an individual faculty member's skill in using a specific technology. ***No Use:*** Although the faculty member might be aware of the given technology, he or she has never used it. ***Basic Use:*** The faculty member is aware of the technology's general capabilities and is beginning to learn the basic skills for use. ***Knowledge of Tools & Features***: The faculty member is moving beyond the basics of the given technology's features and is learning to use those features according his or her personal needs. ***Independence & Confidence:*** The faculty member expresses an improved attitude or a raised confidence in his or her skills in the given technology. The faculty member's use of the technology reflects that change. He or she begins using the technology more independently and might use the technology more artfully, adventurously, or publicly, that is, for course content delivery or student communication. Additionally, he or she might begin letting students elect to use their own skills in that technology to complete course projects. ***Integration & Student Use:*** The faculty member knows enough about the given technology to be able to apply its capabilities to student learning activities. The faculty member is able to design opportunities for students to use the technology in ways that enhance their learning or skill acquisition. Integration efforts will vary. For example, some faculty members might retrofit prior assignments to new technologies, whereas others will redesign class activities and student assignments to capitalize on technology benefits. ***Leadership & Guidance:*** The faculty member has become an expert in the given technology. He or she is able to coach students toward individualized, creative, and exploratory uses of technology to maximize learning or enhance class projects.

The faculty member's use might also reflect a shift in teaching philosophy or classroom methodology. ***Innovation:*** The faculty member integrates the given technology in an inventive way. He or she pushes the limits of the technology, and, invents new instructional and student uses in order to make the technology serve his or her technology needs.

4 Results

This study focused on one of the most promising professional development strategies advanced from the community of professionals for assisting faculty to learn technology – technology mentoring. Does this approach of professional development for faculty, personalized technology mentoring, actually lead towards achieving the goals of the national community to create technology-rich, meaningful classroom experiences for students? The following is a brief summary of numerous findings.

The 78 faculty in this study attempted and completed 307 technology integration projects. In over 67% (n=206) of these projects, faculty learned completely new software and hardware (Table 1). Over 90% (n=279) of technology integration projects included software or hardware that the faculty member had no knowledge or basic knowledge in, before mentoring. Whereas after mentoring only 12% (n=37) of faculty were still reporting no knowledge or basic knowledge. After mentoring, 62% of faculty projects (n=189) were classified as demonstrating technology skills at independence (35%, n=107) or integration levels (27%, n=82). An important achievement is the 13 instances of faculty's skills found at leadership or innovation levels. The data showed no instances of leadership or innovation levels among faculty before mentoring.

Table 1. Number of faculty projects at skills levels before and after mentoring

	No use	Basic use	Knowledge of Tools	Independence	Integration	Leadership	Innovation
Before mentoring	206	73	13	10	5	0	0
After mentoring	1	36	68	107	82	12	1

Approximately three-fourths (57) of the 78 faculty had one semester of mentoring and completed 226 technology integration projects. One-fourth (19) received two semesters of mentoring and completed 75 technology projects. Although fewer faculty received mentoring for two semesters, there are some interesting differences in technology skills gained between these two groups. The 78 faculty members in this study worked on a range of technology projects utilizing nearly 80 different pieces of software or hardware. These technologies were classified into 15 categories: online courseware, web design, presentation, equipment, publishing, graphics, assessment tools, file transfer, communication, internet, file management, utility, conferencing, information retrieval, and spreadsheets. Over 60 (26%) of faculty choose to learn applications related to online courseware. Faculty also concentrated on web design

(46.15%), presentation (44.87%), equipment (41.03%), and publishing (33.33%). Graphics, assessment tools, video, and media tools ranged from 10% to 20% of faculty's choice.

Data showed that faculty who sought to improve their technology skills through mentoring were at a beginning level. They predominantly chose to learn new technologies with which they had very little experience. Secondly, data showed that level of technology use faculty reached was substantial for all participants and campuses. The mode of technology use in the sample moved from "No Use" to "Independence & Confidence, representing three level increments. Thirdly, data showed how technology manifested itself in the instruction for those faculty who immediately encouraged student use of technology in their courses. Approximately 60% of the participants required student use of technology after mentoring. However, only 10% of the participants exhibited use at the two higher levels of technology use, Leadership & Guidance or Innovation. Finally, 23% of the faculty participants perceived technology use in relation to technology content standards. Unlike previous studies faculty did not omit a particular category of technology content standards, however, faculty did disproportionately target the same subset of standards.

5 Discussion

Each campus is different and no single professional development model is guaranteed to work at any one institution. However, through a process of transferring a working TI model, from a four-year institution to seven, very different, two-year CCs, all demonstrated success in encouraging faculty to progress in their technology skill set and to work towards better integration of technology into teaching. Faculty who had none to little knowledge in technologies gravitated to a technology mentoring program. Further, technology mentoring was fruitful in encouraging faculty to learn the newest trend with technology, such as online course development. Was the project successful? It depends. If the goal was to produce faculty who could facilitate students' individualized, creative, and exploratory uses of technology to maximize learning or enhance class projects, then no. Few faculty members were able to gain this level of skill and comfort with technology even after two semesters of mentoring. However, the evidence of growth, over two semesters compared to one, indicates that continued mentoring might increase the number of faculty achieving this level. Not a single faculty member, who taught at the community colleges in this study and was unknowledgeable about technology, was left behind in learning new technologies.

If the goal was to enable faculty to know enough about a given technology to apply its capabilities to student learning activities and design opportunities for students to use the technology in ways that enhance learning, then again, the answer is no. Although several faculty achieved this level within the study, the majority of faculty did not reach this level of integration with only one or two semesters of mentoring. Again, continued mentoring and targeting these specific skills may have a positive impact. Although, participants did immediately transfer the technologies they learned into classroom instruction and modeled the use of these technologies for their students.

However, if the project goal was to create faculty who model learning even when it comes to the area of technology and are motivated to continue on their journey, then the answer is a resounding "YES!" The majority of faculty, even with as little as one semester of mentoring expressed an improved attitude or a raised confidence in his or her skills in the given technology. The faculty member's use of the technology reflects that change: The faculty members began to use the technology more independently, more artfully, adventurously, or publicly.

Additionally, some faculty began allowing students to elect to use their own skills in technology to complete projects. People learn at different rates, and some faculty only reached skill levels of basic or knowledge of tools with a specific technology even after one or two semesters. However, it is important to understand that these too are great strides for someone who has never used a software application, email program, or searched on the Internet. This was especially the case on campuses that focused exclusively on faculty members known to be "technophobes."

The world of technology is forever changing; so listing the particular software applications or hardware learned by faculty members may not be that useful. Even using the categories of technology does little more than paint a picture of the current trend of technology and faculty's efforts in trying to stay up-to-date. Clearly, the need to develop online materials for courses, whether they be fully online, hybrid, or simply supplemental materials, could be observed at these institutions at the time of data collection by the popularity in learning online courseware and web related programs. Interestingly, equipment issues ranging from how to work a digital still camera or a scanner to how to set-up a data projector were prominent. In the vast array of workshops offered for professional development, few focus on the nuts and bolts of connecting hardware and many involve participants at computers that are already set-up. Clearly, the faculty in this study expressed a need to learn how to hook-up equipment, synchronize it with a computer, and make it operate properly. This hands-on practical information was requested nearly as often as how to create web pages or digital slide presentations. Professional development programs should take care to address this important area of need.

Although future studies may want to consider the costs and benefits of mentoring, this study showed that mentoring faculty to integrate technology does work. No matter what level of final technology skill leveled achieved, the data is conclusive about the overall improvement by the faculty in this study. On average, the faculty moved approximately two category levels within their mentoring period, for example, from no use to knowledge of tools and features, or, from basic use to independent use. Studies should also investigate the results of long-term mentoring and the possibility of continued improvement. Individuals may assert that mentoring is expensive or inefficient, considering the heavy demands placed on human infrastructure. These individuals may argue that other professional development strategies, such as workshops or group training, can target greater numbers of individuals. However, this study points to the effectiveness of technology mentoring to 1) address all individuals, despite different learning styles, personalities, or content specialties, 2) translate into changed learning environments for students, & 3) enable faculty to facilitate higher-order technology use by students along categories of technology standards. These outcomes achieved in only one or two semesters speak to the efficacy of using technology mentoring to enable institutions and their faculty to obtain national goals, related to technology, quickly.

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So I Sat Down with My Mother: Connectedness Orientation and Pupils' Independence

Anders Eklöf, Lars-Erik Nilsson, and Peter Svensson

Kristianstad university college, Sweden
anders.eklof@hkr.se, lars-erik.nilsson@hkr.se,
peter.svensson0003@stud.hkr.se

Abstract. Swedish educational policy underlines the importance of independence. In this paper we use socio-cultural theory and Foucault to explain how pupils' independency is transformed into something else in their work. Our results derive from analyses of filmed sessions and entries in the pupils' logbooks. Our findings demonstrate that the pupils' definitions of independence differ from those of the course plan in several aspects: i) the use of certain resources is not considered to show lack of independence, ii) doing things yourself is considered being most independent and iii) to follow instructions, even if this means violating your unique personal thought, is considered a prerequisite for passing/getting good grades and as such a necessary adaption to the school context, sooner than a sign of dependency. Consequently we argue that pupil independency should be regarded as a phenomenon chiseled out within a community of practice rather than a personal capacity.

Keywords: Independence, Project work, Foucault, Instructions, Community of practice.

1 Being Independent in a Collaborative Assignment?

X, Y and Z are planning their project. They have had some trouble getting started. In the transcript represented by the video-frame above, X comments on suggestions included in a mind map present on their computer screen. He claims that most of the suggestions in the mind map are the result of a brainstorming session he and his mother carried out that morning as he sat down with her and talked about their project. His way of speaking about his mother's assistance, demonstrates that this mode of working with school assignments does not present a problem. The only problem appears to be whether parents can spare the time.

X's accounts of what it means to him to carry out work align with the widely-held view that work in a knowledge society is carried out in collaboration. In Sites 2006 [1] this view is presented as a move in policies from a traditional orientation to learning towards a LifeLong Learning or a Connectedness Orientation. Connectedness orientation means learning from local as well as international experts, and from peers

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at a student's local school as well as in distant locations. Students need to form "social networks" or "communities of practice" in order to perform well and information and communication technology facilitates this.

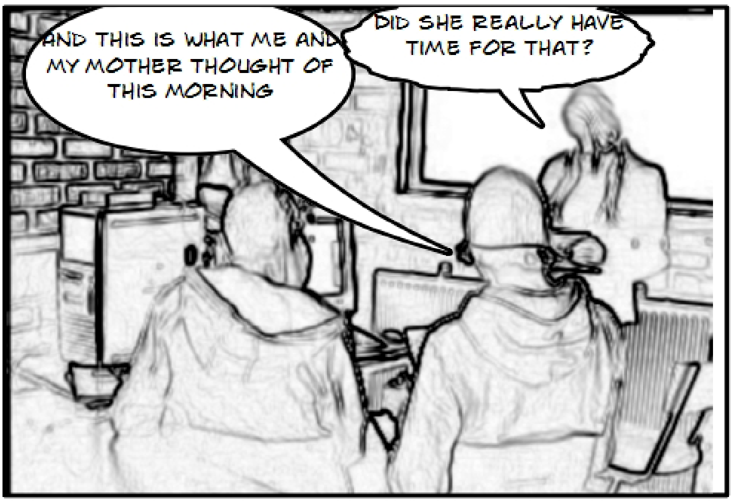

Fig. 1. External assistance

An equally important assumption is that people living and working in an information society need to be able to perform independently and take on individual responsibility for assignments. In the Swedish school system project work is a site for training how to work collaboratively but students doing project work also need to be assessed and graded according to signs of independence. Here we have decided to translate the Swedish word *självständighet* as independence. However the meaning of being independent while working collaboratively seems problematic for both pupils and teachers. What counts as a sign of independence when you are working in a group with a global connection? How can we account for independence with respect to being aided by humans or human artefacts such as digital technology? Is it self-regulation or maybe doing things individually? Should students come up with creative solutions or appear as original authors? This suggested paradox forms the starting point for our study, where we attempt to elucidate how students reason about independence in the context of school-related project work.

2 Situating Students' "Own Work"

Students' "own work" has become an important issue in the current discourse on Swedish education, as represented in bills, curricula and policy documents while becoming an important catch-phrase in media. Researchers use the phrase to categorize a mode of work that has become more common in all stages of the Swedish education system. Österlind [2] argues that *students' own work* is a mode of working that affords freedom for those with an upbringing that fit such a value system but also increased pressure and dejection (p. 99). In political debate students are often considered left on their own to learn and the absence of the teacher is criticized. Sometimes it is literally treated as working individually. Students involved in *"own work"* activities are supposed to master liberty of choice and to take on a high degree of responsibility for planning and carrying out assignments "*independently*". *"Own work"* stands in contrast to traditional work forms which to a greater extent are planned and supervised by the teacher. Rather than being an individual, solitary activity however students' "own work" can be understood as often embedded in a collaborative activity where the students rely on a number of resources. Their management of these resources may in itself present difficulties and the students often spend considerable time on the Internet searching for information [3] and reasoning about the meaning of assignments and instructions [4].

Looking at project work two trajectories can be seen. The first trajectory is related to Dewey [5] and the progressive pedagogy movement which suggests that pedagogical objectives should: i) be anchored in real activities, ii) be formulated by students and iii) allow students to work with methods that align with the formulated objectives. This credo can be clearly seen in the course plan for project work.

> *Project work aims at developing the skill of planning, structuring and taking responsibility for a larger piece of work and providing experience of working in project form [6].*

The other trajectory emphasizes that project-oriented work forms are becoming more common and are appreciated by employers. Project work is thus seen as a positive response to labor market demands, Viewed from this perspective critical remarks are made by authors who ask for whom and under what circumstances this direction is beneficial (cf [7]; [8];[9]).

3 Independence in Project Work

In compulsory as well as higher education in Sweden independence, individual responsibility and self-regulation are required (Higher Education Ordinance, [10]; [11];[12]) and students are supposed to be assessed and graded accordingly. The difficulty that presents itself is what exactly it is that is to be assessed and this difficulty can be assumed to be a concern for teachers and students alike. One issue of concern for psychological research is what the nature of independence is. To what extent can they be seen as practical achievements that exist "in doing" and are displayed in practice? How can students display independence and how can independence be measured let's say by teachers?

From a socio-cultural perspective (Wertsch,[13]; Säljö, [14]) speaking of student independence or autonomy as a quality of human action presents a difficulty, as categories such as independence generally are considered situated, culturally, historically and socially and hence are preferred to be regarded as subjects of discussion rather than qualities having an essence or fundamental nature. If one adopts a connectedness orientation independence becomes something of a paradox since learning takes place under circumstances where students are networked and knowledge exists and is transformed under the very same circumstances. In conclusion the notion of being skilled is also constituted under these circumstances. Lave and Wenger [15] suggest that the meaning of such categories is negotiated through participation in practice and through reification of meaning into object like constructs. From this perspective independence can never be regarded without consideration for the local discourse or artefacts that contribute to learning.

4 Research Context and Methodological Considerations

Foucault [16] argues that subjectivities (such as independence) can be regarded as discursive positions within an order of discourse and as such principles rather than essential human traits. In his later works Foucault [17] argues that individuals engage in self-forming activities and draw on discourse orders to turn themselves into particular subjects, which has induced us to ask questions about how students are invited to recognize being independent as an obligation in our analysis. Other questions being: What ethical issues do they raise? (Students are for example, as we see it, bound to ponder over if and how different activities in group work and different uses of technology are linked to being independent.) How are students invited to recognize being independent as a moral obligation? Do they turn directly to course plans or are these issues raised in tutoring sessions and discussed with teachers or has networking meant giving another meaning to independence?

Questions such as those above are best answered by studying students in action. In this study students in two theoretical programs directed towards natural science or social science in a Swedish secondary school have been video recorded. They are working in groups with assignments related to a course called, PA 1201, Projektarbete. The course was established with the explicit purpose of “developing the skills of planning, structuring and taking responsibility for a larger piece of work and providing experience of working in project form [6].

Our data consists of 60 hours of video filmed interaction collected over a three-year period, additional data being instructions along with entries from the students' individual and group logs. Narrative techniques from sequential art were used to represent interaction. We argue that this technique allows us to describe the dynamics of interaction more efficiently. Transforming films into sequential art strips involves several analytical considerations [18]. However we contend that the analytical considerations made when using sequential art strips are not radically different from those made when using more conventional transcripts. It boils down to decisions about how renderings will influence our analysis.

5 Independence within a Community of Practice

Students' lack of exposure to teacher instruction being left without the proper guidance is often presented as a negative aspect of students' own work in the present political discourse. Using technology to connect to other sources of support however is generally constituted as positive in policies and this view aligns well with a Lifelong learning and Connectedness orientation.

In one session from the video recordings students are working on the introductory part of their project work. In the instruction they are given advice on what and how much to write.

During the session group members left the room to compare their solution to that of other groups asking “how can they have done that?”. They consult others on seven occasions. Problems discussed concerned instruction and technical aspects of word processing (rather than writing). Peers are important for project work. Students sit grouped by the computer, move between groups and networks using different media. Solutions are compared and discussed every step of the way. Consulting other students is rarely turned into an ethical substance and not constituted as being dependent.

6 Other Collectively Accessible Resources

All our data (videorecordings, audiorecordings from tutoring sessions and notes from student logs) clearly demonstrate that students are supplemented by many resources in their work. In some cases students are invited to use these resources through the formal framework provided for project work. This seems to be the case with tutoring sessions and instructions which have been reified as scaffolds in the formal school environment. Occasionally, such as under what conditions they are allowed to use texts, visit websites or draw from other sources, the use of resources constitutes a difficulty that needs to be discussed, (cf. [19]). Consulting parents, peers or distant experts however is rarely reasoned out as threats to independence. External resources come in handy when students have technical problems. In a log notation friends are described as; one who “helped out with the front page”; someone who is “good with Internet pages”; while a father is described as being “good with computers”. Students frequently refer to Anders, the researcher who monitors the video-taping. One group complains over having poor computer skills but they “fix things with a little extra help from Anders”. Another group accounts for their participation in the research project stating that “that way they could get help from Anders on different occasions”. The student logs are accessible to the teachers but such supplementation does not appear to be accounted for as being dependent.

7 Instructions and Independence

Instructions play an important role in students’ own work. Instructions for project work can be located through the school network and students carry printed versions with them. They are always connected to these instructions so how can they appear independent of them? In the transcript below a group of boys start their writing of the analysis section by checking the instructions on the web. The first boy states that they have to use their hypothesis. New information should not be inserted in this section. The second boy indicates that he is in agreement. The first boy states that then they can “just start writing.” Independence does not appear to present a difficulty to reason about.

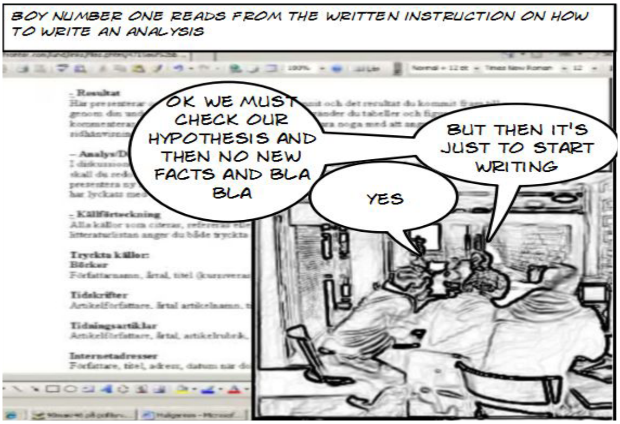

Fig. 2. Instruction as a path

The next transcript illustrates another way to treat instructions. The students have made some alterations to a text they have taken from a book. They express uncertainty about whether they are allowed to do so or not. They compare their notes to the text on the screen.

They account for their alterations as an attempt to meet the needs of their readers. This obligation however is severely limited by the duty to follow instructions. Even though they are in agreement that the alteration improves the text, they decide to reduce their uncertainty by moving their text to “the discussion”. One may say that they are invited by their concern for their readers to present a readable text and by their way of constituting “following instruction” as a demand to follow to the letter. The difficulty is resolved through the suggestion that they present the alteration in the discussion, a genre they construe as one where they can write more freely and use their own voice.

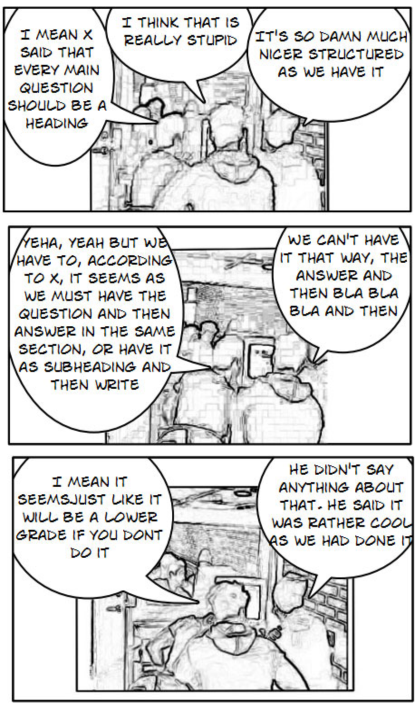

Fig. 3. Instruction as a challenge

In the next strip three boys reason out an oral instruction that the teacher X has given. Boy number one suggests that they have been given instructions by X to the effect that every main question (hypothesis) should have a special section in their report. The other boys oppose, but not on the grounds that X’s instructions should be interpreted differently. Instead they assert that it is a stupid way of structuring their writing. They argue that their structure is superior to that of the instruction and should be used.

It would be tempting to argue that the last group of students shows a considerable amount of independence towards the instructions. We would claim however that all of the students engage in self-forming activities that involve considering independence but they are differently invited. They constitute instructions as clear cut. They them as a foundation for ordering work that needs to be reasoned out. They draw on the teacher's assessment of the quality of their present design as rather cool as a means to reconcile their preferred design with the teacher's verbal instructions and hence reach the conclusion that they can keep their original structure, and possibly get high grades.

8 Connectedness Orientation and the (In) Dependence Paradox

Students working in the course PA 1201 are supposed to be graded on independence. The purpose of this study has been to study what the independent student becomes, treating independence as a practical achievement that exists "in doing", leaving aside philosophical and psychological concerns about "the nature of independence". A demand that students demonstrate independence however is also a demand that they demonstrate dependence. We would like to call this the (in) dependence paradox.

We find that students are governed in the name of independence rather than dependence, but it is a highly situated form of independence. Our results clearly demonstrate that the students working in different phases of "the project journey" make use of a number of resources, primarily human actors, but also electronic devices. Making use of external human resources is rarely constituted as being less independent. Jackson [20] argued that "learning to live in a classroom involves, among other things, learning to live in a crowd." From a socio-cultural perspective it may be differently stated. We spend most of our time in organizations, acting within organizational structures communicating with institutional categories. Learning in itself is overwhelmingly to learn in collectively organized settings with the help of resources provided in these settings. What has changed since 1968 seems primarily to be what students consider to be accessible resources hence what space that can be referred to as their classroom.

Governance in the name of independence does not seem to prevent "our students" from using human or technical resources to supplement their learning. They do however have to consider their relationship to different sources in order to manage impressions. Students clearly indicate that what they need is to appear independent in their relationship with teachers. This demand becomes more pressing as they progress through school. Our students however are not seen as invited to risk challenging teachers' assessments of their work. One might argue that the ultimate proof of independence on the part of students would be to challenge their teachers' opinions but teachers' assessments do not surface as something to reason . The impact on grades when disobeying instructions does.

The political rationale behind the introduction of PA 1201 can, as we claimed earlier, be traced back to Dewey and his credo that pedagogical goals should be anchored in real activities, be formulated by students and allow students to work with methods that align with the formulated goals but also in normative political claims about preparation for work life. The need for collaboration can be anchored in Vygotsky's [21] claim about supplementation, i.e. that learners cannot reach as far on their own as they can with the help of a more experienced tutor, is important to learning. This almost symbiotic dependence, such as in apprenticeship or being part of a dialogic inquiry, is generally favorably presented in literature on pedagogy and aligns well with discourse on use of technology and connectedness orientation. Being a part of a community of practice, a discourse community or an epistemic community is almost solely considered conducive to learning. There are claims that such ideas are common in western policy documents on education and that they give rise to forms of work that stress students' own work, self regulation and independence.[8] There are also claims that such work forms satisfy other needs, anchored in the necessities of schooling such as the need for control as demonstrated by Österlind [2].

In the "prepare for work life trajectory" governance in the name of collaboration is as important as governance in the name of independence. Howard [22] makes a principled claim that there is a difficulty with the constitution of agency within collaborative theory that presents itself clearly in discourse on writing. We see Howard's claim as relevant to a discussion of our students' practice doing project work. She argues that the "prevailing episteme" of the independent *cogito* holds sway even in collaborative theory". It is precisely at this point, she argues, that social constructionism falls prey to the fallacy of the autonomous agent (writer), and we would venture to any form of autonomy. The notion of students' "own work", thus remains firmly embedded in social constructionist theory as described by Howard. It provides the basis for regarding independence as "doing individual work" and also for a connection to notions such as entrepreneurship in "the preparation for work life trajectory." From such a perspective it seems reasonable that our students' most important displays of independence concern independence as "doing".

If one, as in socio-cultural theory, takes into account that individuals in human cultures are supplemented through the use of artefacts ranging from institutions to single devices the construction of independence in collaborative, settings appears to provide a dilemma. The difficulty that presents itself in much project work is that students are expected to perform their work collectively in intimate collaboration with their peers but they are supposed to be assessed based on their individual contribution and mastery. The suspicion that individual students hide behind the collective presents an argument for scaffolds to be put in place that force students to demonstrate independence. In Brown and Cambione's [23] programme called Fostering Communities of Learners is an application of social cohesion theory that the authors claim to be beneficial for learning. What is somewhat intriguing are the requirements for independence. Students form groups in order to master a disciplinary area of expertise. Aronson's Jigsaw method is used in a manner that forces students to independently master this area and as their group is divided they have to report on their area of expertise to the new group.

Governance, albeit in the name of preparation for work life still takes its lead from governance in the name of independence. A difficulty presents itself. How can one be independent in a context where one is required to follow instructions and where one's work is assessed based on a number of criteria present in documents and mediated in different practices? Being graded on independence seems to impose a limit on independence of such a magnitude that it seems fair to ask whether students are not forced into dependence. Students in our material are invited to become independent but only within the limits of policies and written and verbal instructions.

For students doing project work in Swedish schools this governance presents difficulties to be reasoned out. Student accounts clearly suggest that they need to be careful in their appearance. Does this mean that they actually need to be careful in their appearance? Students need to get help, but at the same time they declare that asking for help may be perceived of as displaying dependence. They need to be supplemented in tutoring sessions but they declare that they have to demonstrate that they are independent, by leading the discussions and by not giving the teacher too much talk-time.

In the course plan and commentary material independence can be seen to be treated as an essential concept, transcending history and culture. It presents a mode of subjection as a moral absolute, a higher value and a significant quality providing a discursive position that the students are invited to subject to. In Foucault's terms it would seem appropriate to speak of subjection in "the name of work-life." Students need to be prepared for a modern society. Independence in our material however is displayed in doing. The (in) dependence paradox as we have called it is expressed in the independence students' show in doing. Being independent is achieved in acting on others. The limitations that are imposed on their independence are maintained by the very context that is supposed to foster independence. The contextual constraints seem to turn the students' efforts to answer the call for independence into merely another strategy for receiving as high grades as possible.

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Preparing Graduate Students for Industry and Life Long Learning: A Project Based Approach

J. Barrie Thompson and Helen M. Edwards

Department of Computing, Engineering and Technology,
University of Sunderland
St. Peter's Way, Sunderland, SR1 3SD, UK
{barrie.thompson,helen.edwards}@sunderland.ac.uk

Abstract. The case is made that by undertaking projects that have a real-world dimension the students are more likely to gain the skills and abilities which industry requires. Background information is presented relating to links between academia and industry and the role of student projects. Details are given of taught masters level computing programmes at the University of Sunderland and the project that each involves. A particular approach that has enabled hundreds of successful projects to be undertaken with industry ever year is then described along with an assessment of its effectiveness in giving students life-time skills.

Keywords: Computing, Projects, Higher Education, Industry, Empowering.

1 Introduction

Since the first World Conference on Computers in Education in 1970 there have been significant changes. The capabilities of the Information and Communication Technologies have increased enormously. The provision of university computing programmes has increased not only with regard to the number of programmes and student numbers on them, but also in scope – covering an ever widening spectrum of specialisms. Also, the demands of industry for highly competent graduates who can operate effectively has grown and grown. However, there has been a far from perfect convergence and many industrialists perceive a gap between their needs and what new graduates can offer. The graduate knowledge, skills and abilities that employers' rate highly [1] are often more related to people skills rather than pure technical ones. Also, it is clear that more needs to done to foster more productive industry and university collaborations as was made clear during an IFIP Focus Group which considered the subject in 2004 [2].

One of the most effective mechanisms to bring universities and industry together and also ensure that graduates have the appropriate skills and abilities is for students to undertake projects that have a real world dimension. Clearly the ideal situation is where students can undertake projects that are directly linked to industry and the importance of this type of activity is emphasised in international curricula documents (e.g. Software Engineering 2004 [3]). However, there are significant challenges to be addressed particularly with regard to ensuring that such projects are academically

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appropriate with regard to level, satisfy real industry needs (rather than artificial ones), are achievable by the students within programme timetables, and most importantly that sufficient projects of this nature can be found to satisfy the number of students.

The following sections of this paper are organized as follows: sections two and three provide information on our investigations regarding the links between industry and academia and on the role of student projects. In section four we outline the range of taught masters level programmes at the University of Sunderland and give details of the project that each student must undertake as the final part of their programme. Section five provides details of a particular approach which we have developed over the last few years, successfully ensuring that many hundred students each year complete a suitable externally sponsored project – the majority with industry. Finally some reflections are presented.

2 Motivation Regarding Industry and Academic Links

Both authors of this paper spent a significant time in industry prior to joining the then, Sunderland Polytechnic and close research links were maintained throughout the 1980s and 1990s with external organisations such as the UK government's Central Computer and Telecommunications Agency. We have always believed in the importance of preparing our graduates for effective roles in industry and that they should be equipped with a broad range of technical and non technical skills relevant to being a true professional.

In autumn 2000, to support this wider view and determine trends in the industry we commenced a series of industry orientated investigative activities. These were undertaken primarily within the Software Engineering community and were concerned with both publicising and evaluating a document produced by the International Federation for Information Processing. This provided a framework for professionalism that consisted of six elements: Ethics of professional practice, Established body of knowledge, Education and training, Professional experience, Best practice and proven methodologies, and Maintenance of competence. The work confirmed the value of the overall framework but revealed that there were real concerns regarding the maturity of the areas of best practice and proven methodologies, maintenance of competence, and the educational support for these areas [4].

Subsequently some further work was undertaken in 2004 investigating the area of best practices [5] which did much to reinforce the earlier findings. At this time, as will be discussed in section five of this paper, we took on specific academic roles associated with Masters level projects at our university. We envisaged that this would be a means to reinvigorate our research links with industry and provide information on current industrial practices. Starting in 2005 we commenced a further set of externally funded research activities that concentrated on investigating the links between industry and academia. Our intention was to identify those practices that industry had found to be particularly effective. As part of these investigations we have run four international workshops, been involved with industry led activities, and carried out literature based investigations. The international workshops were held at:

1. The 19th Conference on Software Engineering Education & Training, 2006.
2. The 28th International Conference on Software Engineering, 2006.
3. The IFIP's 2006 Conference on Education for the 21st Century - a constituent conference of IFIP's World Computer Congress 2006.
4. The 14th Asia-Pacific Software Engineering Conference, 2007.

The workshops have exposed the wide range of interactions that exist between industry and academia. However, the workshop discussions made it clear that student projects with industry and internships/placements within industry are viewed as being particularly effective.

3 Project Literature

Over the years a number of key papers have been published specifically addressing industry/university collaborations (e.g. [6] and [7]). However, to determine trends and current levels of pedagogic support we have been carrying out an on-going survey of the papers published in the proceedings of the Conference on Software Engineering Education and Training (CSEE&T) from 2000. The reasons for choosing this source for our analysis are twofold. Firstly we believe that Software Engineering, rather than the other computing disciplines which are addressed in the current IEEE-CS and ACM series of curricula documents, is the discipline that should be aligned most clearly with the industry. Secondly our own interests and prime areas of research lie within the field of Software Engineering and we have a prime interest in educational developments within this field. We believe that since CSEE&T is the premier outlet for papers concerned with Software Engineering education the proceedings should give us a representative spread. In addition, at least one of us has attended every one of the conferences since 2000 and we have personal in depth knowledge of them. We have examined each item within each of the proceedings and allocated each to one (and only one) of the following coded categories (3 specific and 3 general):

- P+I: Projects with industry links;
- P: Projects without industry links;
- LI: Links with industry (non-Projects);
- C: Curriculum, Body of Knowledge, Programme/Course Development, Accreditation;
- T&L: Specific approaches to Teaching and Learning (these can relate to a specific subject e.g. Java Programming or a particular environment e.g. Distance Learning);
- P&R: Software Engineering philosophy, Professionalism aspects (including ethics and legal issues), Reviews (e. g. reviews covering past, present and future, global trends etc),

Our approach in undertaking this investigation was to first carry out a rough analysis (giving us an initial list) and then refine this by undertake a more detailed analysis. As stated above each item in the proceedings was counted once only and decisions had to be made regarding what was the most appropriate category. Each item was treated as having equal weight whether it was a full paper, keynote summary, workshop overview, position paper, tutorial overview or whatever. We recognise that there are limitations with regard to this analysis and that there are other publications relating to the area. However, we believe that this investigation is sufficient to draw some conclusions regarding areas of educational research and trends.

A summary of the results for nine years of proceedings [8] to [16] (CSEE&T, 2000 to CSEE&T, 2008) is given in Table 1 where the columns represent the categories and the rows represent the years of the conference publications.

Table 1. Analysis of CSEE&T proceedings 2000 to 2008, [8] to [16]

	P+I	P	LI	C	T&L	P&R	Total	**P+I/Total**
2000	**2**	0	5	23	24	6	60	**3.3%**
2001	**1**	2	4	6	15	8	36	**2.8%**
2002	**1**	3	2	9	17	5	37	**2.7%**
2003	**2**	6	10	7	12	7	44	**4.5%**
2004	**0**	4	2	5	16	7	34	**0%**
2005	**0**	6	2	4	17	5	34	**0%**
2006	**2**	4	4	4	18	7	39	**5.1%**
2007	**4**	3	6	8	24	2	47	**8.5%**
2008	**5**	3	1	2	17	8	36	**14%**

What is surprising is the relatively low number of papers which directly address industry-related projects. Also, a closer examination indicates that although some approaches are particularly effective with small numbers of students they may not be so effective when the number of students increase, or they may simply prove impractical with large numbers of students due to the staff resource that would be required. Government predictions (e.g. as reported by the UK Council of Professors and Heads of Computing [17]) show that the demand for computing professionals will increase in the coming decade. Hence, it is essential that universities develop approaches in their undergraduate and graduate programs that will ensure their students gain appropriate industry skills. Skills which we believe can best be developed via appropriate industry related projects.

4 Masters Computing Projects at the University of Sunderland

The first taught masters programme was introduced at Sunderland in 1989 backed by government funding. This programme was for non-computing graduates and was a part of a country-wide initiative to address a significant skills shortage within the industry. The programme expanded over the years and was joined by several other MSc programmes each addressing a particular part of the sector. By 2004 the university was offering nine taught Masters programmes in computing (on campus) entitled: Computer Based Information Systems, Information Technology Management, Software Engineering, Electronic Commerce Applications, Electronic Commerce, Health Information Management, Intelligent Systems, Network Systems, and MSc Internet Engineering. In addition three were also available off-campus at centres in the UK, Europe, Africa, Asia and the Arabian Gulf.

The structure for each programme is that the first two-thirds comprises taught modules, with the final third consisting of a final individual capstone project (undertaken for a real-world client). The common details of the leaning outcomes, and the assessment regime for the project modules are provided in an Appendix to this paper.

The important practical parameters associated with each project are:

- The project must have an explicit, identified client.
- The project should take approximately 600 working hours to complete.
- The practical aspect of the project must have a clear link with the subject matter of the specific Masters programme being undertaken.
- The practical work must result in a clearly defined product for the client.
- The student must endeavour to ensure that the client carries out a suitable evaluation of the product.
- The project must be individual in nature. If it is part of a larger project each student's contribution must be coherent, discrete and well-defined.
- The project must offer sufficient scope for the student to conduct a critical review of current and relevant literature and the review must feed into the practical aspect of the project in some defined manner.

Each project involves the following actors: Student, Client, Project Tutor(s) for the programme, Academic Supervisor, and a Second Marker. Further details on the development of these MSc. programmes, their structure and assessment regimes can be found in a previous paper that addressed the students' learning experiences [18].

5 A Scaleable Approach for Graduate Projects

At the start of the 2003/2004 academic we took on a joint role of projects tutor for on-campus instances of the MSc. Computer Based Information Systems, the MSc. Information Technology Management, and the MSc. Software Engineering. As outlined in section 2, a major motivating factor was that we envisaged that such a role would improve external links with industry and help advance the University's reach-out and research in Software Engineering. The first year proved very much a learning experience. As detailed in our previous paper [19] there were many major challenges in particular with regard to finding sufficient projects of a suitable nature.

Projects had normally resulted from a number of sources: contacts developed by members of staff, the University's Business Development Unit, the careers service, the various research groups within the institution, and the students themselves. However, by 2003, the majority of our students were no longer from the UK and hence did not have the same links that could assist them in finding projects local to the University. Students were allowed to take up projects in other parts of the UK (or even back in their home countries) but this in turn raised extra problems with regard to supervision, control, and tracking. We suffered problems with students not only in starting their projects late but also in maintaining progress and completing on time. Nevertheless, it was clear that many of the best projects were those where the students had identified a project with an external client themselves and where there was a large element of self-interest and motivation (e.g. the possibility of subsequent job, or at least a significant entry for their CV). It also became clear that many of the projects that the University's Business Development Unit identified were either too large for an individual student or did not involve a significant research element. In addition, we had concerns with some projects that were being undertaken for research groups within the university where an academic was acting as both client and supervisor and in many cases the practical element was being "lost".

The solutions to these problems did not occur instantly, but developed over a period of time. They were simply to:

- Empower the students to find their own projects.
- Put in place very formal quality control procedures that would assist in identifying and addressing any problems.

5.1 Empowerment

It is unrealistic to expect the majority of students to find suitable projects without support: they need guidance and help. Also, it is necessary that they start seeking potential projects long before the start of the actual project phase. Many students, especially those from outside the UK can find it very daunting to be put in the role of an instigator of a new activity. If students do not have existing contacts they are essentially being put in a position of "cold-calling" potential clients with all the challenges that presents. However, with appropriate support they can gain a set of skills that will benefit them when they come to seek actual employment. The approach we developed has involved:

- Providing formal sessions well before the project phase to introduce the students to all aspects of the projects.
- Ensuring that students have access to previous project reports to help them understand what will be required plus classroom exercises analysing example reports with regard to: research content, proof of success, and structure.
- Making students aware of the wide range of contacts that they probably already have that could lead to a project and helping them to develop strategies to access these.
- Providing sessions run by the university careers service which give guidance on how to approach an external organisation and how to "sell" oneself. And more importantly identifying common pitfalls that should be avoided.
- Providing sessions where the students work in groups to identify areas of interest, brainstorming to identify potential clients, and (if necessary) work on draft letters of introduction.
- Ensuring that there are staff available who can advise students on the suitability of their initial proposals and provide support and guidance in focusing these.

5.2 Formal Quality Control Procedures

We have introduced a number of formal quality checkpoints both before and during the project. These are intended to ensure that the projects are well defined, there is a clear documented commitment from the client, and that once the project is underway any problems are quickly identified and appropriate remedial action can be taken. In chronological order the control procedures are:

- Before the project phase starts students must provide personal information that can be used in judging their appropriateness for a particular project.
- After identifying a potential project a student produces a formal project proposal which is reviewed by the project tutors or other authorised staff to ensure that the project is of an acceptable standard and has a suitable client
- At the start of the project phase each student must produce a formal Terms of Reference which acts as the contract for their project. The student also produces an associated work plan, and it is expected that they maintain records of meetings with both client and supervisor.
- Approximately one-third into the project the first of two formal reviews with the project tutors occurs where progress is judged.
- Approximately two-thirds into the project the second formal progress review with the project tutors takes place.
- A formal deadline is set for submission of the project dissertation, and in advance of this it is expected that the student will have demonstrated the practical product to both the supervisor and second marker (having already delivered it to client and received feedback from them).

6 Reflections

Has our approach been a success? Well, certainly the faculty management believe it has as our model has been adopted across the department; not only for computing masters but also those in engineering. We know that more students are engaging and successfully completing in a managed fashion than was previously the case (where different programmes operated in different ways). It is particularly heartening to see that there is repeat “business” from a number of previous clients. We are also seeing a wide range of well-formed industrially-based projects from around the globe. Certainly many of the problems that the overseas students have previously experienced have been minimised, and they appear to be much more confident in bringing forward proposals. We no longer have the situation where at the start of the project stage there is a significant number of students waiting to be “given” a project.

Most importantly we know that we have a mechanism that will not only result in sufficient projects but that we are equipping our students with a set of skills that will prepare them for industry and life long learning. In particular our approach should ensure that they:

- Are self motivated and have confidence in themselves,
- Have confidence to approach potential employers,
- Have gained skills in negotiating with a real-world client,
- Have improved communication skills,
- Are able to produce a formal terms of reference (a contract)
- Have planning and scheduling skills,
- Are able to adapt to changed situations and re-plan and re-schedule,
- Are aware of the importance of formal reviews and being prepared for such,
- That they are able to work to deadlines,

- They take responsibility for their actions and errors and can take appropriate remedial action.
- That they learn the importance of self evaluation and reflection,
- That they gain skills in demonstrating practical deliverables,
- They gain skills in defending their work and the decisions they have made.

Finally, our overall observation is that the key issue in achieving successful industry-based projects for a large scale student body is that there is a clear and effective process underpinned by appropriate support mechanisms.

Acknowledgement

This paper builds on our previous publications concerned with student projects which are included in the reference list below. It also incorporates material from a short experience report presented at the 2009 Conference on Software Engineering Education & Training.

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Appendix: Details of Masters Level Project Module for the University of Sunderland, UK

Learning Outcome

Upon successful completion of this module, students will have knowledge of:

- Academic literature appropriate to the area under study.
- Critical awareness of current problems and/or new insights in the IT industry.

And the ability to:

- Effectively scope a project and meet the stated objectives.
- Critically assimilate and disseminate research relevant to the specific project area.
- Use effective time management skills to meet the objectives.
- Present the results of a project both verbally and in a written form.

Assessment

Projects will be assessed against the five aspects below:

Research. 30%. The extent to which the methodical and critical investigation of contemporary material has been incorporated into its development. This must be passed in order for the project to be a pass overall

Success. 20%. The extent to which the practical deliverable and the written dissertation achieve the objectives stated in the agreed terms of reference.

Dissertation. 20%. The quality, clarity and logical progression, of the written dissertation which deals with the conduct and results of the project.

Viva/Presentation. 20%. The ability of the student to report, to a viva panel, the conduct of the project and his or her command over the subject area

Reviews/Control. 10%. The ability to plan, monitor and maintain a viable work schedule.

Source: University of Sunderland http://www.cat.sunderland.ac.uk (Accessed 1/2008)

Advanced Networks in Dental Rich Online MEDiA (ANDROMEDA)

Bruce Elson[1], Patricia Reynolds[2], Ardavan Amini[1], Ezra Burke[3], and Craig Chapman[1]

[1] Birmingham City University, UK
bruce.elson@tic.ac.uk, ardavan.amini@tic.ac.uk,
craig.chapman@tic.ac.uk
[2] King College London, UK
p.a.reynolds@kcl.ac.uk
[3] University Hospital Birmingham, UK
ezra.burke@uhb.nhs.uk

Abstract. There is growing demand for dental education and training not only in terms of knowledge but also skills. This demand is driven by continuing professional development requirements in the more developed economies, personnel shortages and skills differences across the European Union (EU) accession states and more generally in the developing world. There is an excellent opportunity for the EU to meet this demand by developing an innovative online flexible learning platform (FLP). Current clinical online systems are restricted to the delivery of general, knowledge-based training with no easy method of personalization or delivery of skill-based training. The PHANTOM project, headed by Kings College London is developing haptic-based virtual reality training systems for clinical dental training. ANDROMEDA seeks to build on this and establish a Flexible Learning Platform that can integrate the haptic and sensor based training with rich media knowledge transfer, whilst using sophisticated technologies such as including service-orientated architecture (SOA), Semantic Web technologies, knowledge-based engineering, business intelligence (BI) and virtual worlds for personalization.

Keywords: ANDROMEDA, Service-Oriented Architecture (SOA), Knowledge-Based Engineering (KBE), Semantic Web.

1 Introduction

Over the years, teaching and learning has changed from the traditional classroom model to an interactive online learning-platform utilizing the internet increasingly to communicate, collaborate and enhance the learning experience. The internet is no longer a novelty. It is recognized as a vital component for e-commerce, research, telephony and leisure. The health sector has been rather slow to fully adopt the possibilities this technology offers, however, this when global economies are heavily constrained, this technology offers the most efficient method of achieving healthcare solutions anytime, anywhere and for everyone.

A. Tatnall and A. Jones (Eds.): WCCE 2009, IFIP AICT 302, pp. 302–309, 2009.
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The European Union is seeking to develop an integrated health strategy to tackle new challenges resulting from increasing social diversity, economic inequality, globalization, aging of the population and the impact of innovation and technological development. Directive 2005/36 lays down minimum training requirements for dentistry, requiring at least five years of full-time theoretical and practical training. This may provide an insuperable financial burden for many new and existing accession states, which may not be sufficiently developed at the present time to provide all aspects of such a curriculum locally. The magnitude of this burden will be different for each institution.

ANDROMEDA aims to address this challenge and create a common online training environment between different universities, hospitals and private research establishments. Each institution has their own sets of requirements in terms of the level and the pace of the learning environment engagement; their separate technology infrastructure; different mobile connections and networks; hence a common learning platform has hitherto been unobtainable. Currently the PHANTOM project[1], is combining haptic-engagement with the virtual worlds to teach clinical dental students. ANDROMEDA can build on this knowledge to construct an open, scalable, mobile platform to achieve the aim of the European ICT FP7 initiative of education "Anytime", "Anywhere" and for "Everyone", harnessing new technologies such as service-orientated architecture (SOA), the Semantic Web, knowledge-based engineering, business intelligence (BI) and virtual worlds (see figure1).

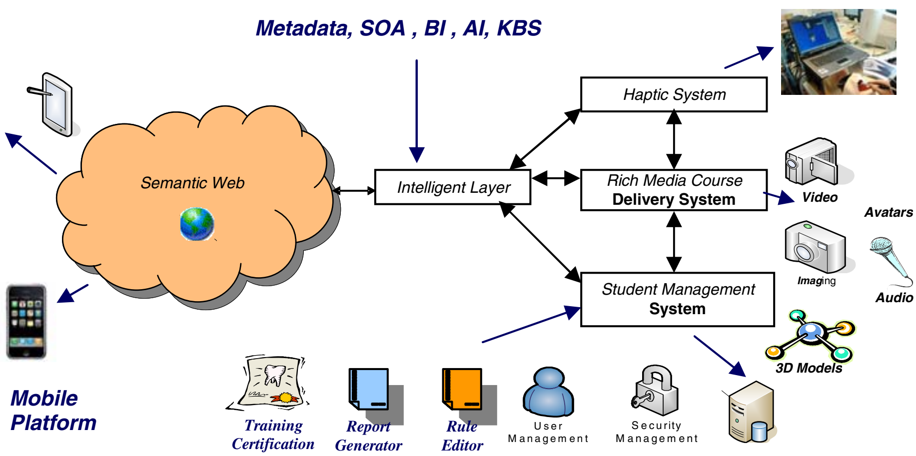

Fig. 1. The ANDROMEDA infrastructure

2 The Need for Change

Providing an innovative learning environment that is dynamic and addresses cultural and ethical challenges, as well as, incorporating the necessary means to engage the

[1] Bruce Elson (Birmingham City University), Patricia Reynolds (Kings College London –Lead).

student with lecturers has always been the challenge for educational establishments and organizations is problematic. Differing hardware and software platforms limit the development of a seamless collaborative environment that is transparent to the end-user yet capable of delivering rich media content.

Currently, a number of companies have developed partial solutions, (mainly for use in the business sector[2]), such as, collaboration and content management software, where users have some level of interaction using web-casts; document and presentations sharing; VoIP and chat. Virtual 3D environments such as Second Life, although popular, lack sufficient support for development and integration with other learning platforms.

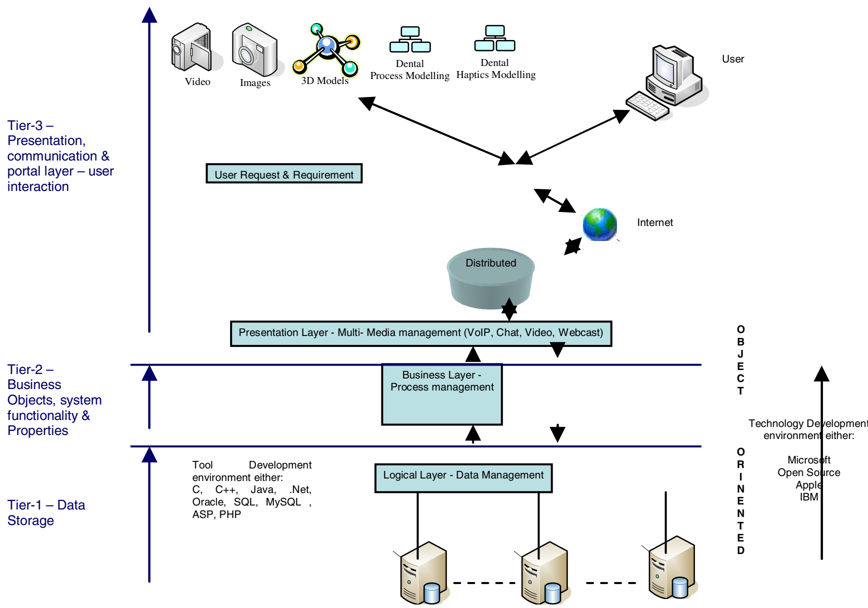

Fig. 2. The current status of technological architecture for online learning environment

2.1 Methodology

Many organizations have adopted different types of methodologies, such as the Structured Systems Analysis and Design Methodology (SSADM), Rapid Application Development (RAD) and Spiral Model. Each has its own set of development tools and techniques for capturing data to establish a dynamic IT infrastructure, in order to address the organization social, cultural, political and economical demands, as well as rapid response to market changes. However, implementation of an IT infrastructure for flexible learning requires a hybrid approach.

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[2] Cisco(Webex) http://try.webex.com/meet/sem/webmeeting/ and IBM(e-Learning) http://www304.ibm.com/jct03001c/services/learning/ites.wss/us/en?pageType=page&contentID=a0000050

3 The New Technology Environment Architecture (TEA)

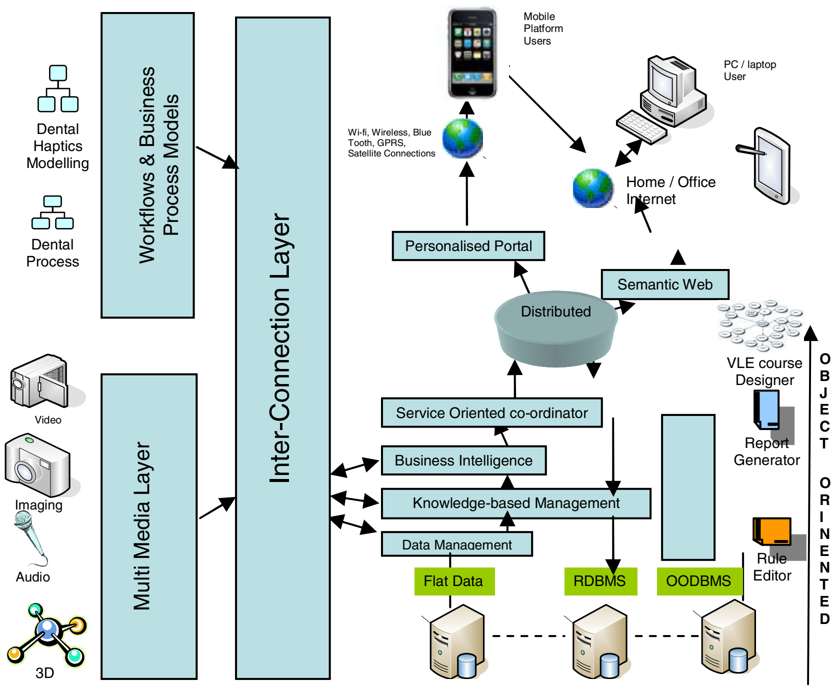

Fig. 3. The proposed technological environment architecture for online learning environment

3.1 The Object Oriented Model

The object-oriented model easily supports the distribution of one database across a number of servers; however, has difficulty in providing a means whereby different database infrastructures may be amalgamated together.

3.2 Knowledge-Based Systems and Artificial Intelligence

Knowledge-based systems have been around in different shapes and forms since the 1980s, however, they have not been adopted by many organizations due to the lack of technology and the unwillingness of the people in organizations to participate, as the thought of passing their knowledge to a computerized system could be seen as taking their job away.

3.3 Service Oriented Architecture (SOA)

SOA, as Mark and Bell[3] explain, is a concept that enables business architecture and its functionality or application logic be made available to the end-users, as shared or

[3] Eric A.Marks & Micheal Bell "Service Oriented Architecture".

reusable services on any IT infrastructure, where services are seen as a model within the architecture that could be used within different interface framework, and are invoked by messages. Service Oriented model would allow the current system to integrate without needing to change the existing systems by integration, loose coupling and abstraction.

SOA has been introduced as the evolution of the object-oriented model to overcome a fundamental limitation regarding integration. A true SOA model will enable various components of a system which are based on different platforms to interact with each other using a protocol accepted by all components.

3.4 Mobile Platform

The mobile technology has advanced in recent years with the introduction of the personal digital assistant in the late '90s followed today by the so-called 'smartphones' such as Apple's iPhone©, Research in Motion's Blackberry Storm© and those based on the Symbian© and Android© platforms of Nokia© and Google© respectively. These devices, with their internet connection and GPS accessibility, have enabled instantaneous messaging, social networking, and access to multi-media objects both locally and via the internet, in effect, giving PC functionality in the palm of the hand at anywhere and anytime.

The software development kits for these devices are being increasingly open-sourced, allowing easy development using common programming languages such as Java and C++.

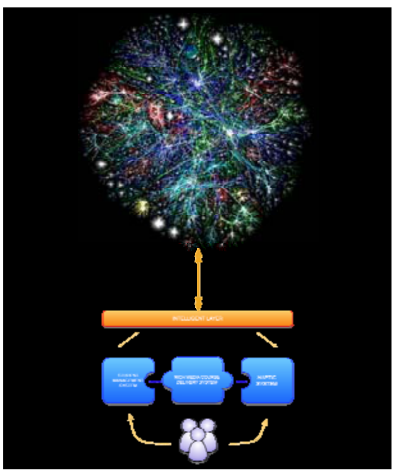

Fig. 4. The framework for linking semantic web and clouds to intelligent and contents layers

3.5 Semantic Web and Clouds

The Semantic Web was introduced by Berners-Lee in 1998 as a natural progression of the world-wide web. The aim is to enable people to co-operate and collaborate with computers more effectively. According to Geroimenko and Chen:

> "[the aim of the] Semantic Web is to delegate many current human specific web activities to computers. They can do them better and quicker than individuals. This can be achieved by adding more and more metadata to web data using XML, RDF technologies."

4 The Andromeda Ontologies

The system will be based on the ontology's that are being developed for the digital description of dental conditions, and will allow any particular condition to be represented in an automated manner in a virtual, haptic-augmented, oral cavity. This approach greatly reduces the quantity of data that has to be handled by the system. Additionally it allows almost limitless flexibility for training purposes. For example, the system might store data for dental decay. Instead of the system requiring a computer model of each decayed tooth, this data can be combined with any tooth data to represent that particular decay-tooth model. In this way we aim to build taxonomy of dental and surgical conditions based on object-oriented principles. Conditions will be divided into classes and subclasses with multiple inheritances. This will represent the teaching the pre-clinical training aspect of the system. The second aspect of the system is live and involves real-time interaction with dental and surgical data.

The system will enable surgical planning and surgical rehearsal using patient-specific data. Standard imaging sources, such as computed tomography, magnetic resonance imaging, positron emission tomography and ultrasound scanning will be used to reconstruct a virtual patient that will be navigable and eventually haptic-augmented. The system will use an automated image acquisition and reconstruction

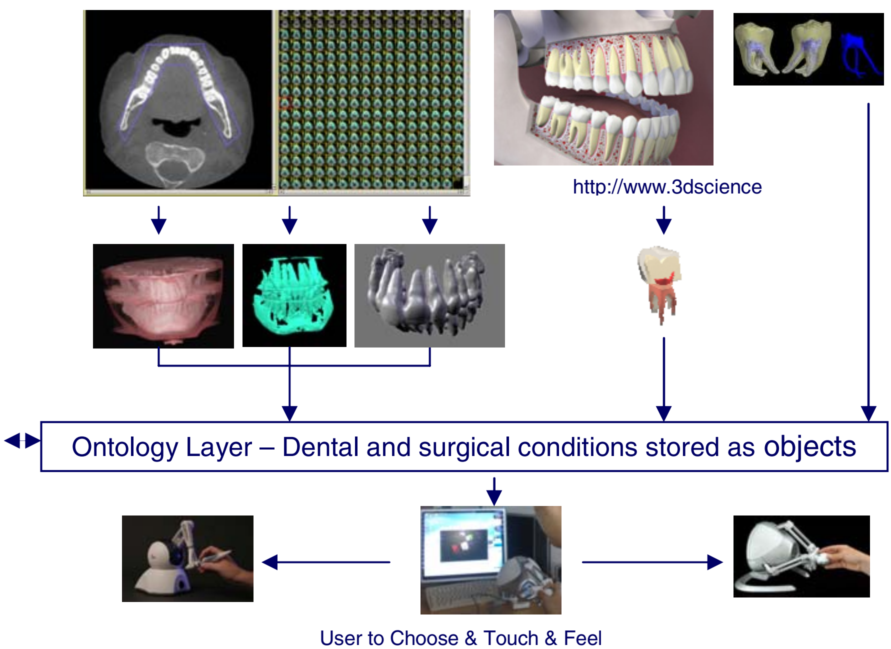

Fig. 5. The ontology layer of the system to capture data from different sources

process that will be transparent to the end user. Haptic-augmentation will vary according to the particular clinical situation, however, it is envisaged that a number of commercially available haptic devices will be useable. An additional feature of the system will be clinical review, where it will be possible to review surgical rehearsal.

5 ANDROMEDA Proposed Framework and Timescale

Requirements, testing and assessment will include dental schools from University of Timisoara, Romania, Brescia University and Barcelona University. Specifically the project will be tackled via several work packages.

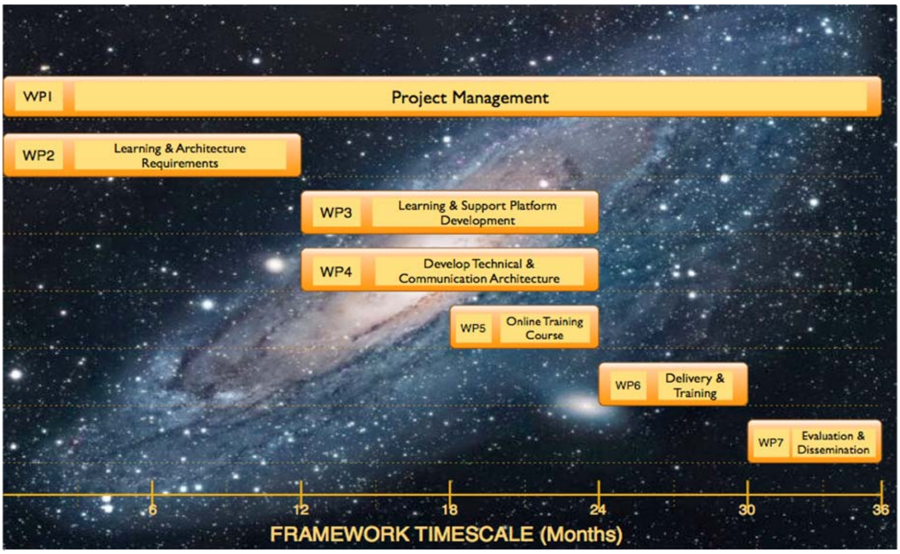

Fig. 6. The Framework Timescale

5.1 Project Management – WP 1: Months 0–36

Manage, Collaborate, Risk Analysis, Quality Assessment

5.2 Learning and Architecture Requirements – WP 2: Months 0–12

Undertake requirement analysis to understand the user requirements and define the support and learning platform environment. Investigate the current state of semantic web and SOA technologies in the field of dental bioinformatics to define the system architecture.

5.3 Learning and Support Platform Development – WP3: Months 12–24

Incorporate results from previous WP to construct required Learning Platform. Release results to other members of consortium for future WP's.

5.4 Develop Technical and Communication Architecture – WP4: Months 12–24

Incorporate results from WP2 to incorporate Semantic Web technologies with Intelligence Layer to manage data and communications. Report on results.

5.5 Develop Online Training Course – WP5: Months 16–24

Transition to a live environment, initial user acceptance testing. Dental School validation is needed at this point.

5.6 Delivery and Training – WP6: Months 24–30

A ‘live’ online version to be broadcast with user training and haptics according to trial design. This is to be validated by the consortium.

5.7 Evaluation and Dissemination – WP7: Months 30–36

Using the results from the Validation, evaluate the impact of the system on the learner, the systems delivery and its effectiveness. From the validation, report on the success of the system, and what advances need to be made. Develop guidelines and suggest advancements.

6 Conclusion

We anticipate that our research will benefit a broad cross-section of society through potential improvements in dental and oral surgical training, leading to more effective and safer patient treatment. Our research addresses the need for a risk-free simulation environment either for basic training or for rehearsing difficult procedures. This method of training has been hitherto available only using cadaveric specimens -a method no longer available in many European States. The ability to import “patient specific” data allows takes the pre-operative rehearsal a stage further than cadaveric training allowing training on an unique surgical condition.

A working demonstration platform will be produced with the aim of producing a commercial tool that can be sold to academic institutions across the European Union. Project partners, will be fully able to give demonstrations and specific training on all aspects of the training platform. It is planned that the software will be made available to non-commercial partners via a Gnu public licence or similar to facilitate a co-operative approach to the system’s future enhancement while safeguarding the IP necessary for its exploitation.

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A Competency-Based Learning Resource Retrieval Process: The LUISA-UHP Case-Study

Monique Grandbastien

LORIA, Université Henri Poincaré Nancy1, France
monique.grandbastien@loria.fr

Abstract. The paper describes a global framework enabling competency-based search of learning resources making a heavy use of semantic technologies. First it presents the generic components. Then it exemplifies how this framework can be adapted to a given environment, i.e. which knowledge representations, Web Services descriptions and other components have to be tailored or added to the framework. Then it shows step by step how a query is processed, Finally, users' feedback, lessons learnt and future trends are provided as well as comparisons with other approaches already published about annotating and retrieving learning objects in Learning Objects Repositories.

Keywords: Semantic based search, competencies, metadata, learning resource, ontology.

1 Introduction

The increasing number of digital learning resources available on the web has resulted in a growing interest for getting support for annotating, searching, retrieving, adapting and reusing such resources [14], [16]. Two main approaches are currently available today, namely the Web search (such as Google extended search) and the use of specialized "learning object repositories"(LOR) that provide search based on local metadata, such as Merlot [13]. In the first case there is a universal Web coverage, based on text, *not specific* to instruction or education. It uses links and not educational quality as the main selection criteria, and does not exploit information specific to learning/instruction. In the second case, the resource pool is limited, and some classification is provided, but it is local to the Web site. Some ongoing initiatives including [7], [4] aim at federating multiple sources but the query does not entail targeting the selection to the best ones. A common feature is that no domain or common sense knowledge is used and little support for queries on instructional properties is provided. Moreover the queries are mostly about topics and not about compentencies to be acquired.

Within this context, the LUISA project [12] (Learning content management system Using Innovative Semantic web Services Architecture) addresses the development of a reference semantic architecture (also called LUISA) for bringing solutions to the major challenges in the search, interchange and delivery of learning objects in a service-oriented context. This entails the technical description of the solution in terms of current Semantic Web Services (SWS) technology, and also the provision of the

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ontologies, facilities and components required to extend and enhance existing learning technology systems with the advanced capabilities provided by computational semantics.

The structure of the paper is as follows: in the next section we describe the global infrastructure provided by the LUISA project as well as its knowledge components. In section 3 we describe the adaptation of the LUISA framework to a university context for allowing competency-based learning resource requests. In section 4 we provide a working example illustrated by several screencopies from the application. Section 5 is devoted to the analysis of feedback from the first end-users and to possible improvements. Finally section 6 compares this work with other close initiatives and discusses possible roadmaps for the future in the field.

2 A Semantic-Based Framework for Learning Resources Management

The common framework is designed as a kernel from which applications tailored to fulfill the needs of a given institution are derived. It includes a general architecture based on semantic web services, and two ontologies, one based on [9] for describing learning resources, the other based on Human Resources competencies for describing the existing and targeted competencies of learners and resources. It also provides an annotation tool named eLUISA which has to be filled with data specific to the target application.

2.1 Global Architecture

This section describes the particular solution of the LUISA architecture (components, data structures and services) adopted for the realization of the current prototype. Figure 1 depicts the layered general architecture. The two middle layers represent the SWS-based infrastructure for e-Learning. The Process Language layer, service Abstraction layer and Data layer represent the actual interfaces of the SWS-based infrastructure. The Negotiation Layer provides the relationship between the end-users of the LUISA framework and the Semantic Web Service environment. There is a common functionality offered by the Negotiation component of the Negociation layer for the LUISA framework and the basic core implementation remains independent from case study particularities. The particularities of the case study are then not in the component itself, but in the Web service implementation that gives access to it and in the specific Query Resolver (another component in the Negociation Layer) developed for the case study.

2.2 Shared Domain Models

Domain models are provided as ontologies for describing a learning resource (based on the LOM standard) and for describing competencies. In LOM compliant metadata, the semantic interoperability is only performed through the meaning given to categories and through lists of values the semantic of which is often unclear, leading end-users to define application profiles. That is why, in LUISA, we propose a semantic version of LOM called s-lom.

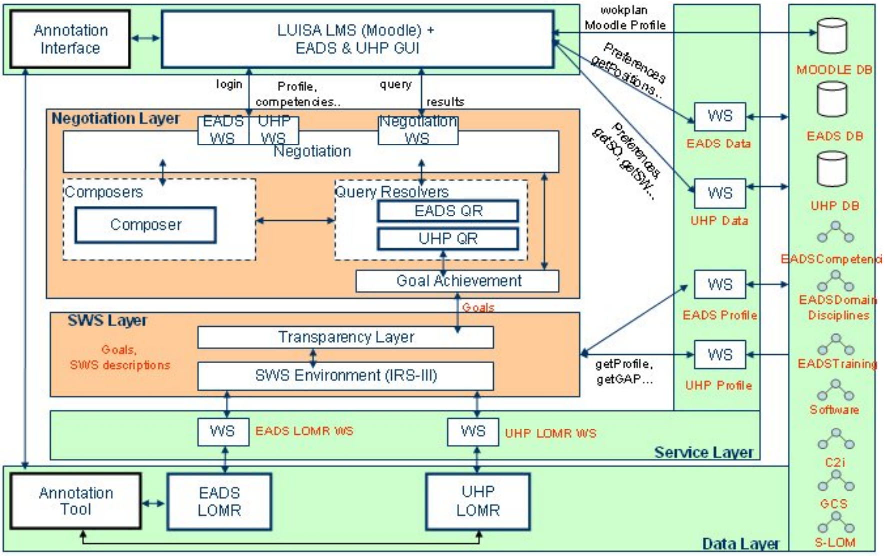

Fig. 1. Layered General Architecture proposed by LUISA

This ontology is mostly based on the LOM schema to allow standard compliance as far as possible but it is designed to provide richer computational semantics. The Learning Object concept is modelled as a class, then the metadata attached to a LO are represented as the property values of a class instance. The value sets are extracted from the developed domain ontologies, which allow further reasoning on them. There is a growing demand of acquiring new competencies either in higher and professional education or in company training whereas learning resources are not all indexed in terms of competency acquisition. So in LUISA we propose a general competency ontology (GCO), derived from [19] each target application provides instances of competencies for enriching the description of resources and for performing competency based reasoning in order to fill competency gaps. The same ontology would also allow to shift from a competency based search to a subject matter based search when needed, as each competency definition is linked to one or several subject matter items. For example the competency instance “being able to use a textprocessor” is linked to the subject matter item “textprocessor”, which in turn is exemplified by Word or OpenWriter in the computer literacy ontology.

2.3 eLUISA, a Flexible Annotation Tool

The flexibility of the knowledge framework would not be possible without flexibility in the annotation process. That is why the knowledge framework is completed with a flexible tool derived from the SHAME editor. eLUISA is configured for end users through Annotation Profiles. An Annotation Profile (AP) is a configuration of the metadata editor defining what to edit and how to edit it. Indeed, more and more users participate through different roles in the edition of complex metadata coming from different metadata structures. Thus APs easy definition in the editor of which pre-defined values (from taxonomies or ontologies) should show up in which style (drop-down list, cursor to move, etc.) or how data types have to be checked. An administrator can compose an AP by creating and aggregating some modular bricks of annotation. For example, he can create a brick for the "language" metadata by associating a view (display a field entitled "Language") and a model (linking this field to the category 1.3 of LOM). Then, the administrator can decide to ask the annotators for competencies by adding into the AP a brick displaying a drop-down list dynamically filled with some instances of the competency ontology and associated to another structure than LOM.

3 Customizing the Framework for a Target Application

3.1 Problem Addressed

The general LUISA framework has to be customized for building working environments according to end-users needs. It has been applied to an academic environment and to an industrial environment. The academic prototype explores how semantic technologies could be used to discover the best suited Learning Objects for a given learner in a given domain. The chosen domain is computer and Internet literacy as exemplified in a French diploma called C2I. The main competencies are organized as follows (each competency is further subdivided into sub-competencies):

General and transversal competencies

A1: Be aware of the evolution of IT.
A2: Understand the ethical issues.

Specific and instrumental competencies

B1: Control his environment of work.
B2: Search for information.
B3: Save, secure and back-up his data in a local place or on a network.
B4: Build documents for printing.
B5: Build presentations of his work offline and online.
B6: Communicate remotely.
B7: Produce a joint project.

The environment should allow the learner:

- To express a query by exploring a set of competencies and additional criteria.
- To obtain the more appropriate resources retrieved from one or several Learning Object Repositories (LOR) specially gathered and indexed for the prototype
- To be provided with tentatively packaged resources. The system can compose some Learning Objects (LO) to create a new one.

3.2 The Customized Prototype Architecture

The specific components, data structures and interfaces developed or adapted for the LUISA-UHP environment are labelled UHP on figure 1. They are summarized in Table1.

Table 1. Resources customized or designed for the LUISA-UHP environment

Resource	***Nature***	***Description***
GCO/C2i	Ontology	Represents the competencies used in the C2I context. These competencies are based on the concepts of the General Competency Ontology. Example: "k_email" is aKnowledgeElementDefinition required by the "B6 competency: communicate remotely" which is a CompetencyDefinition.
Computer Literacy Ontology	Ontology	Represents the items (hardware or software) involved in the C2I competencies. Example:"k_email" is a KnowledgeElementDefinition about "EmailApplication" which is a "PrivateCommunicationTool" in the Computer Literacy Ontology.
Discipline Ontology	Ontology	Represents the fields of study in the university. Example: "Medicine" is a specialization of "Health" and is "linked_to" "Biology".
LOM/WSML	Ontology	LOM/WSML is a semantic implementation of LOM. It represents all the aspects (from technical requirements to rights management and educational characteristics) of a Learning Object.
UHP Profile	Database	MySQL database including all the other data about UHP users.
C2i LOs repository	LOMR	Including all LOs metadata about C2I.

The SWS infrastructure and the Annotation tool have to be integrated into a Learning Content Management System to allow users access the semantic functionalities supported by the core components of the architecture. For the first prototype an extension of the Open Source Moodle LMS has been developed. We also notice that some additional information about the user is needed for the UHP use case with respect to the information of the standard Moodle user profile, such information comprises: user competencies, user preferences about operating systems, available software, discipline, university preferences about cost and language. The additional information is stored in local databases.

4 A Scenario Step by Step

In this section we provide a scenario, focusing on the learner interaction with the prototype. The scenario is the following: a learner wants to find a suitable package of Learning Objects that suits his needs. The learners will use the prototype on their own, making use of the LUISA-based application in order to create a work plan to increase their competencies. For his first visit the learner has to describe his practical environment (Which operating system, which software suite, etc…) which will be stored in the UHP local database.

Step 1 – Login and First Set C2I Competencies

The learner logs in the LUISA UHP application and, once authenticated in Moodle, the prototype shows the learner his set of competencies according to his profile. The learner may select the competencies he wants to reach as illustrated in figure 2 and sends the query to the Negotiation Layer. The C2I competencies are presented as a dynamic expansible/ /collapsible tree showing the competencies he acquired and the missing ones. The tree is dynamic; when the user selects a competency new competencies (depending on the selected one) become available. The user can also select the duration he desires to practice.

Step 2 – Rules for Negotiation

When the learner posts the request, the Negotiation Layer sends it to the SWS Layer by choosing the appropriate goal. The first invocation of the SWS layer tries always to retrieve LOs for the same competency and discipline that the learner provides. The Query Resolver component is in charge of analysing the response for all queries performed to the SWS Layer, trying to check the suitability of the selection. In the current prototype we have provided a specialization of the Query Resolver for the UHP case study that implements the following rules:

R1. If the competency chosen by the learner is a sub-competency:
R1.1 If there are no LOs that fulfill the exact match: The system selects the LOs about the same sub-competency but with a more general discipline.

Application of organizational specific e-Learning rules.

- R1.2 If there are no LOs with these features: The system selects the Los about the general competency and the same discipline.
- R1.3 If there are no LOs with these features: The system selects the Los about the general competency and a more general discipline.
- R2. If the student chooses a general competency: If there are no LOs that fulfil the exact match: The system selects LO about the same competency and a more general discipline + LOs about same discipline but whose target competency are sub-competencies included in the selected general competency.

The result of this phase is a set (possibly empty) of resources that fulfil the request as exemplified in figure 3. On the figure one can notice two kinds of ranking : the first one is related to the adequacy of the resource to the query, for instance a resource that does not cover all the subject have only 2 stars, the second one takes into account peers' rating, that is how useful the resource was for peer students, for instance a resource is possibly very useful for medicine students but not for students in history ! Further developments about social rating are described in [5].

Step 3 – Rules for composition

The **Composer** component is in charge of creating learning packages by combination of a set of Learning Objects. The implementation of the composer for the current prototype assumes that the LOs are SCORM compliant and the resulted package is delivered as a new SCORM compliant LO. If the Query Resolver proceeds to a decomposition of a competency given by the end-user into a set of sub- competencies, then the Composer gathers and packs the results for each sub-competency into a set that, as a whole, matches the super-competency.

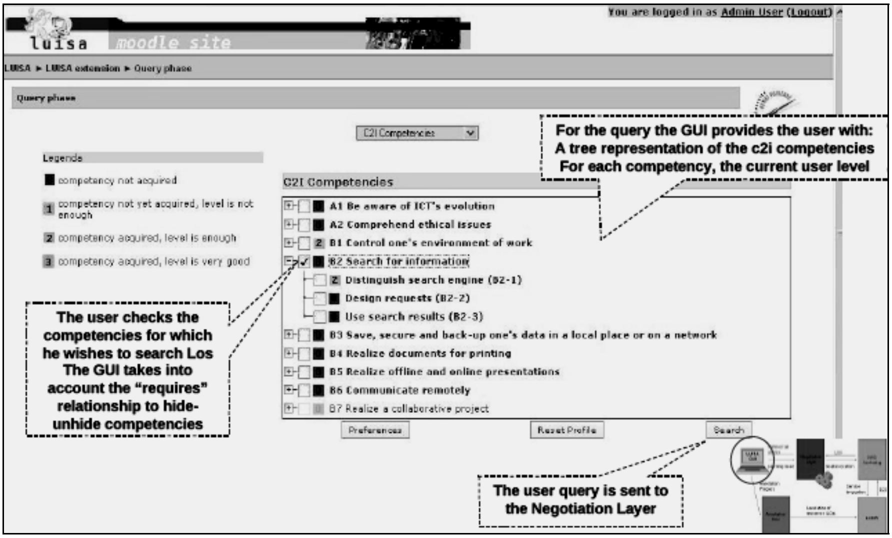

Fig. 2. Target competencies displayed according to a learner profile

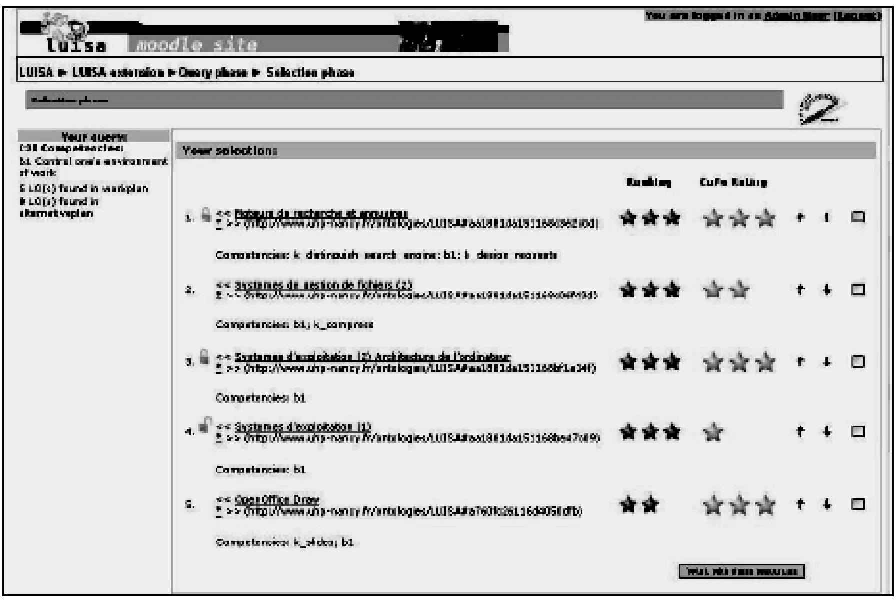

Fig. 3. LUISA-UHP selection

Step 4 – Workplan

Once the user selects the appropriate LOs, the work plan is saved in Moodle as the selection made by the user. Then the user has to download the selected resources. After completing the work, his profile will be updated.

5 Users Feedback, Related Work and Future Trends

The LUISA-UHP prototype has been proposed to academic staff, librarians and students. Teachers and trainers would like to use the system for selecting resources they would provide to their own students. They are interested in the packaging of resources and asked for more parameters (indeed the implemented criteria are very simple and merely provided as a proof of concept). They are also interested in more explanations on how the system has selected the resource (exact match, versus sub-competencies computations versus shift from competencies to topics). From a pedagogical point of view, the exploration and interactions with the tree of competencies is expected to improve the user's perception of the learning domain (meta-cognition). The librarians underline that the indexation process is not heavier that a LOM based one and the result is far better. Students were interested by a better harvest than with a Google based search.

We have demonstrated that a semantic based environment allows to create an efficient competency based learning resources retrieval system. Many other on going projects aim at enhancing the description, the retrieval and reuse of appropriate learning objects by using semantic web technologies [11], [2], [3], [8]. Among them, LORNET [17] also proposes an ontology and a web service based architecture in its TELOS component. Another nation wide project in Korea [1] proposes the same kind of common knowledge framework but does not uses at all the flexibility provided by SWS and WS.

None of those systems is really similar to LUISA-UHP which

- Is a framework for developing specialized systems or brokers for other systems
- Enables exploring a set of competencies and the expression of queries in terms extracted from ontologies.
- Locates the best sources/providers for given queries (given learning needs and a learner profile).
- Suggests tentative compositions based on learning needs.
- Enables different query resolution/composition strategies, including educational knowledge.
- Searches over several LORs using manual ontology alignment
- Takes into account peer rating
- Is extensible in terms of addition of new competencies or new topics, all existing rules and services remaining unchanged.

As building an ontology is time-consuming and as sharing ontologies will enhance interoperability between LORs, one of the next steps in our view is to cooperatively build, document and broadcast ontologies for the education world. Examples are to be found in the INTERGEO [6] project for geometry teaching, the LT4eL [10] project also about resource retrieval, but making an intensive use of language technologies, the Share.Tec project [18] for teacher training in Europe or the OMNIBUS [15] project including an educational theories ontology.

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Part VI

Networking and Collaboration

Is There a Role for Social Networking Sites in Education?

Ieda M. Santos[1], Michael Hammond[2], Zenilde Durli[3], and Shiao-Yuh Chou[4]

[1] Emirates College for Advanced Education, P.O. Box 126662
Abu Dhabi, UAE
isantos@ecae.ac.ae
[2] University of Warwick, Coventry, CV4 7AL, UK
M.Hammond@warwick.ac.uk
[3] Universidade do Oeste de Santa Catarina, Rua Getúlio Vargas, 2125,
CEP - 89600-000, Joaçaba, Brazil
zenilde.durli@unoesc.edu.br
[4] National Institute of Education, 1 Nanyang Walk, Singapore
shiaoyuh.chou@nie.edu.sg

Abstract. Social networking sites such as Facebook and MySpace have become popular among millions of users including students of all ages. There are ongoing discussions over the potential of these sites to support teaching and learning, particularly to complement traditional or online classroom activities. This paper explores whether social networking have a place in teaching and learning by investigating how students use these sites and whether they find opportunities to discuss study related activities with their peers. Two small scale studies were carried out in a face-to-face undergraduate course in Singapore and students enrolled in a face-to-face Master's programme in Brazil. Data were collected using surveys and interviews; findings were mixed. Many of the Brazilian students used social networking sites to both socialize and discuss their studies while the Singaporean students used such sites for social interactions only. The paper discusses these differences and offers suggestions for further research.

Keywords: Social networking, informal learning, support.

1 Introduction

The concept of Web 2.0 surfaced out of the potential for interconnectivity and interactivity offered up by the Internet ([1], [2]). In terms of software, tools generally include blogs, wikis, podcasts, second life and social networking, a mix of new and longer established programmes [2]. In terms of application, Web 2.0 is often associated with collaborative, user-generated content which is often open to the world, and normally free. This has transformed the way many people use the Internet and the associations they may make with it [3]. It has also led to considerable interest across all sectors of the education industry [4].

Social networking sites (SNSs), for instance, have attracted millions of users worldwide [5]. Individuals use these SNSs to interact with others they have met

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offline or to meet new ones, though there is some evidence that they mostly support existing social relations [6]. Nevertheless, by visiting a friend's space, one can easily expand his or her network [7] and thus establish new relationships. Such sites enable users to connect to wider distributed members; they are emergent, self-organised, and generate less homogenous contributions [8]. Anderson [8] argues that SNSs can be used effectively to expand learning beyond course-based groups. Such expansion may include a network of peers, teachers, professional experts and other communities [4]. Researchers believe these sites can be used to complement traditional and online classroom activities ([9], [10]).

Sites such as Facebook and MySpace are popular among students [11] and, although not created for educational purposes [9], it is argued that they may encourage informal dialogue and knowledge sharing, mediated by the students themselves ([8], [12], [13]). Conrad [14] adds that with such technological advancements, students are likely to learn as much from social networking sites and blogs as they are from their assigned tasks and textbooks in the class. Selwyn [15] observes that most of the learning taking place in Facebook is the kind of learning that would happened, for instance, in the school corridors, canteens and phone conversation after class. This suggests an informal learning that rests in the hands of the students which is not classroom-based or structured [16]. This is more in line with Vavoula's [17] definition of unintentional informal learning in which the goals of learning are not specified in advance but can develop as learning opportunities arise.

Despite its potential, there is clear lack of research to address whether SNSs can be used effectively in education ([7], ([9], [13], [16], [18]). It is therefore vital to understand the way students are using these tools and their expectations in relation to their learning ([19], [10]). This paper contributes to the growing discussion on the role of social networking sites in education. It seeks to explore to what extent University students are using social networking sites to engage in study-related activities and whether they benefit from these exchanges.

2 Background

Social software can be largely characterised as software that supports group interactions - email, discussion forums, SNSs and applications such as wikis and blogs ([20], [8], [7]). For example, studies show that students have used Facebook for fun, to kill the time, to meet existing friends or to make new ones ([6], [21]). A study at the University of Minnesota found that only few students were aware of the academic and professional networking opportunities the sites provided [22]. In Palmer et al's [21] study, students primarily used Facebook to maintain a satisfactory social life, though some organised course related activities on it.

Shukla [23], on the other hand, suggested that graduate students of biology discussed course topics in Facebook ranging from cell development to residency programme. Similarly, Meulemans and Chu [24] found that the majority of students on a graduate programme used both Myspace and Facebook to communicate with others about school, instructors and courses. JISC Report [25] indicated that 73% of the students used social networking sites regularly to discuss course activities with members. Among these, 75% felt that such sites were useful to enhance their learning. Selwyn's [15] research on undergraduate use of Facebook suggested that the nature of student interaction was profoundly informal and often at a tangent with the official learning objectives of instructors. JISC Report [25] indicated that when learning is initiated by students it can be seen as more social and may not be perceived as learning. The report also showed that students were clearly mixing social networking sites with study-related activities. In the same vein, Anderson [16] reported that students tended to look at course materials in the Learning Management System (LMS) but discussed its content using Facebook. The author also indicated that a lecturer found it easier to join students on Facebook to discuss a week's coursework than trying to use the Institution LMS. This suggests a shift to students making decisions about which tools best suit their needs and how to use them ([4], [12]). It is therefore vital that educators reflect on the learning affordances offered by such sites [13].

3 Context and Participants

This study is based on two case studies. Study 1 was conducted in a 12-week face- to-face undergraduate course delivered in a teacher-training Institute in Singapore during fall semester 2008. The course goals were to provide students with an understanding of how theatre can be used as a means of intervention, development, empowerment and expression in fields outside of the theatre as traditionally conceived. All students enrolled in the course agreed to participate in the study (n=13). The sample comprised of 11 females and two males. Most of the students (85%) fell within the 20-25 age group. The majority of the students (92%) had considerable experience with computer use. The same percentage indicated they spent, on average, more than three hours per day using the Internet, with one participant spending between 8-10 hours. All students had Internet access both at home and at their school.

Study 2 was conducted in a face-to-face Master's programme in Education taught at a Brazilian University located in a regional area in the South of Brazil. The programme focused on policies and educational processes. Students (n=22) were randomly selected from a cohort of 71 to take part in the study. The sample was comprised of 17 females and 5 males. The age range of the sample group was 20 to 45, with 45% within the 20-25 age group. Regarding computer use, 77% had some experience, 18% a lot and 7% had extensive experience. All students had Internet access at their school while 73% had Internet at home. On average, 77% of the students spent between 1-6 hours per day using the Internet. A few (14%) did not use the Internet daily and 9% used between 15-30 minutes daily.

4 Methodology

This study adopted a survey design [26] to obtain information on students' usage of social networking sites and activities. The survey was the most appropriate approach because it allowed convenient collection of data using a consistent approach. The survey had a mixture of open-ended and closed questions, multiple choices, though it included more open-ended ones. The smaller the sample, the more open the survey can be [27], which allows greater opportunity to gather more in-depth responses. The same survey was administered to students in both countries. Each teacher delivered the survey to students using the email tool. Data were collected at one point in time [26]. All participants in both studies returned the survey. In addition to the survey, a semi-structured interview was conducted by email with five students within each study who were randomly selected. The objectives of interviewing a small sample were to understand students' experience of using social networking sites in greater depth [28] to both enrich and complement the data gathered from the survey.

Analysis of closed questions from the surveys consisted, as suggested by [27], of assigning a code number to each question. After developing a code frame, a spreadsheet was used to organise the data and process the responses for each study. The next task was to engage in meaningful analysis. Percentages for each of the quantitative variables covered in the survey were calculated.

Qualitative data were analyzed inductively (open-ended questions and interviews) based on Merriam's [29] suggestion in which category construction begins by reading the documents and making notes on the margins of the text that seemed to address the study aims. Coding was performed across the documents. The next step involved grouping the notes and identifying categories so that data could be coded. After coding the data, themes relating to the use of social networking sites and activities were explored.

5 Findings

This study first investigated whether students enrolled in a higher education course and Master's programme were members of SNSs. Out of 13 Singaporean students, 12 were members of at least one SNS. Among these 12, 67% used Facebook (with 33% using it regularly, and 25% often). Most of the students (85%) said they also used other SNSs (with 54% using it regularly and 8% often). Meanwhile, the majority (92%) said they never used MySpace. The student who did not use SNSs had concerns over the time involved and the purpose of social networking. Within the Brazilian group, two students were not members of SNSs explaining that they were not interested in these sites and did have time for it. Among those who were members (n=20), 85% used Orkut (with 9% using it regularly and 59% often). More than half (64%) also used other SNSs (with 32% using it often). Over 90% did not use the well-known sites Facebook and MySpace.

5.1 Purpose for Using SNSs

Figure 1 displays students' purposes for using SNSs for the Singaporean students. It suggests students used these sites primarily to socialize. A significant percentage (42%) used SNSs to both keep in touch with friends and 'have fun'. As seen, only a small percentage used SNSs to exclusively keep in touch with friends.

All five interviewees confirmed they used SNSs to keep in touch with friends. One explained that "…I can be updated on what goes on in the lives of my friends, especially if we rarely meet as they can upload pictures of themselves, which I can view as well." Another, in particular, also used SNSs to find new friends. The Singaporean students further indicated what they most liked about SNSs. For example, 42% liked SNSs because they allowed them to be in contact with their friends. Thirty three per cent liked to post photos while a few (17%) liked to view

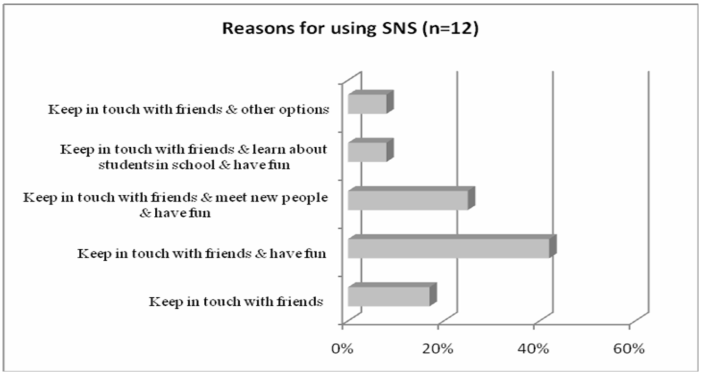

Fig. 1. Students' reasons for using SNSs within the Singaporean group

their friends' photos, with one saying "it is a good way to keep up with them and get updated with what goes on in their lives." However, despite their popularity among students, 25% felt SNSs lacked privacy and 17% said people, who they do not know, wanted to be their 'friends'. Other things students did not like about SNSs included: too many applications, the sending of bulletins, lack of human touch and receiving junk mail.

As displayed in Figure 2, the Brazilian students had multiple reasons for using SNSs. Only a small percentage used SNSs exclusively to keep in touch with friends.

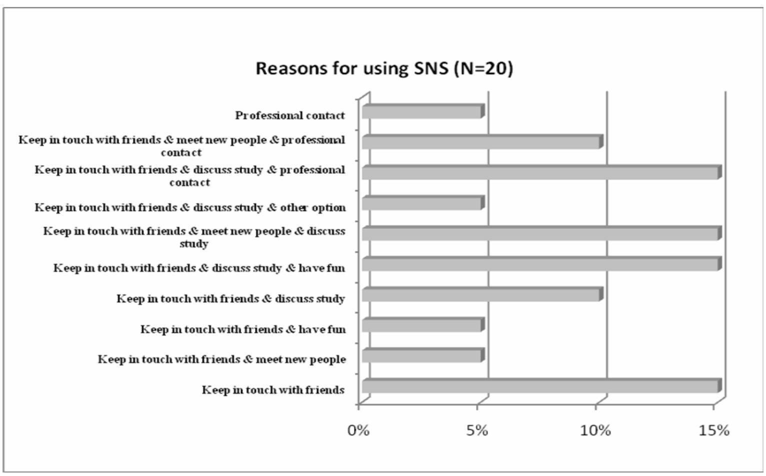

Fig. 2. Students' reasons for using SNSs within the Brazilian group

Comparing Figure 1 with Figure 2, an immediate conclusion is that the second group did not only use SNSs for socializing but also to discuss study related activities. Figure 2 also suggests that some students used SNSs to make professional contact. Two participants, for example, said they used these sites to exchange work related messages with other members.

All interviewees confirmed they became members of SNSs to keep in touch with friends and saw this as a major benefit. They added that they used SNSs to discuss study related activities with members. Students further explained what, in particular, they liked most about SNSs. For example, 40% felt they could interact with members who lived at distant locations while 25% found it an easy way to communicate with others. Being able to interact with a diversity of people, read relevant messages, chat with friends and make new friends were also mentioned. One, in particular, saw a benefit in that the sites were free to use. Despite the positive comments, 40% of the students felt there was lack of privacy in SNSs and 25% said that other people may copy information on their sites (e.g. photos and messages) and use this in inappropriate ways.

5.2 SNS Activities

The primary activity performed by 75% of the Singaporean students was to post photos to SNSs. This was followed by 67% posting messages. A few (17%) also used SNSs to chat and to send files. Other activities included challenging each other on games, add friends, look at photos and friends' profile. None of the Singaporean students seemed to have exchanged information, ideas or resources about their studies with other members through joint membership of SNSs. All five interviewees confirmed this. One, however, observed that although she did not talk about course content via SNSs, she discussed with members possible meetings for group projects. Four students pointed out that they had class colleagues as SNS members, but they did not discuss study related activities with them.

Students from Singapore had mixed opinions whether SNSs should be used to discuss study related activities. Half indicated these sites should be used for social exchanges only while the other half felt they should be used for both social and study exchanges. All interviewees said they would not like to discuss their studies via SNSs. Three of them saw SNSs as a place to relax. One explained: "...these social networking sites are a means for us to distress away from work and hence, we tend not to discuss work on these sites...[we] would instead take part in more relaxing activities such as viewing pictures of friends." Two interviewees felt there are many distractions within SNSs such as chatting with other people and games that would interfere with study related discussions. One suggested this may lead to producing work with poor quality. One student, in particular, mentioned that discussion forums and educational websites are more suitable for study related discussion. Another added that face to face encounters would be a better option.

As for the Brazilian students, the primary activity performed by 90% was to post messages. This was followed by 45% posting photos. Some (35%) also exchanged information, while 20% posted reminders (including professional and academic ones). Other activities included participating in debates, "having fun" and making new friends. Analysis also showed that 60% of the students had exchanged information, ideas or resources about their studies via SNSs. For example, 43% said they benefited from discussing group work with members. One remarked that the discussions helped the group move forward with the activities. Twenty nine percent said they benefited from exchanging bibliographies and web sites for their studies. A student exemplified this by explaining that she was pointed to new literature in her field of inquiry. The same percentage (29%) also mentioned that the discussions via SNSs helped them to better understand course topics and get ideas on how to proceed with assignments.

Through the interviews, the Brazilian students confirmed they had discussed their studies via SNSs. Three of them indicated they exchanged ideas related to the disciplines in which they were enrolled. One, in particular, was able to improve her assignments based on suggestions given by her peers via the SNS. Another exchanged bibliographies, sites and other materials for a particular class. All interviewees had class colleagues in the SNSs as members. One, for example, had all her colleagues from one course in her list of friends. All interviewees indicated that interactions with peers were important to share knowledge about course content and to keep them up to date with assignments, with one saying that such interactions contributed to her learning on topics being studied.

In contrasting to the Singaporean group, all the Brazilian students agreed that SNSs should be used for both social and study related exchanges. All interviewees held similar opinions. One, for instance, believed "that everything that contributes to social or study is important. These sites can be used as a tool for learning. With such a busy life, technology contributes to keep in touch with course colleagues and we can discuss assignments and activities related to our studies." Another felt that using SNSs exclusively for study purposes would have a reduced number of people as members. In her view, SNSs should be open to different forms of interactions including study activities.

6 Discussion

This paper aimed to investigate whether students used social networking sites (SNSs) to discuss study related activities by exploring two cases within higher education. The outcomes of this study offer mixed results. As with Palmer et al's [21] findings, the Singaporean group clearly used SNSs primarily for social interactions. In contrast, and agreeing with other studies ([25], [16], [24]), a significant number of the Brazilian students used SNSs to both discuss their studies and socialize. However, the two groups shared two common themes: (1) SNSs were popular among most of the students and (2) they used these sites to keep in touch with friends.

A possible explanation for the results obtained might be related to access to learning resources. The Brazilian group was affiliated with a University located in an inner region far away from any big cosmopolitan centre. It is possible that access to libraries, conferences and other educational centres were not easy available to this isolated group, meaning they might need to travel long distances to use such facilities. Many may have used SNSs to obtain support from members for their studies. Indeed, 60% used SNSs to exchange resources, information or ideas with members, a point confirmed in the interviews. Another possible explanation might be that the Brazilian group did not have so many opportunities for face-to-face encounters. In light of this, they may have taken advantage of SNSs to interact and discuss course activities. This could be the case as 40% said they liked SNSs because they were able to interact with distant members. This, however, requires more research. Moreover, it was clear that the study-related exchanges occurring in SNSs were self-organized by the Brazilian students, agreeing with others' findings (e.g. [8], [13]). It seems that such exchanges happened informally and, referring to [15], were similar to those discussions taking place in the school corridors or canteen where students offer suggestions, bibliographies and organise group work. This study shows that many students felt they benefited from these exchanges in the SNSs. Further research should investigate in depth how much learning happens.

The Singaporean students, on the other hand, clearly preferred to use SNSs to interact with their friends, and as some suggested in the interview, to "relax." It is possible that these students used other means to discuss their studies such as other technologies. They may have had more access to learning resources such as libraries and bookshops and more opportunities for face-to-face meetings as they may have been physically near to their colleagues. Perhaps, an additional reason could be that these students lived more stressful lives than the Brazilians, who are known to live in a more "laid back" society. Thus SNSs might have been a way to "stress out." Moreover, it could well be the case that due to cultural differences, the Brazilian students had stronger sense of community and took more advantage of SNSs for study purposes. Finally, it could be that the Singaporean students may have not seen value in using SNSs for study purposes as suggested by a few in the interview. Research could investigate more deeply the reasons for these students not using SNSs to discuss their studies.

7 Conclusion

In conclusion and despite the limitation of the sample size, this study has, nevertheless, suggested that there is a place for SNSs in education. It has shown that many of the Brazilian students were, in fact, using SNSs informally to complement their course activities. Perhaps, SNSs may play a bigger role in the lives of students' living in regional areas where access to learning resources are not always easy or long distance becomes an issue. SNSs may suit these students' needs because they are free and easy to use. However, not all Brazilian students were members of SNSs nor used them to discuss their studies. Perhaps, what is needed is to develop awareness among such groups that SNSs may be used as a learning tool.

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Collective Text Editor: A New Interface Focused on Interaction Design

Patricia Alejandra Behar, Alexandra Lorandi Macedo, Jaire Ederson Passos, and Paula Caroline Schifino Jardim Passos

NUTED - Núcleo de Tecnologia Digital aplicada à Educação, Universidade Federal do Rio Grande do Sul, Av. Paulo Gama, 110 - Prédio 12105 - 4° andar sala 401 - 90040-060 - Porto Alegre (RS), Brazil
pbehar@terra.com.br,
{alorandimacedo,jairepassos,paulacarolinejardim}@gmail.com

Abstract. The Collective Text Editor ETC is a tool that follows Web 2.0 philosophy. Thus, its aim is to foster collaborative work mediated by computer and to create a space where the synchronous and asynchronous construction of collective texts among geographically dispersed users can be encouraged. The ETC is linked to a research project of NUTED/UFRGS. The present article deals with the reconstruction of the interface so as to adapt it to the current technological demands, giving it credibility and new personality.

Keywords: Collective text editor, Interface for collective learning.

1 Scenario

The Collective Text Editor – ETC[1] – aims to provide a space for collective elaboration of texts, synchronously or asynchronously, by users dispersed geographically. This tool was developed by NUTED[2] (Nucleus of Digital Technology applied to Education) of the Federal University of Rio Grande do Sul. The first version of ETC was built in 2001. Since then, the editor has been used in different teaching-learning situations, considering a variety of work groups, among teachers and students from graduate, extension and post graduate courses in different areas of knowledge.

Throughout the use, NUTED has always prioritized the improvement of the tool following evaluations made by users. Several actions, in this sense [2], [3] and [4] have been developed and implemented in order to enhance the editor and to contemplate the demands presented. The research group team is currently readapting the ETC's visual interface and navigation, aiming to update and innovate.

Within the new key-concepts originating from Web 2.0 cooperation and interaction can be highlighted. To promote this process, however, it is necessary that the interface follow the principles of usability, contemplating users and their objectives. In the case of ETC, visual communication criteria were included and discussed since its initial

[1] Available in: www.nuted.edu.ufrgs.br/etc
[2] www.nuted.edu.ufrgs.br

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implementation. But, with technological advances, it is necessary to review this application so as to approximate the editor to new visual constructions that emerge from Web 2.0 technologies.

The present article presents a new graphic project which aims to provide greater comfort and visual harmony. It is a more attractive and intuitive interface whose graphic design has been improved offering a better environment where interaction and cooperation can be developed. It is believed that, this way, better results in the interactive processes can be reached as a result of the collective constructions in the editor. Thus, this article presents the pedagogical foundations that have underlain the development of ETC, it describes the design principles highlighting not only the main problems found in the previous version but also the solutions that have been proposed for the new, ending with final considerations.

2 Educational Support for ETC

The ETC, as its name suggests, is a Collective Text Editor. In this sense, it is necessary to define what the present article understands by such concept. The term "collective" depends on the kind of interaction that takes place. In this case, this study deals with the inter-individual relations occurring among participants in an activity, in other words, the collective elaboration of a text supported by Piaget's premises [12]. It is important to emphasize that the theoretical support of the present study is based upon Jean Piaget [12], according to the definitions of interaction types taking place among subjects (individual or inter-individual).

The collective construction of a text implies a dynamic interaction among people involved. It is understood that an interaction occurs between subject and object. This is a dialectical movement and is part of a process of knowledge construction. We highlight that subject and object relating to one another are an undissociated whole and, in this context, the object can be considered the support material, the tools of the environment, the content discussed and constructed besides the subjects involved.

In a process of collective authorship there are moments in which subjects coordinate different viewpoints. Thus, this is understood as a movement of displacement of perspectives, of opening to new meanings, new relations and connections between writing objects, between events and characters, building new and permanent authorship possibilities [1]. In this social relation the subject is "we" and object is the other subjects. Thus, "(…) social facts are exactly parallel to mental facts, with an only difference that "we" is always referred to as "I" and cooperation, by simple operations" [12]. To coordinate different perspectives about the same theme, the subject needs to decentralize, in other words, to analyze different viewpoints through a view that is not his/her own.

Aiming to support this movement of interaction, the ETC makes functionalities available that favor synchronous and asynchronous communication. We understand that the collective text editor offers conditions for a dynamic self-organization of the group so that the common goal is a coherent and meaningful whole. Therefore, collective construction implicates eminently in the actions of subjects. Such actions refer to physical and cognitive coordination that can change each subject in particular as well as one in relation to the other [13]. This collective movement forms a contribution network and exhibits a relevant construction process in that it centralizes ideas and reveals propositions based on different life experiences.

Educational professionals have realized the potential of Web 2.0 in learning processes. Among its advantages we can highlight the power of interaction tools to foster group consciousness, keeping participants permanently informed about each others' work as well as about production as a whole [18]. Besides, technology that supports collective edition can be not only attractive but also convenient to the teacher who is able to identify each student's process in relation to the group, having as a resource for such the tools for production follow up available in the ETC.

It is clear that the relevance to the continuity and improvement of ETC lies in the search to develop tools that respond to the priorities of educational needs. That is why applications and analyses are permanently supported by the public who show the potential of use and projections of the tool. Thus, based on these principles, a new interface development was articulated aiming to support the dynamic exchanges generated from the collective construction.

3 Design Addressed to User

Interaction design is an area of design devoted to projecting systems that enable communication and work through computer interfaces. Many products that require human interaction are not developed with the users in mind but are focused on the functions that such products should perform. Re-directing this focus, interaction design brings usability into the design process. Preece [14] defines this activity as "the design of interactive products that provide support to people's daily activities" (p.28). This way, it is centered on the user, aiming to provide comfort for his/her activities and efficacy in the results.

The main focus of interaction design is to offer the user favorable conditions so that objectives are reached and so that the development of the activities can occur nicely. To do so, usability goals are established in order to highlight the main points to be observed in the development of a system. Within these usability goals we list system efficacy concerning how successful the task performance can be; efficiency that is related to the way the system helps the user perform his/her tasks and if it is productive. Moreover, security issues, which concern users not being exposed to undesirable situations, preventing errors and enabling retrievals; and utility, which evaluates whether the system provides enough and adequate functions to help users in activities he/she needs to perform [14].

Usability means optimizing the relations among people and interactive products. In the case of ETC, the interaction design aims, above all, to promote textual production through group work. This project needs, therefore, to highlight usability goals so as to minimize the cognitive load[3] , so the user can concentrate his efforts in the activity under way and not in learning to use the system. Fleming [9] claims that time spent trying to figure out how a site works hinders the comprehension of the content. It is necessary that the interface be easy to learn, intuitive, with easy navigation and easy to remember in a first contact, guaranteeing users a good performance next time they need to use the system.

[3] Cognitive load refers to the demands made upon the learner's work memory during instruction.

For the new ETC project, two points were then highlighted: the capacity to learn (learnability) and the capacity to memorize (memorability). The capacity to learn concerns how long it takes to initiate the system and to learn to perform a wider range of activities. The capacity to memorize, in its turn, is related to the kind of support that is provided the user to help him/her remember how to use something, especially those things that are not used very frequently [14].

Besides the usability goals, there are also those related to the experience of the user regarding how he/she will feel in contact with the interface. It is desirable that an interaction system gives its users agreeable, satisfying, fun, interesting, useful, motivating, aesthetically attractive, compensating and/or emotionally adequate moments [14]. Rarely will it be possible to encompass all these characteristics simultaneously. Each project needs to highlight which, among so many aspects, is more important to its system. In the ETC case, the intention is that the environment should promote interaction and group work being agreeable and aesthetically nice and that it should stimulate creativity.

Having defined the objectives and the main usability goals and experience of users to be searched for to develop the system, we went on to a new design that tackled the deficiencies of the previous model. The next segments highlight some of the problems encountered in the previous version and how they were solved in the new version.

4 ETC: The Construction of a New Interface Focused on Interaction Design

Constant technological innovations in our days make software and hardware easily obsolete and cause an endless search for new systems. It is no different with systems developed for Education that need constant recycling. Such is the trend that it has been observed that the editor needed to be updated through suggestions made by users of ETC since 2002. The previous project of the editor presented navigation problems

Fig. 1. Previous ETC version of text management interface

with links that were difficult to identify because they were scattered through the pages. The visual information lacked unity and coherence, with an excess of dispensable elements and without any hierarchical definition. User performance was harmed due to time lost trying to understand how the system worked. In Fig. 1 we can see one of the content management pages from the previous version of ETC.

According to Nielsen [10] interfaces must not contain irrelevant or rarely used information because extra units of information compete with relevant information and reduce their visibility. The interaction for ETC's new version aims to cut down on noise in communication and brought a cleaner and clearer interface, as shown in Fig. 2. The new design meant to create a non-polluted environment with blank areas, driving the look of the users to the content that matters.

Lévy claims that "human memory is structured in such a way that it understands and retains better that that is organized according to spatial relations."[8]. For the new ETC version, units of information were re-organized and hierarchized according to their relevance and function and re-distributed in a more harmonious way following a construction grid.

For Nielsen [10] the core issue as far as navigation is concerned is to inform the user where he is, identifying the site well, preferably with a logo positioned on the upper left corner. In addition, it is also necessary to show the user clearly where he/she was previously or where he/she can go, in other words, which ways he/she took in the present tool to be where he/she is at the present moment and where he/she still can go. This matter was tackled in the new ETC interface with a heading: site logo and brand and some localization links, such as home, site map and contact. In a vertical column links were placed creating a new menu, as shown in Fig. 2. These elements should remain constant throughout the pages of the site as it guarantees visual unity to the interface as well as navigation stability.

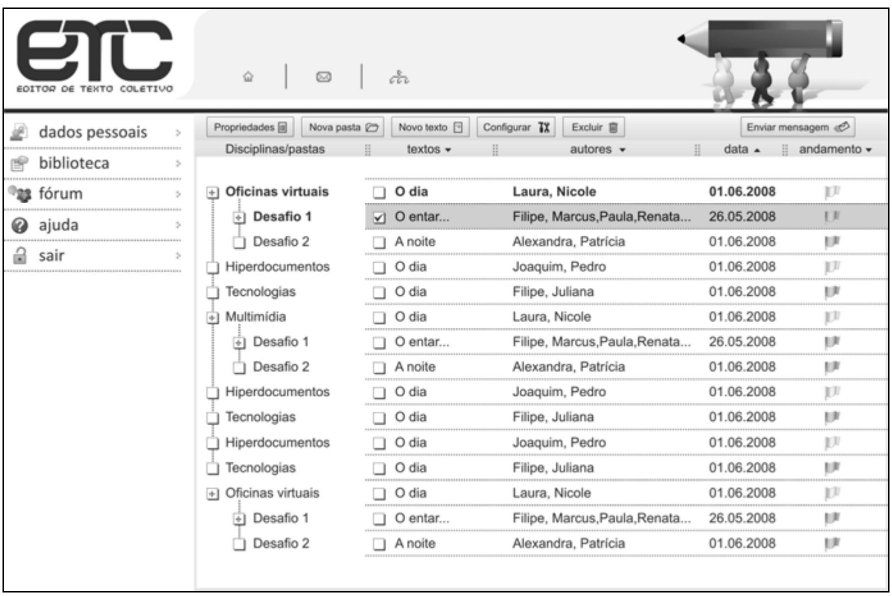

Fig. 2. New ETC interface

Fleming [10] lists some characteristics of sites with good navigability. Among them, two that are desirable to this project: consistency and contextualization. Consistency refers to the way the system guides its user through standard menus throughout the pages and contextualization refers to how clear the visual links' definition is. For Nielsen [10], consistency refers to keeping presentation homogeneous and coherent. Consistency is a characteristic that guides and makes navigation easy to learn, one of the usability goals of the new ETC project. Thus, a new visual identity and new menus were developed aiming to guarantee consistency in all the pages of the site. Fig. 2 and 4 show all the pages of ETC and demonstrate how the pattern was maintained.

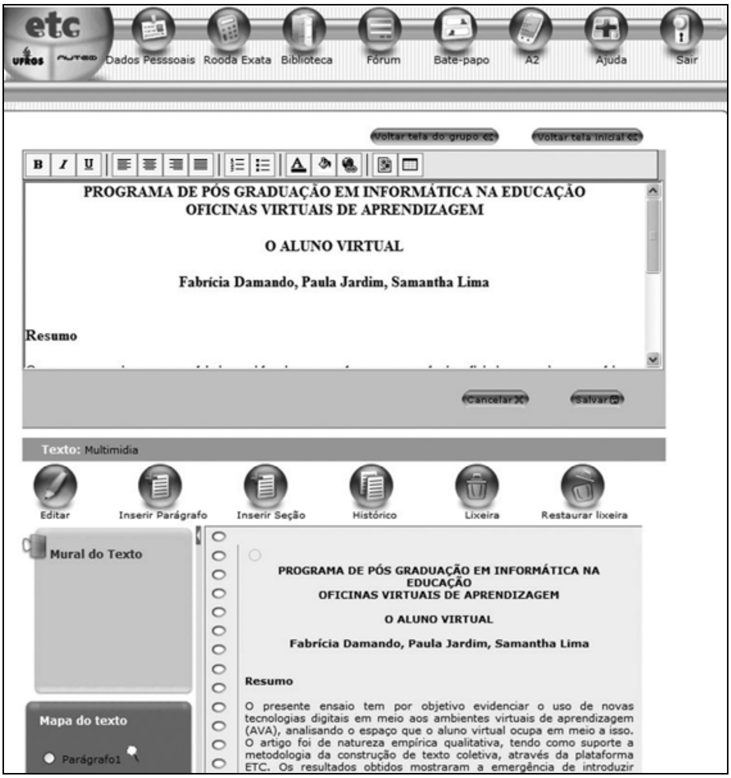

Fig. 3. Previous version Interface of text editor

In a menu, alternatives are presented enabling the user to choose an action. According to Dul and Weerdmeester [5] the advantage of the menu is that the user needs little previous experience to understand it, in other words, the system is simple to operate even for beginners. This format requires little digitations and little mental effort, something that is considered adequate to the system in project once the idea is to diminish the cognitive load. In the new interface of the ETC five menu links were worked with allowing for possible tool additions identified as necessary. The ideal is to work with a menu of up to seven alternatives so that selection can be made quickly.

To ensure link contextualization, new icons were drawn. Such icons personalize the Editor, make function recognition instantaneous and contribute to another usability goal which is to help the user remember them in a second visit.

Fleming [9] also highlights that a site must guarantee that time will be saved allowing user to quickly arrive where he/she needs to. In this sense, Norman [11] highlights visibility, claiming that functions should be within reach of the user or else the user will have difficulties finding them and knowing how to use them. This author claims that the more visible functions are, the easier it will be for the user to proceed. Filatro [7] advises that a system should enable the navigator the use of menus to find what is necessary in no more than two or three clicks. In the new ETC, we tried to reduce the number of clicks by concentrating the management that was spread throughout 11 pages to one general page of content management. Fig. 2 presents a page that was developed concentrating all the pages of the previous version to only one.

The page meant for text editing is where all the actions of users are concentrated as it is on this page that the collective text productions take place. Fleming [9] highlights that the most important in a tool is that this tool works to help the user reach his/her objectives. It is necessary, therefore, that the interface be simplified and lead the user, clearly, to the functions that help him/her.

The previous model of page editing underwent the same problems of management pages, cited above: lack of visual unity, hierarchy and organization, as shown in Fig. 3. Some of these problems were solved with the new heading and the new lateral menu, as specified above. New icons were then developed and implemented right on the menu bar and on the bottom bar of the editor. Thus, grouped and duly identified, the functions can be easily found and understood.

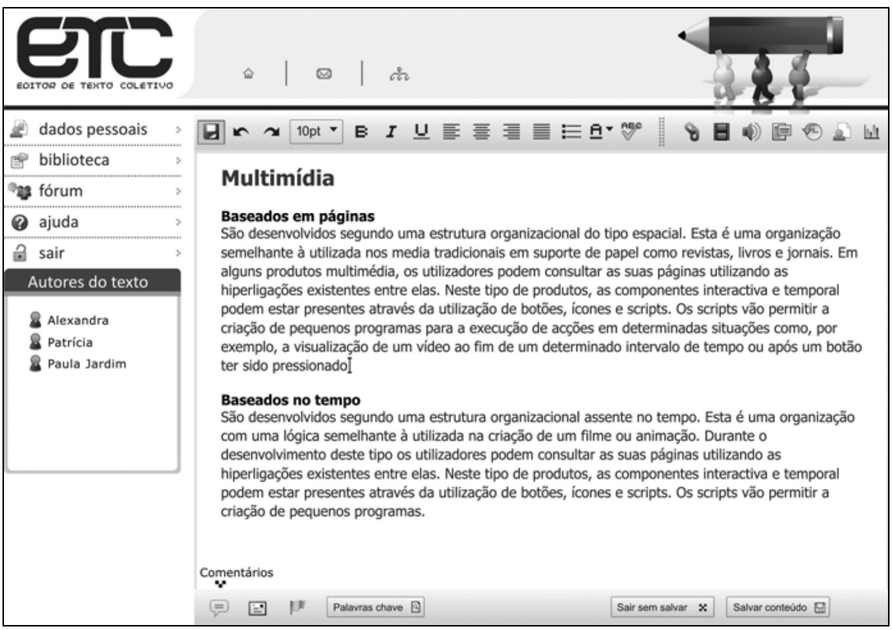

Fig. 4. New interface of ETC text edition

Another meaningful change took place in the editing box, which now shows the whole text and not just the paragraphs. This way, it was possible to eliminate the bottom area of text exhibition and the box for choosing the paragraph to edit (Fig. 3). Based on these considerations and with the innovations presented, the new editing page has become cleaner, more spacious and cognitive overload-free, which allows more room for productivity and creativity. The environment has become, therefore, more agreeable and aesthetically pleasant living up to the goals proposed in relation to the experience of users, as we can see in Fig. 4.

Nielsen [10] states that web pages normally look alike, with relatively similar interaction techniques and layouts which is an advantage as it allows for some skills transference from one site to another. This author also states that, according to his studies of usability, users complain about sites that try to use drastically different navigation interfaces from the majority. Complementing this idea, according to Radfather [16], people look for patterns and recognizable shapes in the environments for their guidance. The new ETC page edition was drawn, on purpose, similarly to other existing tools for textual production (like Word, Microsoft and Google Docs, for example), so some familiarity can be found, making the work of the user easier.

5 Final Considerations

The world offers new alternatives regarding communication and information technology every day. Education must follow these trends regarding the offer of resources which allow knowledge construction to happen naturally and spontaneously, even if mediated by the screen of a computer.

Through the new ETC interface design we look for greater efficacy in the system in order to meet expectations, and, still we intend it to be more efficient as far as helping the user to perform his/her tasks. Moreover, the changes presented in this article also aim to allow it to be part of Web 2.0. According to Filatro [7] interface and navigation logic in Web 2.0 tend to be simpler due to international patterns and protocols. Thus, code-free tools can be easily incorporated one to another after being tested by many users. This way, we hope the Editor can become more user-friendly and accessible to a larger number of people and that it can help them in their productivity.

For Nielsen [10] one of the main objectives of a web page design is to establish credibility. Due to the enormous amount of information available on the Internet and due to the impossibility of identifying sources, the choice of reliable content is difficult for any person. Since the first contact of a user with the system is always visual, it is very important that a site have good appearance so as to be seen as worthy of credit.

In this sense, having in mind the popularization of the Editor, its logo brand was re-formulated and re-positioned, making it ready to become an Internet free tool. We aim, therefore, to create an identity with the other web collaborative tools, adding common visual elements of all but, at the same time, giving it personality and credibility, contributing to consolidate its image as a useful tool for intellectual productivity and collective interaction.

Validation of the new interface is predicted to the first semester of 2009, when it will applied in extension, graduate and post-graduate courses. We hope that, through collective writing activities proposed, it be possible to identify efficacy as well as possible limitations/advantages of the new interface developed for the Collective Text Editor. From the experience, analysis of the new material will be possible, both from pedagogical and interaction design perspectives, aiming possible adjustments and/or improvements as well as the availability of use to the community, outside the university.

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An Open-Source Learning Content Management and Assessment System

Gerd Kortemeyer[1] and Émerson Cruz[2]

[1] Michigan State University, USA
korte@lite.msu.edu
[2] Michigan State University, USA, and University of São Paulo, Brazil
efcruz27@gmail.com

Abstract. In this paper, we describe the development and functionality of the LearningOnline Network with CAPA (LON-CAPA; http://www.lon-capa.org/) system. We summarize published findings obtained over the years regarding its content sharing and online assessment features, and present some new findings on gender differences in the usage of online homework.

Keywords: Course management, learning content management, online assessment.

1 First-Generation Online Homework Systems

In 1992, CAPA (a Computer-Assisted Personalized Approach) was started to provide randomized homework for an introductory physics course at Michigan State University [1,2]. The system provided a way to offer relevant practice problems and feedback to the students in spite of limited availability of teaching assistants. Different students were assigned different versions (for example, different numbers, graphs, formulas, images, and options) of the same problems, so that they could discuss problems with each other, but not simply exchange solutions. As an example, Fig. 1 shows two versions of the same homework problem, as it appears today on the web. When CAPA was first introduced, students received paper printouts of their problems, and had to enter their solutions through a Telnet terminal, where they received immediate correctness feedback. Students typically had a limited number of allowed attempts ("tries") to arrive at the correct solution. In later years, as the web became more widely available, a web interface for answer input was introduced.

A number of other homework systems were developed in the 90s, namely the UT Homework Service [3], WeBWorK [4], and WebAssign [5]. These systems offered very similar problem functionality with comparable randomization features. The systems however differed in their distribution mechanisms, their technology choices, and their problem-editing interfaces. For example, CAPA and the UT Homework Service initially were strongly driven by paper-based assignments and terminal input, and only later added web interfaces, while WeBWorK and WebAssign were web applications from the start. When it came to problem editing, CAPA, the UT Homework Service, and WeBWork offer highly flexible (but complex) programming

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languages, while WebAssign features easier-to-use but more restrictive web templates. CAPA, the UT Homework Service, and WeBWorK are free, while WebAssign is a commercial product.

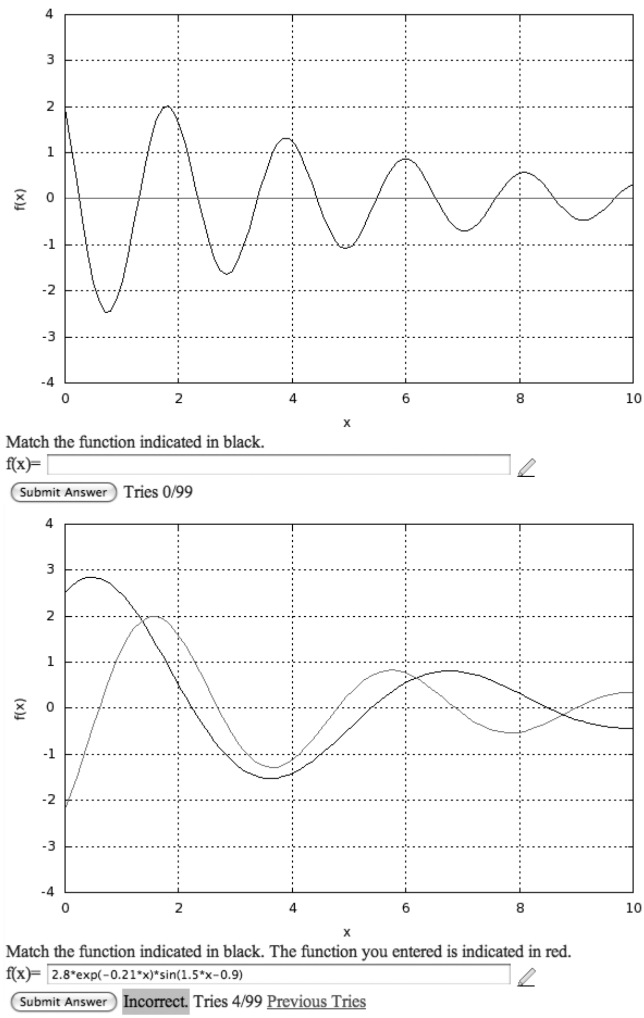

Fig. 1. Two versions of the same homework problem (LON-CAPA screenshots). Since the graphs are different, each student would have a different answer. In bottom graph, the student already entered a solution attempt ("try"), demonstrating some of the instant feedback features that the system can provide.

A major difference between CAPA and the other systems is that CAPA (and today LON-CAPA) relies on local installations at the user institutions, while the other systems are centralized with just one server farm at the institutions where the system originated. The distributed nature has some advantages: in terms of student data privacy, data relevant to grading never leaves campus, and in terms of scalability, the distributed setup is better suited to handle high workloads. As another benefit for regions of the world that have limited communication infrastructure, homework functionality can be delivered reliably at institutions that may have a stable intranet, but unstable or slow connections to the outside world.

None of the systems we have mentioned thus far offers full-featured course management functionality, and none of them can be seen as a replacement for a course management system such as BlackBoard [6], WebCT [7], or ANGEL [8]. Because the homework functionality in these commercial course management systems is insufficient and not well adapted for use in science and mathematics, we consider the above specialized physics homework systems as complementary rather than competing with mainstream course management applications.

2 Features of LON-CAPA

Because editing new problems is a time-consuming task, and because standard introductory physics problems are very similar, faculty at different institutions using CAPA soon started to exchange problem libraries with each other. Here, CAPA's distributed nature brought some challenges that the centralized services did not encounter: since CAPA had separate installations, exchanging materials meant sending the associated files via FTP or exchanging floppy disks. Overcoming this infrastructural shortcoming was one of the main design principles in the next generation of CAPA, the Learning*Online* Network with CAPA (LON-CAPA) [9-11]. The features of LON-CAPA include the following:

- Cross-institutional resource management. Although LON-CAPA is still deployed at separate installations, problems and content pages are copied on-demand between machines and automatically updated. Digital rights management protects sensitive content (for example, exam questions) and potential commercial interests (for example, back-of-the-chapter libraries of textbook publishers).
- Cross-institutional load balancing. Although all permanent data storage is at the instructor's home institution, any server in the network can host any session. Thus, sessions can be offloaded across the network in peak load situations.
- Completely web-based interface for all system functionality.
- Access to the full sophistication of the CAPA problem engine through an XML-based problem format with optional embedded scripting; this allows for the use of template-driven editors, while preserving the flexibility of programming languages when desired by authors.
- Multimedia content and problems are made available through an embedded course-management system with functionality similar to commercial systems, thus eliminating the need to use two separate systems for the same course.
- While being a distributed system, LON-CAPA is robust against connectivity dropouts and latency. For example, the system has content replication and subscription mechanisms, so internet connectivity to the site where the content originates does not need to available in order to make content available within the intranet of an institution.

3 Content Sharing

In Fall 2008 LON-CAPA had over 130 participating institutions (about half secondary and half postsecondary) with over 310,000 shared resources, over 120,000 of which are randomizing online problems, almost 100,000 are images, and almost 60,000 are web pages. The remaining 30,000 resources are other multimedia assets, for example, content assemblies (approximately 10,000 "learning paths"), sound and movie files (approximately 950), and animations and simulations (approximately 1700). Figure 2 shows the growth of the resource pool over the years.

The system is also used internationally, currently in Brazil, Canada, Germany, Israel, South Africa, South Korea, and Switzerland. The system had also been successfully deployed in Zimbabwe, where the redundant nature of its architecture overcame challenges posed by intermittent connectivity and latency problems (unfortunately, as of 2008, this installation is not active anymore). The system supports Unicode and has been translated into German, Japanese, and Portuguese; currently, efforts are under way for a Chinese translation (simplified script).

Faculty members have written most of the resources in the shared pool, originally mostly for use in their own courses. We found much willingness on the part of faculty to make their materials available to the pool, and the vast majority of the material in the system is published "system-wide," some of them even "open-source," thus allowing derivative works.

Initially, we believed that monetary incentives or bartering schemes would be needed to motivate faculty to share their materials. However, we found that faculty members are far less interested in earning usage fees than feeling a sense of accomplishment when they see the usage counters increasing or receive positive feedback from peers. The "e-commerce" schemes were also seen as too complicated, and we came to the realization that they might inhibit rather than foster the expansion of the network. From discussions with authors, it is apparent that the few authors who wish to restrict use of their materials are often hesitant to submit materials to public scrutiny, rather than generally unwilling to share.

It seems that sharing resources fits into the academic culture, just as for example research papers and findings are "shared." Arguably, this might be subject area specific: most participating faculty are from the natural sciences, and most resources are intended for introductory courses. Faculty members might take pride in writing a high quality homework problem regarding angular momentum conservation, but would hardly base their reputation on it, nor are they competing with peers teaching the same topic. Also, for example, introductory physics is far from controversial, so authors do not have to worry about scrutiny with regards to matters of opinion.

The most important aspect appears to be good stewardship of the material: the project needs to guarantee that materials, some of them exam or grading-relevant homework problems, do not "leak" out of the pool; students only have access to the material that faculty select for them, and only in rendered form. Particularly sensitive is the XML source code of the problems, because it allows for reverse engineering of the randomization and determination of the correct solution for any variation of the problem. Authors need good reasons to trust the system.

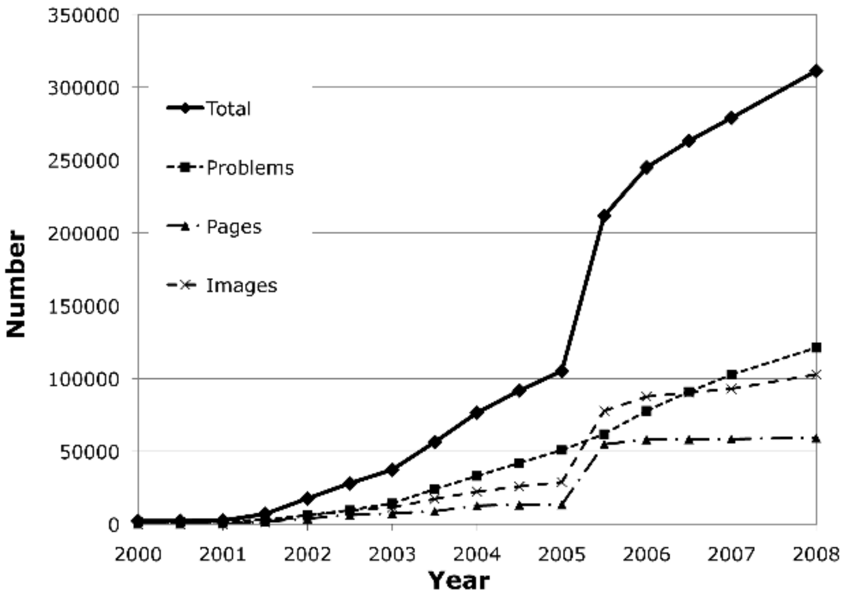

Fig. 2. Growth of the LON-CAPA resource pool over time

4 Measures of and Influences on Learning Outcomes

4.1 Course Grades

Although faculty acceptance in part depends on factors such as time-savings, convenience, ease-of-use, and philosophical considerations, both faculty and students care about learning outcomes: instructors care, because it is frustrating to see bad exam scores, and students care, because they want good grades.

A simple measure of learning outcomes is – hopefully – the course grade. Though in an individual year, many factors might play a role, Figure 3 shows grade distributions over several years in the standard introductory physics course for scientists and engineers (PHY 183) at Michigan State University [11,12]. A 4.0 is the highest grade, a grade lower than 2.0 results in failing the course. The solid graph shows the averaged distribution in the years 1992 to 1994 without online homework, and exhibits the classic bell shape with a maximum at around 2.5 (since this historical data was only available in semester-averaged form, no standard deviations are given in the graph). Unfortunately, we were unable to reconstruct which sections of the course correspond to the data, but we do know that at least six different instructors were involved over the years [11].

In 1996, online homework was introduced. We were able to obtain semester data from five different instructors who taught the course between 1999 and 2007 (gray graph in Fig. 3) [11]. Only one of these five instructors may have also been included in the data of the pre-CAPA time period. We indicate standard deviations, which reflect grading differences between the five post-CAPA instructors. The consistent observation in subsequent years with online homework is that the grade distribution is depleted around 2.0 in favor of higher grades, and overall becomes skewed.

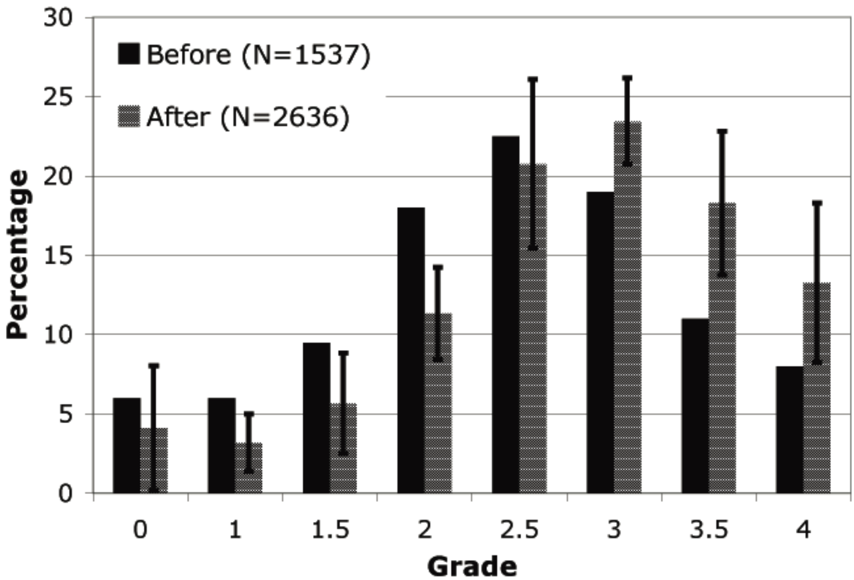

Fig. 3. Grade distributions across several sections and semesters of a physics course for scientists and engineers before using online homework *(solid)* and after its introduction *(gray)*. Data for the pre-CAPA period was only available in averaged form [12], but for the post-CAPA period, error bars reflecting the variation of grading between different instructors and semesters are given [11,12].

The average course grade was 2.4±1.0 before the introduction of online homework, and 2.7±1.2 afterward – the difference (0.3 grade points) is not statistically significant (or inflationary), but noticeable. It is important to note that the difference is not simply a result of an increased number of points for homework, because homework in all of these courses constituted only a small contribution of the grading criteria, but a result of higher exam grades [13].

4.2 Student Attitudes

One of the main reasons for the learning gains is most likely increased time-on-task: students are self-reporting that with the introduction of online homework, on the average, they are working one to two hours more per week on physics than without online homework [13]. Students who found online homework particularly helpful on the average worked 2.4 hours more per week after its introduction. Surprisingly, there were even a few students who worked ten hours more per week on physics, some of them still finding the system very helpful, but others (who failed the course), finding it useless. Another frequently quoted reason for the system's helpfulness is the immediate feedback and the ability to do the problem over and over (within a limited time and for a bounded number of attempts) until mastery is achieved. Although this feature is certainly perceived to be helpful by students and appreciated by faculty [14], there is some well-reasoned concern, confirmed by research results, that it can also “turn thinkers into guessers,” where students adopt a trial-and-error approach to problem solving [15] – here, however, gender may play a role.

4.3 Gender Differences

Online homework consistently most strongly helps students who are on the brink of failing courses. Comparisons between grade distributions before and after introduction of online homework typically show that formerly strictly bell-shaped grade distributions get depleted around the 2.0-grade. As an example, in an earlier study we examined a two-semester course, where in a particular year the first semester was taught without, and the second semester with online homework [12]. Grades improved (compatible with Fig. 3), but surprisingly, it turned out that this was mostly due to female students. In the first semester, the average grade of male students was 2.8±0.8, versus 2.5±1.1 for female students. In the second semester (after introduction of CAPA), it was 2.8±1.1 for the male and 2.8±1.0 for the female students.

Figure 4 shows the grade distributions for female and male students in the first and the second semester [11,12]. It can be observed that for female students, the grade distributions in the first semester (black, without online homework) and the second semester (gray, with online homework) are very different, while for male students, there is hardly any difference between the semesters with and without CAPA. The grade distribution for female students was significantly different from the male distribution in the first semester (χ^2=3500; p<0.0001), indicating a significant gender gap, but this difference almost vanished in the second semester (χ^2=14; p=0.05).

A similar effect was observed at Central Michigan University [16]. In that study, only one gender difference in student interaction with online homework was discovered, namely, it was also found that females in semesters where they outperformed the male students usually did their online homework earlier, i.e., not as close to the due date.

We were able to exclude simple population, instructor, or attrition effects. Also, in a study of one particular course, we found no significant differences in the online usage data, such as average number of attempts used, and both male and female students reported the same average amount of time-on-task, i.e., 5.1±3.6 and 5.6±3.3 hours per week, respectively. Both male and female students also solved the same number of online problems, i.e., 381±40 and 389±30 problems over the course of the semester.

However, in an open-ended survey, we found indicators that male and female students make different use of being allowed multiple tries to solve online homework problems: male students frequently, before anything else, attempt to immediately solve the problem, while female students are more likely to first interact with peers and teaching assistants before entering answers. Particularly, the online discussions, which are part of LON-CAPA’s course management features, appear to be used more by female than by male students, both in posting and reading. More male than female students state that they use the multiple allowed attempts to enter “random stuff,” while more female than male students state that having multiple attempts allows them to explore their own problem solving approaches without “worrying” or “being stressed out” about grades.

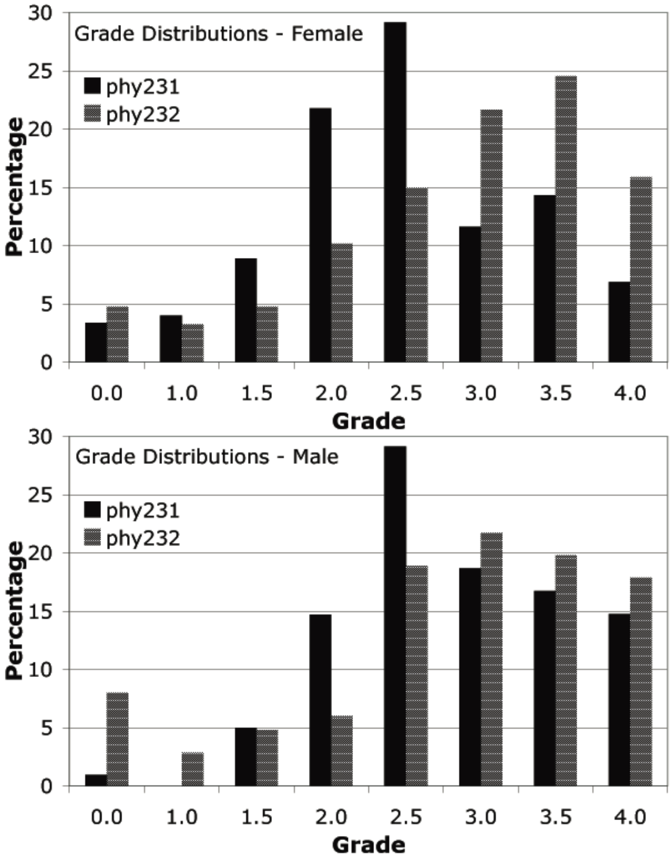

Fig. 4. Grade distributions in the first semester *(solid)* and the second semester *(gray)* of a non-majors introductory physics course. The top panel shows the grade distribution of female students, the bottom panel of male students. Online homework was used in the second, but not the first semester [12].

5 Conclusions

We have introduced LON-CAPA as an open-source tool to develop, use, and share online teaching and learning resources. We find that individualized online homework can be an effective learning aid, particularly in the sciences, and particularly for students who are at risk of failing the course. There is evidence that online homework helps to close the gender gap usually present in science courses. The sharing of such resources across institutional boundaries is a reality, as shown by international collaborations around online teaching and learning, which have continually grown since LON-CAPA was first introduced in 2000.

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Supporting Collaborative Learning Activities with a Digital Library and Annotations

Tiago Rios da Rocha[1], Roberto Willrich[1], Renato Fileto[1], and Saïd Tazi[2,3]

[1] Dept. of Computer Science, UFSC, Brazil
{tiagoriosrocha,willrich,fileto}@inf.ufsc.br
[2] LAAS-CNRS, Toulouse, F-31077, France
tazi@laas.fr
[3] Université Toulouse; UT1, UPS, INSA, INP, ISAE; LAAS, Toulouse, France

Abstract. Digital Libraries (DLs) usually provide facilities for browsing and searching their collections, and can enhance noticeably learning activities. The integration of an annotation tool with a DL can foster knowledge exchange between instructors and learners. It is important that an annotation system for DLs should be easily integrated with existing DLs. This paper presents an annotation system, called DLNotes, which can be easily embedded in DLs in order to enable free-text and ontology-based annotations. DLNotes also supports supervised annotation activities and allows discussion threads to be associated with each annotation, what is particularly important for e-learning.

Keywords: Digital Libraries, free-text annotations, ontology-based annotations.

1 Introduction

Digital Libraries (DLs) are systems that provide facilities for organizing digital collections. They enable the creation of metadata catalogs that facilitate the information discovery from the DLs' collections. However, the basic facilities of a DL are not sufficient in the e-learning context. The editing and annotation of documents and the interactions among users need to be integrated [1]. An annotation can serve several objectives in the e-learning context [2]: procedural signaling for future attention, place marking, aiding memory, problem-working, interpretation, and tracing progress through difficult narrative or reflection about the material circumstances of reading. Moreover, annotation facilities embedded in a DL allow users to collectively build knowledge, enabling teaching and learning actors to communicate, and facilitate pedagogical evaluation.

Annotations fall into two broad classes: free-text and semantic annotations. Free-text annotations associate a selected portion of a document to a free-text providing additional information about the marked passage. Semantic annotations or ontology-based annotations associate terms occurring in a portion of a document to their respective semantic descriptions, which can be contained in an ontology or in a Knowledge Base (KB). These annotations help to make the knowledge explicit in a formal and machine-processable way, enabling semantic-based access [3]. Several

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works have shown that this is a promising technology for e-learning [4]. However, most annotation systems deal with either free-text or semantic annotations, while both are relevant for e-learning.

This paper presents DLNotes, an annotation system for DLs allowing the creation and sharing of knowledge about the DLs contents for e-learning activities. By using DLNotes, instructors and learners can freely enrich the DL contents, by associating relevant parts of documents with both free-text and semantic annotations. The instances and relationships generated by the DLNotes semantic annotation process are stored and related in KBs that can be used for semantic browsing and semantic information retrieval. DLNotes also supports collaboration thanks to public annotations and discussion threads associated with annotations. Discussion threads are mechanisms particularly important to allow communication between learners and instructors about annotated subjects. Moreover, by using DLNotes instructors can propose tasks to their learners, such as the collaborative construction of sets of associated annotations. The execution of these tasks can be guided and evaluated by the instructors.

The remainder of this paper is organized as follows. Section 2 presents an overview of related work. Section 3 describes the proposed annotation schema and the DLNotes' architecture. Section 4 shows DL-Notes functionalities in use with the Brazilian Literature Digital Library [5]. Finally, section 5 presents the conclusions and future works.

2 Related Work

We consider that an annotation system for DLs should meet the following requirements: (i) both free-text and semantic annotations must be supported; (ii) an access policy must be associated with annotations, that are allowed to be private or public; and (iii) the communication and discussion between instructors and learners must be supported. In this section we discuss related work, outlining the main features of some relevant annotation systems. None of the analyzed annotation systems satisfy all the requirements enumerated above simultaneously.

There are several free-text annotation systems. Some of these systems adopt or extend the annotation schema proposed by the W3C Annotea project [6]. Annotea defines an annotation schema based on the Resource Description Framework (RDF) [7] and a protocol for publishing, retrieving and managing annotations. RDF is a W3C standard language for representing information about resources in the Web. The annotation systems based on Annotea, such as Amaya [8], allow only simple free-text annotations.

A number of systems allow manual or semi-automatic creation of semantic annotations. Manual creation of annotations have a high cost, is prone to error, and usually require domain expertise [9]. Despite these drawbacks, we believe that manual annotation is interesting for e-learning, allowing the users to collaboratively annotate the DL collection and share knowledge. Moreover, it can be a learning activity by itself in some domains such as literature or scientific text analysis.

SHOE [10] and Ontobroker [11] allow the annotation of Web pages with ontological metadata using HTML extensions. The drawback of these systems is that they change the original document that is not allowed in DLs.

Some semantic annotation systems are oriented to learning. MemoNote [12] is a semantic annotation system for teachers. SABRE [13] is another annotation system oriented to learning. It is allows the authors to semantically annotate their documents with their pedagogical intentions, with the objective of facilitating the reuse of annotated documents. However, these systems do not allow learners to create annotations and discussion threads during the learning process.

Vannotea [14] and COHSE [15] are examples of annotation systems supporting both free-text and semantic annotations. Vannotea extends the Annotea schema to annotate objects of any media type, where annotations can be free-text, files, URLs or terms from a controlled vocabulary (*e.g.*, WordNet) or ontology. The COHSE system also extends the Annotea schema to support three types of annotations: textual annotations, link annotations, and semantic annotations.

Various free-text annotation systems allow public and private (including group) annotations. Conversely, semantic annotations systems generally allow either public or private annotation. One exception is Vannotea. However, its authors do not detail the management of public and private semantic annotations.

What differs DLNotes from previous systems is that it supports free-text and semantic annotations, including public and private ones. Moreover, two other functionalities of DLNotes are particularly important for learning: (i) discussion threads about the annotated content, and (ii) the annotation activity concept, as detailed in the following. In addition, DLNotes can be adapted to different domains by changing the ontologies used for semantic annotation.

3 The DLNotes System

This section presents DLNotes, our free-text and semantic annotation system for DLs. The main purpose of this system is to support learning by offering functionalities to enrich the DL collection with annotations inserted by instructors and learners. Concerning free-text annotation, instructors may annotate the document to ask questions, to make suggestions or to discuss with learners. Learners may annotate text to answer questions posed by the instructor or discuss his answers with other learners or with the instructor. Annotations can support the learners' critical thinking and argumentation activities. The annotation process is characterized by interaction and exchange of experience, supported by shared public annotations and discussion threads about these annotations. Semantic annotations are made by both instructors and learners. They are used to identify concepts and relations of the studied matter that render a conceptualization of the studied texts. The system allows identifying text's features and helps in the analysis and comprehension processes.

3.1 Annotation Schema

DLNotes adopts an extension of the Annotea schema, satisfying the previously cited requirements. Some properties shown in Figure 1 are described below. The *rdf:type* property indicates the creator's intention when making the annotation. Its value can be *rdf:type Annotation* or some other specific type of annotation (Advice, Change, Comment, Example, Explanation, Question and SeeAlso). Each type is associated with an icon. The *annotates* property refers to the annotated document. The *context*

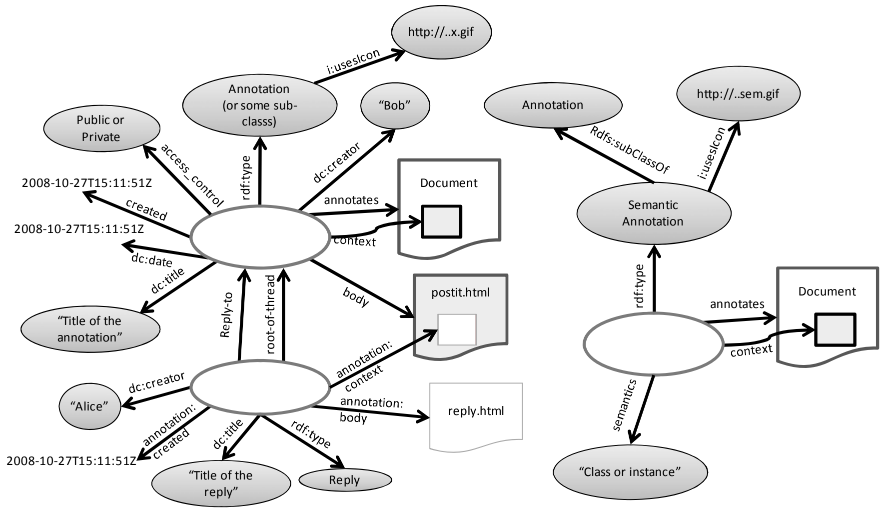

Fig. 1. Annotation Schema of DLNotes

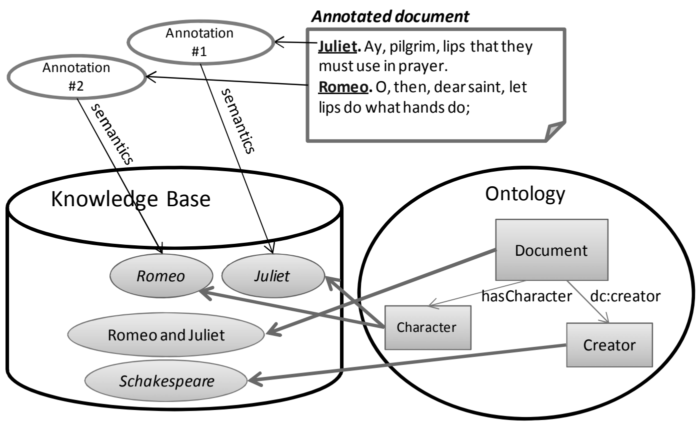

Fig. 2. Semantic Annotation with DLNotes

property specifies to the actual place of the annotation within the document with XPointer. The *body* property contains the content of the annotation. Annotea uses multiple RDF schemas, including Dublin Core (DC) [16], a set of standard metadata largely used in DLs. The descriptive properties *dc:title*, *dc:date* and *dc:creator* are taken from DC. The *created* property defines the date and time on which the annotation was created. Two properties keep tracks of discussion threads: *reply-to* defines which annotation or reply was the previous one in the discussion thread; and *root-of-thread* is the first annotation in the thread.

We have extended the Annotea schema by including new properties and a new annotation type. The new *access_control (Public/Private)* property allows defining public and private annotations (group annotations are private annotations with more than one creator). Moreover, we defined a new annotation type, called *Semantic Annotation* and the property *semantics*. The latest associates a context with a class or instance defined in an ontology or KB via an URI.

In DLNotes, one or more ontologies and some KBs provide a vocabulary, specifying concepts, entities (concept instances), and their semantic relations. DLNotes allows the user to associate document fragments with ontological concepts or instances they refer to. If a new term or named entity is identified by the user, he/she can create a new instance in the respective KB when inserting the annotation. For instance, in Figure 2, the user can annotate the named entities Juliet and Romeo by creating two instances of the Character concept described in the domain ontology.

3.2 DLNotes Architecture

There are three categories of Web annotation systems [17]: server-based, where only documents on a specific server can be annotated; proxy-based, where the annotated documents are accessed through a proxy; and extension (or plug-in) for a Web browser, which requires the installation of a specific browser or plug-in. DLNotes is aimed to annotate HTML documents that make up a collection made available by a DL server. Therefore, we have adopted the server-based approach. This approach does not require any software installation or browser configuration. Moreover, the server-based approach simplifies the annotation sharing between the users of the DL. Figure 3 illustrates the overall architecture of the DLNotes system. Its main components are described in the following subsections.

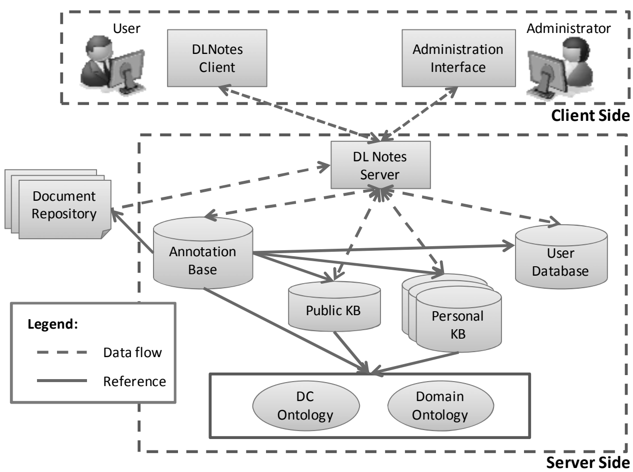

Fig. 3. Overall architecture of the DLNotes System

Dublin Core and Domain Ontologies. DLNotes uses Dublin Core (DC) and Domain Ontologies, all represented in RDFS (RDF Schema), in the annotation process. The Domain Ontologies specify the domain specific concepts and relationships handled by DLNotes in order to create semantic annotations. These ontologies can be set by the administrator using the Administration interface, providing a way to customize DLNotes to specific domains. The DC Ontology is a predefined ontology with the DC elements. It is used to map some DL's metadata repository into individuals in the public KB.

User Database. The user database maintains users' IDs, passwords and profiles. The user profile maintains his preferences and privileges. The preferences indicate if the user wants to see public and/or private annotations. We defined four privilege levels: administrator, instructor, specialist, and regular. The public annotations created by regular users are published only after an approval of the administrator. Specialists and instructors can publish public annotations without authorization. Instructors can access the private annotations of regular users for evaluation purposes.

Administration Interface. The administration interface is a Web page allowing the DL's administrator to manage the DLNotes system. The main functionalities provided by this interface are: importation of Domain Ontologies; importation of the DL's metadata to a KB; creation of annotation activities; the management of KBs, User Base and Annotation Bases; and the management of public annotations.

The instructor can also propose annotation activities to his learners. An annotation activity is defined by a unique identifier and a list of annotation types that the user is authorized to create within its activity. When a learner accesses a document within an annotation activity context, he may create only annotations of the authorized types. For instance, if the user accesses a document in a *FreeTextOnly* annotation activity, he/she can create only free-text annotations.

Using the import ontology functionality the administrator can load the Domain Ontology to be considered by the annotation system, adapting DLNotes to the DL's domain. Another important DLNotes functionality is the mapping of the DL's metadata into instances at the Public KB. Two options are supported: importation of DC metadata using a standalone application, or using the OAI-PMH protocol [18] to harvest the DC metadata to populate the Public KB.

The management of public annotations includes the acceptance of new public annotations posted by regular users. When accepting a public semantic annotation referring to an instance, that instance must be moved from the Personal KB to the Public KB, if it is not already there. The administrator is responsible for the consistency of the Public KB, and can remove or edit inconsistent annotations.

DLNotes Server. The DLNotes Server offers an Application Programming Interface (API) used by the Digital Library and by the DLNotes Client to pose annotation requests. The only method currently available is *startAnnotationSession*, which starts an annotation session and returns the HTML page coding the annotated document. Three arguments can be passed to this method: the URL of the document fragment to be annotated; the annotation activity; and the user authentication information. The latest is optional. If it is not informed, the DLNotes Client requests the user login. After the user authentication, the DLNotes Server verifies the user profile and dynamically includes annotations.

DLNotes Client. The DLNotes Client allows the user to select a fragment of a document and create an annotation associated to it. The right side of Figure 4 illustrates the creation of a free-text annotation. The user can select a portion of the document (Juliet in Figure 4) and add the annotation (to describe Juliet). The first step is to select the option “free-text annotation” and define if the annotation is public or private one. After that the user can provide its title and contents. When the annotation is saved, DLClient changes the HTML code representing the document to include a link to the created annotation and it sends this annotation to the DLNotes server.

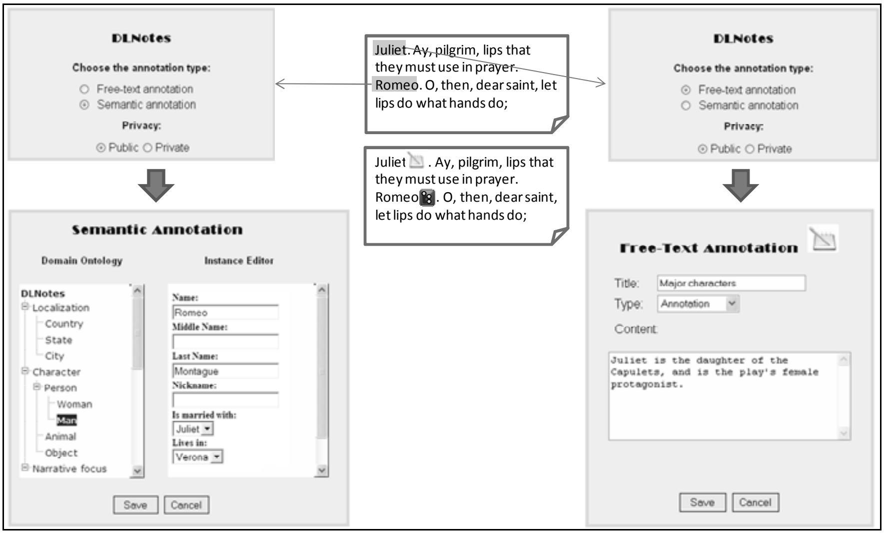

Fig. 4. Creating free-text and semantic annotations with DLNotes

The left side of Figure 4 illustrates the creation of a semantic annotation. When the user chooses the option “Semantic Annotation”, the DLNotes Client displays the Semantic Annotation window. Using this window the user can select one class and choose whether the annotation will be associated with a class or individual of that class. In the latest case, the user can select an existing instance in a KB or he can create the individual using the instance editor panel. During the instance creation process the user can create new relations with other entities on the KB. For instance, during the creation of an annotation for the *Character* Juliet, the user can specify that Juliet *isCousinOf* Tybalt (another instance of Character).

Annotation and Knowledge Bases. DLNotes stores all annotations in Annotation Base, which is separated from the documents themselves. These annotations are represented using the RDF annotation schema illustrated in Figure 1.

The Public KB maintains all instances and relationships obtained by the DL metadata importation, and those created by the users during the generation of public semantic annotations. This KB is the basis for the semantic browsing and querying. The Private KBs maintain instances and relationships created during the generation of private semantic annotations.

In DLNotes, any annotation can be the root of a discussion thread. When the user clicks in an annotation, the annotation content is displayed, accompanied by the existing discussion threads. The user can create a discussion thread or message, by choosing the New Thread option associated with an annotation or the Reply option associated with a discussion thread.

3.3 Implementation and Integration of DLNotes in a DL

The DLNotes system is being implemented using the LAMP (Linux, Apache, MySQL, PHP) open source platform, AJAX (Asynchronous JavaScript And XML), and the RDF API for PHP (RAP) [19]. AJAX is used to implement all the interactivity with the user. It allows the user to interact with the DLNotes Client without the need to reload the entire Web page on each interaction. The RAP API allows parsing, querying and handling of RDF models.

An annotation system for DLs should be easily integrated with existing DLs. The integration of DLNotes with a DL requires changing how the user accesses the collection. The URL giving access to the documents should be changed to a URL calling the *startAnnotationSession* method. Moreover, the existing DL metadata repository must be taken into consideration. For that purpose, DLNotes provides the importation of this repository contents into the public KB.

4 A Case Study: DLNotes integrated with a Literature DL

DLNotes is being integrated with the Digital Library of Brazilian Literature [5], in order to demonstrate its use and conduct learning activities. The purpose of this DL is to make available a great collection of Brazilian and Portuguese literary texts of public domain, with information about authors, dates of publication, publishers, and literary genres. The available resources are used in several learning activities such as text comprehension and analysis at Santa Catarina Federal University (UFSC).

A small ontology was developed for testing DLNotes in the literature domain. This ontology defines basic concepts (such as character, protagonist, antagonist, narrator, and geographic place) and their relationships, extracted from literary texts, along with concepts related to learning activities using these texts.

The activity of literary analysis was chosen to demonstrate the possible uses of DLNotes to deploy annotations for e-learning purposes. This activity involves interpreting a literary work and arguing for a particular way of understanding it. The literary analysis in general evolves through several steps accomplished by the learner. Using the annotation activity concept of DLNotes, anyone can follow the guidelines to develop literary analysis. In each step, the user can access the literary work within an annotation activity, which limits the annotation types to be created.

In a "Character Identification" annotation activity, the learner can access the literary work to identify the characters and semantically annotate each character to identify its traits and relations (using *Character* class). Using free-text annotations, the user can write comments about each character.

In a "Figure of Speech" annotation activity, the learner can identify the figures of speech used by the author. It is done by selecting a paragraph and creating a semantic annotation associating this paragraph with a sub-class of *FigureOfSpeech* (*e.g.* *Antithesis*, *Apostrophe*, *RhetoricalQuestion*).

Another important activity is to create the plot, *i.e.* the arrangement of events and actions that make up a literary work. The user can identify some text and create semantic annotations to identify instances of the *Event* class or the *Action* class. Each one of these instances can be related with instances of *Character*, *Event* or *Action*. Semantic relations between instances of *Event* and *Action* can specify causal relationships (*e.g.*, an *Event* can cause an *Action*), conflict (struggle between opposing actions or events), and so on.

5 Conclusions

This paper presents DLNotes, an annotation system designed to satisfy the basic requirements of a DL for e-learning. DLNotes adopts an extension of the Annotea Schema that allows both free-text and semantic annotations. DLNotes users (learners and instructors) can identify important passages in the text, create different interpretations, and make relationships of the contents with formal semantics described in an ontology. DLNotes supports annotation ownership, access control, and discussion threads. The users can share their annotations with others and engage in organized discussions supported by the system, so that there is an exchange of experiences and the possibility of building knowledge through discussion, reflection and decision-making.

DLNotes provides facilities for easing and speeding-up the understanding DLs' contents. It can be adapted to different domains of DLs just by changing the domain ontology. It adds to e-learning technology, by supporting the cycle of production and aggregation of knowledge.

The following developments are among the future works: (i) integration of DLNotes with Moodle, (ii) services for semantic searches based on the knowledge acquired by using DLNotes, (iii) a module for making inferences on the knowledge base, (iv) techniques for mapping ontologies in order to integrate knowledge and provide unified access to diverse DLs, and (v) treatment of inconsistent knowledge.

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Using Cultural Historical Activity Theory (CHAT) to Frame 'SuperclubsPLUS', an Online Social Network for Children

Jennifer Masters

La Trobe University, Bendigo, Australia
j.masters@latrobe.edu.au

Abstract. This paper uses a Cultural Historical Activity Theory framework to describe a social-networking online community project, "SuperclubsPLUS", for children aged 6-12. The use of the CHAT frame enables a detailed description of connections within the project as participants work together to achieve individual and common goals. Application of this structure to the SuperclubsPLUS environment supports the concept that the community is continually changing, shaped by the interactions of the participants. It is anticipated that this snapshot of the project will provide a tangible base in order to further develop and map ongoing patterns of interaction for research.

Keywords: Cultural Historical Activity Theory, Online Social Networking, SuperclubsPLUS, cyber safety, cyber bullying.

1 Introduction

Cultural Historical Activity Theory (CHAT), also known simply as "Activity Theory", is a psychological theory that emerged in Russia in the 1920s based on the work of Lev Vygotsky. The core concept of this theory is that awareness emerges from an individual participating in a social structure where activity incorporating the use of tools to produce artifacts leads to socially valued outcomes. In doing so, the individual develops their own perspective, changing the way they think and behave in future situations. The CHAT model is represented by Engestrom [1] in the form of a triangle where the subject interacts with the community, rules, division of labour, the instruments and the object (artifact) to reach the outcome. This triangle has now become a common framework for representing understanding based on this theory (see Fig 1).

Cultural Historical Activity Theory has been used for over 20 years as a perspective for investigating a wide range of human activity and, because of its emphasis on artifacts, it is particularly suited to human-computer interactions (HCI) [2]. In an edited book, Nardi presents a number of applications of CHAT used for HCI, ranging from the design of software interfaces to transformations of education communities through the use of ICT. Some other diverse examples where CHAT has been used to support HCI analysis include the use of computers in a remote Australian Indigenous school [3], an online community for mathematics and science teachers [4] and a Multimedia workshop for at risk children [5].

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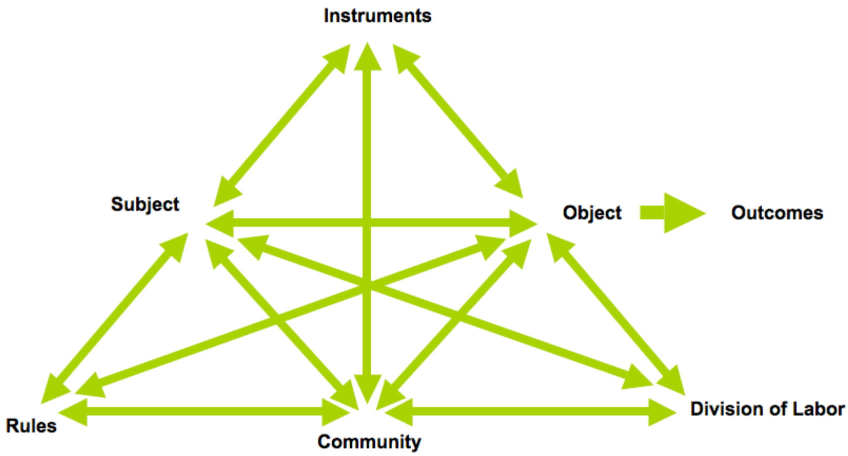

Fig. 1. The basic CHAT Triangle (based on Engstrom [1])

The SuperclubsPLUS project is intended to foster a rich environment where a number of research avenues will be investigated. A broad theoretical framework based on Activity Theory will be used as a global structure to represent the SuperclubsPLUS community and environment. As Cultural Historical Activity Theory not only provides a theoretical basis but also a guide to practice, the CHAT triangle is used for an analytical framework. In this context, the study considers the environment as an activity system and maps the interactions between participants (children, teachers and mediators), the technology, and the virtual environment. Understandings are drawn primarily from transcripts of online communication, but also virtual artifacts created by participants.

2 What Is SuperclubsPLUS?

SuperclubsPLUS is an online learning community for children 6-12 to participate in social networking. SuperclubsPLUS was an initiative of an organization called Intuitive Media that was founded by in 1998 in England. SuperclubsPLUS emerged in 2006 from a previous project known as GridClubs: SuperClubs and provides an online learning community for children to talk to current friends and meet new ones, publish and be creative, participate in forums and discussions and learn new ICT skills. SuperClubsPLUS is a safe environment because:

- All members are authenticated through their schools, and only children and teachers from registered schools can access the environment
- Teachers can see everything that their students write or create
- Highly trained mediators are rostered on to facilitate interactions and scaffold creative work and to actively protect the children
- Sophisticated content checking tools are used by the mediators to monitor all communications, protecting children from bullying or abuse.

The program was very successful when it was introduced in the UK, and the English program has 120,000 children and 13,000 teachers as members. The Australian implementation is an initiative of Intuitive Media Australia in collaboration with La Trobe University, Victoria, with funding from the Telstra Foundation. SuperclubsPLUS was introduced in Australia in May 2008 and officially launched in September. At the end of March 2009 there were around 47,000 children participating in SuperclubsPLUS Australia, along with 3000 teachers. There are currently 18 trained Australian mediators who support the children online. It is anticipated that there will be 100,000 Australian participants within two years.

SuperClubsPLUS provides a rich environment for personalised and social learning. While the program may be implemented by a teacher as part of the school curriculum in a traditional sense, much of the interaction is informal with children (and teachers) participating in their leisure time in out of school contexts. This type of use is supported by the extended opening hours, including weekends. The children have full access to all facilities during 'Live Time', usually from 8.00am to 8.00pm and then 'Build Time' allows them to work on constructions such as articles, web pages or projects, but not communications at all other times.

Fig. 2. The SuperclubsPLUS interface, showing the hub with the club activities and the mediator on duty

While the SuperclubPLUS environment is informal and free-form, there are plenty of activities to keep children engaged and involved. Children usually get started in SuperclubsPLUS by doing their "stars". There are five different coloured stars that are awarded to the children as they complete lists of ICT skill orientated tasks. When the tasks are completed satisfactorily, the star automatically appears on the child's personal web page. The first star, the white star, relates to safety online and requires the child to successfully complete a quiz before proceeding. The subsequent stars (red, green, blue and yellow) support the children to build their web pages within a template, construct email and contribute to forums, create and upload images and use 'BB' codes (a subset of html) to hone their page display. The children also participate in a wide range of forums. These can be play orientated, such as telling jokes or role-play but can also be related to topic discussion, notably in the form of a "hotseat" where the children get to talk with an expert about their particular area of interest.

3 SuperclubsPLUS within a CHAT Frame

As a contained virtual community, SuperclubsPLUS is an ideal candidate for framing within a Cultural Historical Activity Theory framework. Blanton et al. [6] identified that a CHAT context is determined by five principles. The first CHAT principle is that human behaviour is social in origin; the second principle is that human activity is mediated through tools; the third principle is the centrality of communication in activity; and the fourth principle the meaning of values, beliefs, and normative expectations, is brought about by the process of objectification. The last is the principle that learning and development are incorporated in the activities of communities of practice (p. 438-440). An important consequence of the activity within the system is that this activity brings about change to the very structure of the environment. This means that rather than being a static construction in which the activity takes place, the system is organic, grows and changes as objects are achieved.

In SuperclubsPLUS these principles are clearly evident. The genre is social networking and the online environment provides powerful tools to facilitate social connections, embedded in activities provided for members. Online communication in the form of publication, forums and email is the conduit for all interactions in SuperclubsPLUS and "objectification" is evident in the construction of artefacts that members strive for, either displayed in personal web pages or published in communal spaces - the clubs. Learning and development are underlying concepts that drive SuperclubsPLUS. While learning is quite often informal and is initiated by the learner rather than an external influence, eg. a teacher, the collective growth of knowledge and content in SuperclubsPLUS truly establishes its status as a dynamic and vibrant activity system. In order to use the CHAT structure for analysis in this context, the SCP environment needs to be represented in the context of the CHAT triangle.

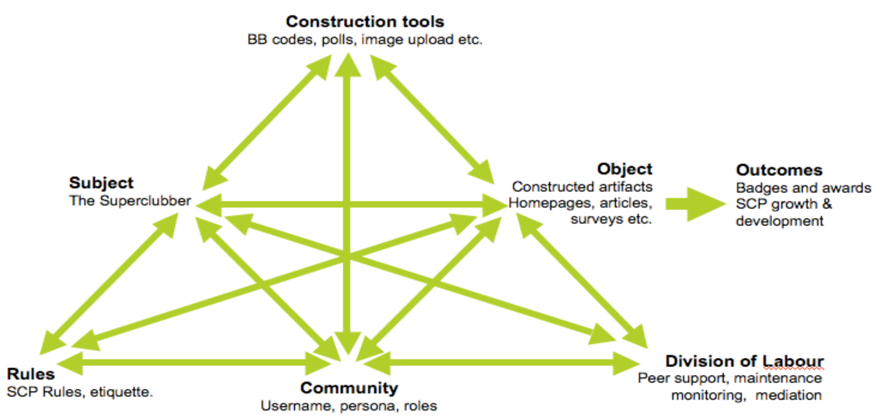

Fig. 3. The SuperclubsPLUS environment in a CHAT context

3.1 Subject

The subject is the participant in the community. In most contexts this refers to an individual but may also refer to a group [7]. In SuperclubsPLUS everyone who is subscribed to the community is a subject - a "Superclubber". While some of these participants may have roles beyond this base status, every subscriber has, by default, a password and a "My Home" space where they can build a profile. This means that every participant, including the teacher, can play the role of the subject.

3.2 Construction Tools

In some representations of the CHAT triangle, "instruments" are listed as "tools", "means", and "artifacts" or even mediating tools/means/artefacts [6]. In the SCP environment, "tools" probably serves as a better metaphor. The tools used for SCP could be considered on a technical level and include the computer or perhaps a mobile device such as an iPhone and the software, the Internet browser and the ICE engine1 that is used to power SuperclubsPLUS. For this analysis though, it is perhaps more valuable to consider the tools within the SuperclubsPLUS environment used to scaffold the Superclubbers' construction processes, nominally "construction tools". For this purpose we can include devices such as the edit mechanisms on the home pages, the BB codes that the students to publish text, quizzes, emails and checklists (that are used to trigger award processes), article and library upload mechanisms and forums.

3.3 Objects

"Object" refers to the object of the activity. It can means goals or purpose, often leading to the construction of an artefact. Roth [7] identifies that the object may represent a desired state where the subject works towards achievement. When the goal state is reached the object represents the outcome and the subject is able to set new goals bringing about change to their position and consequently changing the dynamics of the community, even if it is at a microscopic level. The SuperclubsPLUS environment provides a context where objects are tangible and accessible for community members on a number of layers. Although Superclubbers are not prescribed activity, the environment provides a wide range of activities, tasks and challenges where participants can work towards goals they select. Some of the objects in SuperclubsPLUS include the development of home pages that represent the owner in aspects such as hobbies, interests, musical and sporting preferences, achieving the Star awards and additional awards, creation of project pages and publishing of articles. Superclubbers can also set more immediate goals for themselves. These include outcomes such as making new friends via email, getting other Superclubbers to visit their page, and participating in one of the many forum activities where they can contribute to discussions on current topics and play in scenarios, such as the virtual pet shop.

3.4 Rules

The SuperclubsPLUS community is governed by a set of ten clearly defined rules. These rules provide a charter for all members of the SuperclubPLUS community and include codes of conduct to prevent intimidation or cyber bullying, aspects of cyber safety relating to sharing personal details (including passwords and contact information), engaging in unsafe practices on any website and respecting copyright.

The rules are used as the basis for mediation of interactions. Any communication is constantly monitored and the mediators will intercept any discussion or a publication that infringes the defined rules. Further, community members are asked to be actively involved in practising these rules and are encouraged to contact a mediator if they feel that the rules have been compromised.

In addition to the formal SCP rules, Superclubbers will encounter a number of processes and policies that they will need to abide by. These include aspects such as technical requirements, eg. the format and size of images, etiquette, such as only making a single entry per post in repetitive games (eg "count to a million") and publishing requirements for particular forums. In SuperclubsPLUS the rules and regulations of the environment help to shape a functional and dynamic society in which all members feel safe, valued and able to explore and build their understandings and confidence.

3.5 Community

In SuperclubsPLUS each community member has an icon that represents their online presence. Every member selects his or her own icon and this image can be changed to any icon in the library whenever desired. There isn't a problem with Superclubbers having the same icon and this happens quite often. In one forum it was noticed that two different Superclubbers had an identical icon - a flashing square with a logo reading, "I am unique"! The icon is always displayed next to the SCP username. Children are allocated their first name, the initial of their surname and a number that increments for the number of users with that particular combination. For example, AmyP82 is the 82nd user to have the first name "Amy" and the initial "P". Teachers are allocated their title and surname for a username "Mr Walsh", and they also have a small T symbol next to their name. A mediator is given their first name and their surname and has an M symbol.

While it is easy to distinguish between children, teachers and mediators, at the basic level all are Superclubbers and have a similar persona online. A Superclubber is represented by a homepage where he or she can post images and information and host polls and guest books. Each page has a user statistics bar across the top. On the left side, it displays the page title, username and icon and the affiliated school. It also has a gender icon; pink for girls, blue for boys, that can be activated if the user desires (see Fig 4).

When Superclubbers start out they have a single page to work with, however, as they earn stars and complete projects they can increase the number of page they can have to use. The status of a child Superclubber remains much the same while they increase stars, awards, page numbers and visitors to their page until they become eligible for the Tech Team. Children can apply to join the Tech Team when they have all their stars, have a well designed home page, have had over 200 visitors to their page, know the rules thoroughly and haven't received any warnings from the mediators for breaking the rules in the previous 6 months. When they achieve Tech Team status, a TT icon appears next to their username.

Fig. 4. Examples of the SuperclubsPLUS Profiles displayed on home pages

A teacher in SuperclubsPLUS has similar interactions with the SuperclubsPLUS tools and activities, with a notable difference in terms of communications. Teachers can email all students in their school but are not able to email children in any of the other SuperclubsPLUS schools. There are forums for teachers to talk to each other but teachers can't contribute to most of the children's clubs or forums. The only exception is the "Hotseats" forum where both children and teachers can post to the forum to ask the guest questions. A mediator is able to access all aspects of SuperclubsPLUS. They also have access to the mediator's area powered by the ICE Engine where email monitoring, image uploads and other mediating tasks are performed.

3.6 Divisions of Labour

At a cursory glance it may be possible to mistake SuperclubsPLUS as a "virtual school" environment where children interact with each other and adults - teachers and others - a space where adults tell children what to do. This, however, is a superficial perspective and does not reflect the true interactions in the space. In SuperclubsPLUS the children really own the environment. While mediators and teachers can suggest activity, the children decide on content, avenues of play and the communication they will have with others. The "work" that emerges through SuperclubsPLUS activity is primarily individual but often collaborative as children support each other to gain stars, critique each others web pages and participate in collaborative activities in forums. The division of labor is complicated, yet subtle and is allocated through negotiation, often scaffolded by the mediators. In this environment the teacher's role can be quite different.

The teacher may do fairly traditional roles such as maintain the school web site, which includes profiling the school and selecting children's work for publication. They may also check children's project pages and award badges for particular achievements. However, it is possible for the teacher to simply be a Superclubber, albeit a restricted member because they can't email to everyone who is online. In this situation the teacher is able to explore building pages, do their stars, complete surveys and complete special activities, just as the children do.

The mediator's role is more like a party host than a police officer. When a mediator is on duty, he or she is there for the Superclubbers. The duty mediator's name and photograph is displayed on the front page and they can be emailed with a simple click. Superclubbers can ask questions, report problems or simply have a chat at any time. The Duty Mediator also monitors the emergency bell. This is displayed on every SuperclubPLUS page and has priority over every other duty. The other roles of the duty mediator include monitoring the forums, approving image submissions, and checking emails. At busy times more than one mediator will be rostered on, and the duties will be shared, with the lead or "Heads Up" mediator orchestrating this process. Mediators are often online when they are not on duty. In these instances the mediator may be doing other roles like approving articles for publication or they can be working on their own skills and resources, basically being a Superclubber. At these times the mediator can choose to be "hidden" or "visible" to the children.

3.7 Outcomes

The outcomes in SuperclubsPLUS can be examined at an individual level but also at a community level. In terms of an individual, outcomes are represented iconically through the use of badges and awards (see Fig 5).

Fig. 5. Badges and awards on a SuperclubsPLUS homepage

These icons are truly representative of objects achieved because in many instances a Superclubber will remove a product once the award is achieved in order to reuse the page allocated on the home site. For example, a Superclubber must, amongst other things, upload a particular image of "egg on toast" to earn their blue star. Once the star has been awarded the image can be removed from the page. The object is no longer present but the outcome is evident through the blue star icon.

While the outcomes at a community level are less tangible, they are much more profound than the visual symbols as they represent the growth of the SuperclubsPLUS as a dynamic and vibrant community. Community outcomes in SuperclubsPLUS are represented by the transforming environment, created by the constant tweaking of functions, new activities and processes and better and more efficient ways to achieve the communities' desire for objects.

4 Summary

While Cultural Historical Activity Theory can be frustratingly multi-dimensional, the premise that activity cannot be understood without understanding the way artifacts are integrated through social practice [2] has been a useful principle for the studying the SuperclubsPLUS environment. The components of the CHAT triangle have provided an effective lens for examining interactions in the community and the mapping process highlights the complexities and the nuances in the roles, tasks and relationships in the community. For example, this frame has been used for examining the project as a mechanism to teach children about "cybercitizenship", where the potential of the adult mediation to develop online social behaviour, especially in the context of preventing cyber bullying, is discussed [8].

The mapping activity described in this report captures a moment in time for SuperclubsPLUS. Through the process of completing this task, the nature of the community as an organic entity becomes obvious. The community is constantly changing as Superclubbers explore new options, meet new people and achieve new goals. The SuperclubsPLUS production team is consistently looking for options to provide more material – construction tools and tasks for the participants and mediation mechanisms for the mediators. It is anticipated that the adults in SuperclubsPLUS, the mediators but also the teachers, will progressively become more experienced at working in SCP and therefore capitalize more on the educational opportunities provided. Conversely children in SuperclubsPLUS will become more skilled and sophisticated in their activity and it is likely the balance will change where more children take on the TechTeam role to support novice Superclubbers.

Regular mapping of the SuperclubsPLUS community within the CHAT framework will help to establish a familiar understanding for those who are working in the environment. This exercise will also contribute to our understandings of social networking, particularly in regards to children developing an awareness of practices and principles over a period of time.

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Using Text-Mining to Support the Evaluation of Texts Produced Collaboratively

Alexandra Lorandi Macedo[1], Eliseo Reategui[1], Alexandre Lorenzatti[2], and Patricia Behar[1]

[1] PPGIE, UFRGS, Av. Paulo Gama, 110 - Porto Alegre/RS - CEP: 90040-060, Brazil
{alorandimacedo,eliseoreategui}@gmail.com, pbehar@terra.com.br
[2] PPGCC, UFRGS, Av. Bento Gonçalves, 9500 – 91501-970, Porto Alegre, Brazil
alorenza@gmail.com

Abstract. This paper presents a collaborative writing system which has been conceived to be used by teachers as a collaborative learning tool in distance learning courses. Besides enabling students to communicate with each other and elaborate a text in a collaborative way, the system has an embedded text mining tool to enable teachers to extract graphs from student's writings. The graphs give teachers a concise view of the students' works by showing important concepts that appear in the texts. An extension course was organized in order to provide an initial validation for the collaborative writing tool. The experiments carried out during the course demonstrated the potential of text mining for the analysis of students' work. The experiments carried out as well as their results are presented here, followed by conclusions and suggestions for future work.

Keywords: Collaborative writing, text mining, distance learning.

1 Introduction

In the last few years the number of collaborative writing tools has proliferated, especially with all the services and interactive features made possible by the Web 2.0. At the same time, educators have realized the potential of such tools in learning activities. Among other advantages, the use of collaborative writing tools may increase group awareness, making group members more informed about other members' writings and more conscious about being engaged in a cooperative team work [1].

From a teacher's perspective, the possibility of getting students to work collaboratively through the use of computational tools is both attractive, from a learning perspective, and convenient: each student's progress may be monitored through historical records without too much difficulty.

However, although computational tools may store the steps taken by each student in the creation of a document produced collaboratively, the actual monitoring of each student's work is a very demanding task [2].

This paper presents ETC, a collaborative writing system which has an embedded text mining tool to enable teachers to extract graphs from student's writings. The graphs give teachers a concise view of the students' works by showing concepts and

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relationships that seem to be relevant. The tool has been evaluated in an extension course in which 9 students participated. The results achieved are presented and discussed in the last sections of the paper. The next section gives a brief overview of the collaborative writing tool ETC; section 3 presents the embedded text mining tool called Sobek, which is capable of extracting graphs from students' writings; section 4 presents the experiment carried out with the 9 students who used the collaborative writing tool during a whole month; section 5 discusses results, presents conclusions and directions for future work.

2 ETC: A Web-Based System for Collaborative Writing

The appeal of collaborative writing in learning activities is particularly interesting as the act of producing a text in a collaborative way can motivate writers to work in a recurring process of critique and re-elaboration of their work in the pursuit of better results [3]. The web-based tool ETC, designed and developed at the NUTED center, Federal University of Rio Grande do Sul, has been conceived specifically to be used by teachers as a collaborative learning tool in distance learning courses. ETC's main features are listed below:

- administration control to allow only registered users to access each text;
- simultaneous access to enable several users edit the same text at the same time;
- possibility to "lock" parts of a text in order to prevent other users from editing the "locked" portions;
- text mining feature enabling graphs to be extracted from students' writings;
- conventional text formatting functions.

Most of these features can be found in the majority of collaborative writing systems, such as the historical tracking of text changes, or formatting functions. But some of them are not so common, such as the possibility to block a portion of a text in order to prevent other users to change it while one is working on it. Such a feature is interesting specially when a text is being edited by several hands concurrently, and a user needs to work on a given part of the text without the intromission of others.

But the truly innovative feature of ETC is its capacity to extract graphs from the users' writings, giving teachers a brief view of the students' work. The next section presents Sobek, the text mining tool embedded in ETC, detailing its main features as well as its mining algorithm.

3 The Text Mining Tool: Sobek

Text mining can be defined as a knowledge-intensive process in which a user employs different tools in order to look for useful information from data sources through the identification and exploration of interesting patters [4]. While in the area of data mining these patterns are sought in formalized database records, in text mining the data sources are unstructured document collections.

Our text mining tool has been called Sobek, which comes from the Egyptian mythology where it represents a god of discernment and patience. Although Sobek can be used for the analysis of documents in different formats ("txt", "pdf" and "doc"), its development has been inspired by an actual need of university professors who work with distant education and who have to review a large number of texts produced by students. By presenting a concise view of a text, Sobek intends to provide clues about problems, or about the quality of a text, that can be recognized promptly. Sobek can be used in different ways. The analysis of plain text is Sobek's simplest operation. The text to be analysed can be copied and pasted in the tool or it can be loaded from a file. If the text is in a PDF or DOC format, it is automatically converted to the text format. The main goal of the text analysis is to extract concepts from the text and to visualize the graphical representation of those concepts and their relationships in a graph. Figure 1 shows a graph extracted from the five initial paragraphs of a Wikipedia text about global warming [5]. In the graph one may find important concepts that were extracted from the text, such as *global, warming, climate, change, surface temperature and greenhouse.*

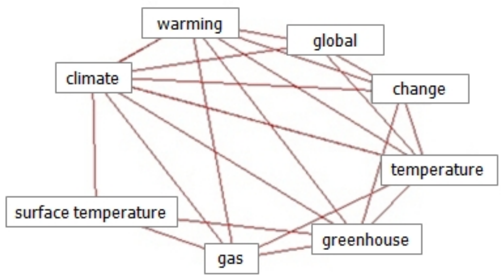

Fig. 1. Graph elicited from part of a Wikipedia text about global warming

Although the graphs cannot be used to reconstruct the original text, they may give a good notion of the main ideas and concepts considered. The use of graphs to represent relationships between objects and/or concepts can be justified by the fact that they are a form of abstraction that is widely applied and is easy to understand [6]. The next subsection details the text mining process.

3.1 The Text Mining Process

In our project, a particular text mining technique based on statistical analysis has been used to generate a graphical representation of the concepts extracted from texts. The information extracted from the texts is represented in a modified graph, based on a graph model proposed in Sckenker's PhD thesis [7], whose goal was to extract information from internet pages. He also proposed six different graph models to represent the information extracted from texts. One of these models, the *n-simple distance model*, was modified and used in our work to represent the texts. The *n-simple distance graphs* are based on the idea that each statistically relevant word of the text is going to be connected to the N subsequent relevant words. In Schenker's model, each node of the graph contains one single word. In the modified version created here, a node can have more than one word, so that it can express a more complex idea. For instance, figure1 showed a graph mined from a global warming text. Notice that there were nodes with one term (*e.g. climate, global, change,...*) and a node with two terms (*surface temperature*).

While other text mining approaches rely on the analysis of relevant morpho-syntactic patterns (such as Noun Noun, Noun Preposition Noun, Adjective Noun, etc.) in order to generate compound terms for the mining process [8], here we used a simpler method which was based on the frequency with which these compound terms appeared in the text. Our method relies on a parameter N to extract the compound concepts with more than one word. According to this parameter we create a combination of the current word with the N subsequent words. What we try to do is to create a wide combination of words to find the most frequent group of words that appear in the text. For instance, considering N=3, the analysis of the sequence of terms AA BB CC DD EE FF GG HH would lead us to the following combinations AA, AA BB, AA BB CC, BB, BB CC, BB CC DD, and so on. In order to avoid sequences starting with prepositions or articles, specific filters are used. After identifying the most frequent combinations of words, which we will call concepts, the mining process selects the most relevant ones based on their frequency in the text.

The next step is to compute the similarity between concepts. Consider two concepts a = AA DD BB and b = BB CC DD EE FF AA. The similarity coefficient is calculated with the scale product, in the same fashion used in Vector Space Models [9]. The similarity coefficient, represented by SC, computes the quantity of words present in both concepts represented by QB, and the quantity of words of the largest concept represented by BC. Therefore we have:

$$SC=QB/BC$$

In the example above SC=0,5 as the concepts have three words in common, words AA, BB and DD. Concept b, being the biggest, has six terms. After computing the value of SC, the relevancy coefficient RC is computed for each concept. The size of the concept (number of words) (NW) and the absolute frequency (AF) are introduced in the computation process. To calculate the RC for each concept, the following formula is employed:

$$RC=SC*NW+AF$$

The concept with the biggest value for RC is kept on the base, and at the end of the process, it is included in the graph. In the example above, let us consider that concept ***a*** has NW=3 and AF=3, and concept ***b*** has NW=6 and AF=2. We can conclude that concept ***b*** is going to remain in the base to be part of the graph, even if its AF value is smaller then that of concept v ***a*** In summary, when Sobek receives a text for processing, it breaks it down word by word and after that, it tries to single out the concepts that will compose the graph. After completing the analysis and before building the graph, a list of stopwords is used to remove articles, prepositions and terms with no meaning from the base of concepts.

4 Experimentation

An initial experiment was carried out in order to evaluate ETC and its text mining tool Sobek, focusing on their capacity to provide clues about the texts written collaboratively by students. An extension course about collaborative writing was organized by NUTED/UFRGS, as part of the research on the ETC project. Nine students participated in the course during a whole month. After learning the importance and the main features of collaborative writing tools, the students learned how to use ETC to produce collaborative texts themselves. However, they did not have access to the tool's text mining features. At the end of this period, the students were asked to produce a text on the topic "authorship". The texts produced by the students were analysed by an experienced teacher in collaborative writing, using the text mining feature, in an attempt to verify whether Sobek could really provide interesting clues about the texts written. The graphs below were extracted from the final texts produced by the students.

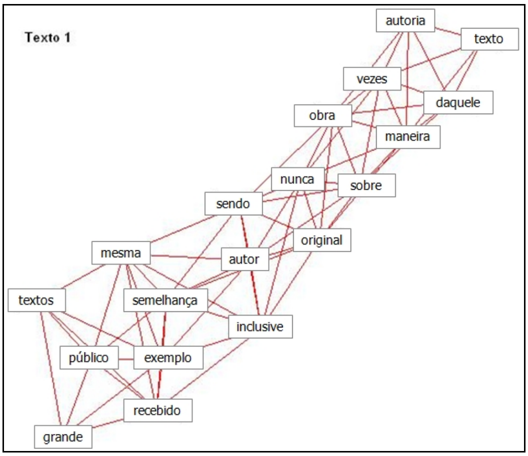

Fig. 2. Graph extracted from students' text – group 1

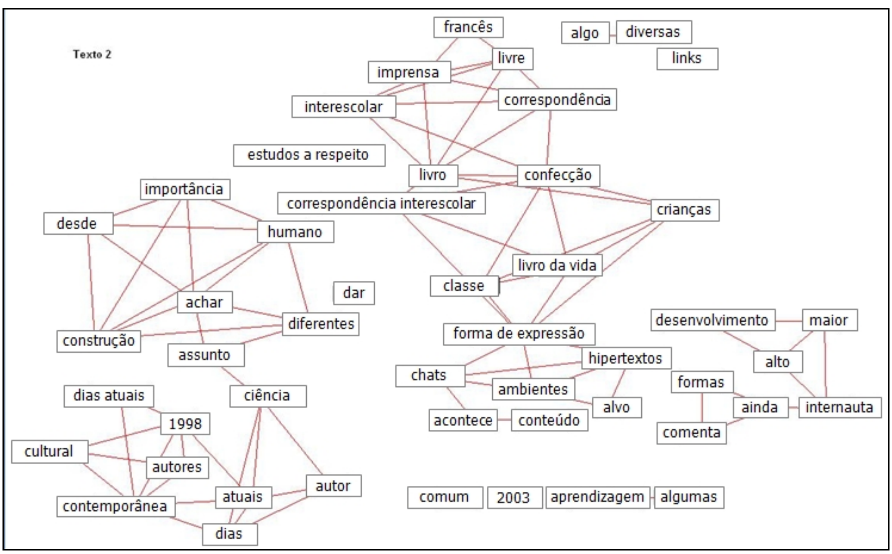

Fig. 3. Graph extracted from students' text – group 2

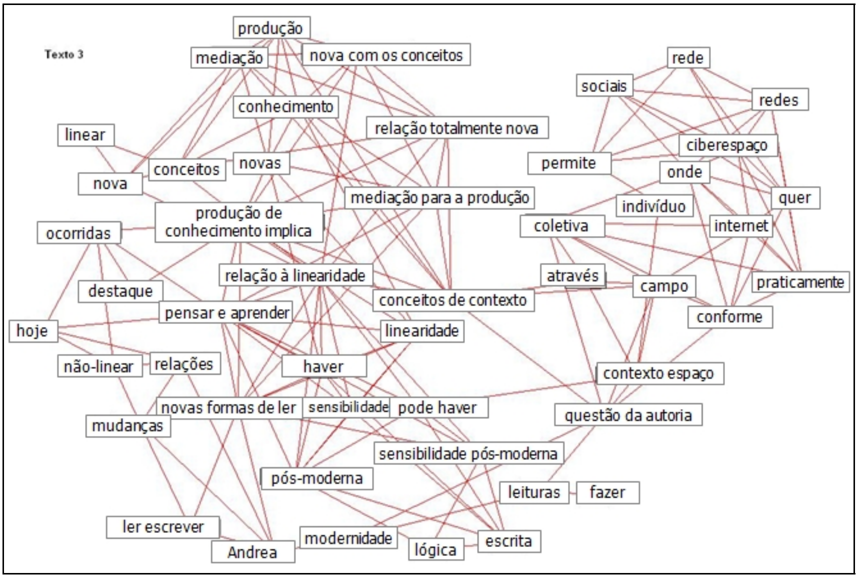

Fig. 4. Graph extracted from students' text – group 3

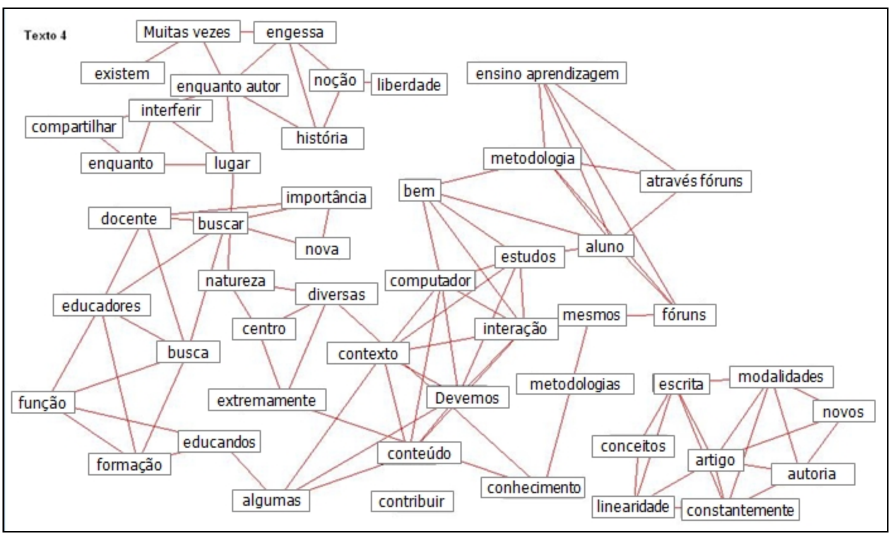

Fig. 5. Graph extracted from students' text – group 4

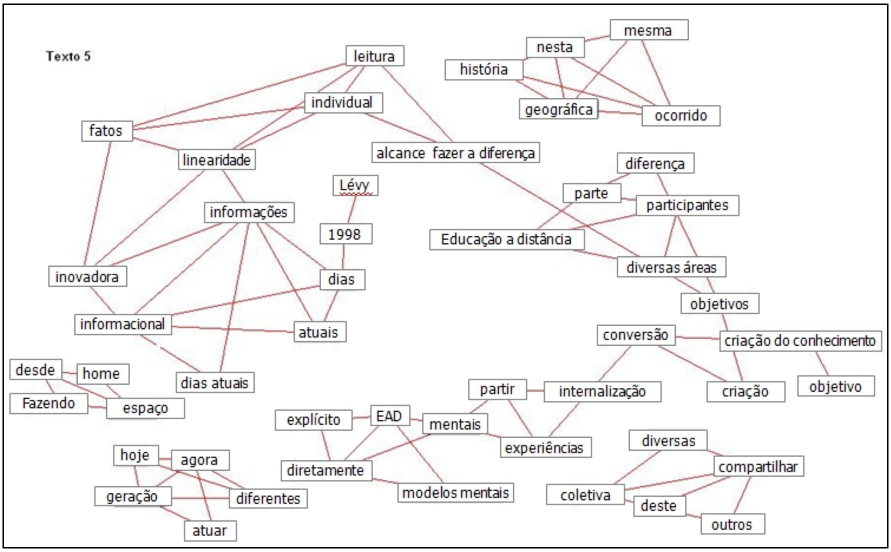

Fig. 6. Graph extracted from students' text – group 5

By looking at the graphs in figures 2 to 6, it was possible to say that they contained important concepts related to the central topic of the assignment, such as[1].

- Text 1: authorship, text, original
- Text 2: learning, author, construction, hypertexts, forms of expression
- Text 3: authorship, mediation, linear/non-linear, collective, individual, cyberspace, social, network.
- Text 4: sharing, educators, student, authorship, linearity, writing, forums, teaching-learning
- Text 5: authorship, individual, linear, innovation, distance education, knowledge creation, collective, mental models

It was noticeable in the list of terms above that the number of important concepts appearing in the graph of text 1 was much smaller than in the other graphs, which may signal out that text 1 did not discuss extensively other relevant topics related to the main theme. This hypothesis was later confirmed by the evaluation of the original text.

A further analysis of the graphs may show other characteristics of the texts from which they originated. For instance, graphs that were composed of smaller isolated terms and sub-graphs matched their corresponding texts where concepts were also treated in an isolated fashion. It was noticeable that these texts were created as a juxtaposition of paragraphs, and not as a fluid exposition of ideas and relationships between terms related to the central theme. In the examples presented, these smaller sub-graphs occurred more in texts number 2 and 5, where the actual reading of the documents confirmed that the connection between paragraphs in the texts were not

[1] The terms appearing in the graph, originally in Portuguese, have been translated here to make it easier for the reader to understand this section of the paper.

fluid. Text number 3, on the other hand, had a different and better writing style ,where the main concepts were considered and related throughout the text. The same can be said about text number 4, even if number 3 was the most consistent of all.

Considering this same premise, the graph extracted from Text 1 did not have isolated concepts as in the graph extracted from texts 2 and 5, but it also did not present significant terms related to the central theme proposed. A brief look at Text 1 was sufficient to demonstrate that the authors did not treat any subject in depth. The text spoke about the general theme proposed, and followed by presenting the interpretation and re-writing of the same subject by each collaborator, without bringing new information that related to the central topic.

In this sense, the text mining tool may provide positive and/or negative clues about a text, enabling the identification of problems such as: the need for further exploration of a given topic; the need to produce a text that is more fluid, and not only a juxtaposition of paragraphs that are not well connected.

5 Discussion and Final Considerations

The main contribution of this work has been to propose the use of a text mining tool embedded in a collaborative writing system, and to show how it could support the qualitative evaluation of written material produced by students. The results obtained from a preliminary evaluation of the system showed that the graphs elicited from the students' writings may show intrinsic characteristics of the texts that can lead teachers to further evaluate the students' work regarding certain problems, such as the need for additional development of a given topic, or the need to produce a more fluid text.

Another contribution of this work has been to propose an improvement in a known text mining process based on the use of graphs, as to produce more knowledgeable outcomes. While the original method generated graphs with one single term represented in each node, in our approach several terms could be placed in a graph node. It could be argued that by connecting nodes with words that appear together frequently in the text, one could represent concepts just the same way we do by placing them together in a single node. However, for the user who has to interpret the graph, it is more difficult to grasp the meaning of a compound term that is dispersed in different nodes, than if all of them were represented in a single node. A possible future development could be the comparison of other text mining techniques with the chosen technique based on Schanker's graph extraction. The idea of building a new text mining tool instead of using an existing application has been mainly because we wanted to develop some features that did not exist in other software, such as the capability of building a base of concepts from a set of papers, and getting the tool to consider only those concepts in the generation of a graph from students' writings. Besides, as we needed to integrate the mining tool to ETC, and to adjust many of its functions to our educational application, we understood that the best way to do it would be to build the application from scratch.

Natural Language Processing (NLP) is another approach that deals with textual data. Although it is easy for a human being to understand a document written in natural language, developing algorithms that can understand and extract the meaning of a document is a big challenge. Therefore, in practice NLP is frequently combined with statistical analysis in order to build more accurate systems for the understanding and the interpretation of textual data [10]. In our case, Sobek's text mining approach is based exclusively on statistical analysis, which has the down side of sometimes eliciting from documents terms that would not really be relevant. A possible solution is to work with a database of concepts previously formatted and to use a mechanism such as WordNet to take into account synonyms, as one may find nowadays in different application such as in text categorization [11].

Other known text mining methods group together terms in order to make more accurate concept extraction from texts, as in [8] where relevant morpho-syntactic patterns are searched for in order to create meaningful tokens. While such procedure relies on the some level of linguistic processing, our approach is much simpler in that it is based mainly on a statistical analysis of the frequency with which the complete tokens appear in the texts.

As in [12], it has been observed that the simple application of statistical analysis on small texts can, in many cases, produce undesirable results, and that's inevitable. In order to deal with this problem, a complimentary process of using a database of concepts before mining students' contributions is also being considered in the next version of Sobek.

The use of Sobek by students, instead of teachers, is another research that is starting in our group, which aims at verifying how students could benefit from automatically seeing summaries of their writings.

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PLME as a Cognitive Tool for Knowledge Achievement and Informal Learning

Tobias Nelkner, Johannes Magenheim, and Wolfgang Reinhardt

University of Paderborn, Germany
{tobin,jsm,wolle}@upb.de

Abstract. Since 2003 the research on Personal Learning Environments has increased. These environments support problem based, situated and informal learning in social networks within organisations and educational institutions and in subject related communities. The EU project MATURE [1] enhanced this idea with the concept of a Personal Learning and Maturing Environment (PLME), which shall support and foster learning and knowledge maturing. In this paper, we present a model that describes the maturing of knowledge and informal learning. Based on an example of changing a university study course, we present the personal, community and organisational perspective on knowledge maturing and informal learning. This leads to a derivation of requirements for a PLME implementation.

Keywords: Lifelong Learning, Open Flexible Learning, Informal Learning, Support Services for Learning, Knowledge Representation, Communication, Social Networks.

1 Introduction

There is a rapid change of contents, digital media and cognitive tools, partly in relation to teaching and learning methods in educational institutions and organisations, which demands a change in learning design. It also creates the need for a transformation from traditional structured into learning organisations. The required and necessary skills of knowledge workers (like students, teachers or lecturers) are capabilities in informal and lifelong learning. The introduction of ICT in education, for example, plays an important role in the development of informal learning processes. The main challenges are to gain access to new information and to perform rapid learning in situations of emerging problems. This comprises problem-based learning and situations of ‘learning on demand’. The knowledge achieved during classroom lessons in secondary and vocational education is no longer suitable for the whole working life. Furthermore, knowledge can only partly be conveyed by traditional courses in classrooms or training on-the-job. Therefore, it is necessary to support and foster abilities for problem-based learning and lifelong learning as core competences supported by ICT even in traditional educational institutions. In fact, the knowledge worker, such as a teacher or student, should be able to participate in necessary changes and communication within his or her (educational) institution as

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well as following his or her individual objectives in a better way. The community of researchers in the area of ICT based support of lifelong learning and informal learning in education has increased. For example, the IFIP Agora [2] initiative does research on several aspects (e.g. ethical, individual, organisational) of lifelong learning and establishes social networks of practicioners and researchers. Hence, the need has emerged to provide a social network with software that supports informal learning processes and fosters the transformation of organisations into learning organisations.

Therefore, the four-year large scale EU funded IP project MATURE, which started in April 2008 within the 7th. Framework Programme, aims to develop a Personal Learning and Maturing Environment (PLME). This concept should support the idea of informal learning and working processes within organisational contexts of both the individual knowledge worker and the communities of knowledge workers (e.g. lecturers). The maturing process has to be clarified in order to provide (informal) learners with adequate services for their knowledge achievement. Furthermore, the maturing of knowledge should be made recognisable, visible and analysable in order to realise a high degree of learning success, personal customisation and work efficiency. Hence, in this paper we present a model of different instantiations of knowledge, such as documents, interaction and competences. Based on this model, we describe the maturing processes of various instantiations of knowledge from different social perspectives. By analysing these maturing processes, we derive requirements for a PLME implementation, which shall support individual learning in the workplace. This includes personal customisation of learning objects, personal knowledge achievement and connection, and the visualisation of social networks. Therefore, PLMEs should aggregate and integrate the functionality of existing and new social platforms, such as, for example, wikis or microblogging.

This paper is structured as follows: after the introduction, the underlying theory of knowledge maturing is explained. This is supplemented by an example of a transformation process that is based on individual experiences of stakeholders in educational institutions. By describing the change of a university degree programme, the multiple social layers of the model will be illustrated in an exemplary way. Based on these considerations, section 4 of the paper presents the derivation of a subset of functional requirements for a PLME. These requirements enable the PLME to support workers like lecturers in learning processes. The paper concludes in section 5 with conclusions and an outlook on further research.

2 Knowledge Maturing and Instantiations of Knowledge

Knowledge maturing as described, in this section, occurs always in the individuals' mind. Artefacts and social interactions are observable externalisations of knowledge. Nevertheless, an individual not only acts for themself, but almost always in a community or an organisation. Therefore, these (abstracted) perspectives have to be considered too. In order to describe a knowledge maturing model that comprises learning from the personal, community and organisational perspective, it is useful to present the basic idea for the individual level. After this we will extend the concept of knowledge maturing regarding two other levels.

Figure 1 shows a model for describing the emergence of knowledge according to the theory of symbolic interactionism [3]. Two people with their own personal identity, and their own biography and personal attitudes communicate, each of them positioned in his or her social identity. These social identities may even overlap. The social identity relates to the different roles a person owns in a specific social context or within an organisation. The roles may be formal or informal and partly determine the behaviour, reactions, attitudes etc. of a person. Each person interprets the content of the communication by taking the view of his or her counterpart into account. By exploiting experiences, attitudes, knowledge and the interpretation of exchanged information, new knowledge can emerge within the consciousness of each person. This instantiation of knowledge that we call ***cognifact*** is closely linked to personal expertise as a result of formal and informal learning and communication processes.

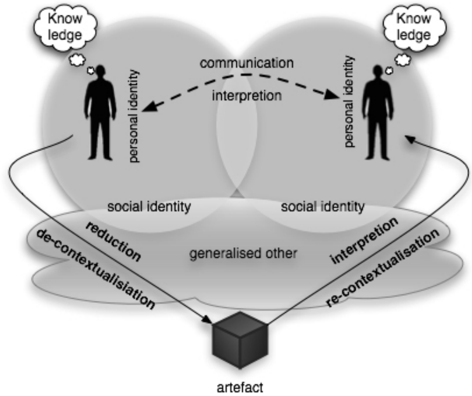

Fig. 1. A model for knowledge emergence

The other relevant strand is the creation of ***artefacts,*** another instantiation of knowledge. Artefacts are all kinds of reproducible physical or digital results of an externalisation process, e.g. books, digital media or written laws and serve as an external memory [4]. Creating an artefact goes along with the abstraction from the subject domain and therefore is equivalent to a process of de-contextualisation of the content. By writing a paper for example, we often abstract from the reality-oriented scenarios we have in mind and generalise concepts from a concrete context into an adequate, but more abstract form. The result is a paper with de-contextualised content, which can become persistent and can be transferred to someone else. Therefore, the availability of artefacts is essential for sustainable knowledge maturing, which includes a process of re-contextualisation of the content by an individual. For example, if a person reads a book he or she interprets it with previous knowledge and may gain new knowledge within a different context. This re-contextualisation goes along with a possible blurring of the intented meanings of the book's author. Blumer [3] states that every action and behaviour always involves earlier experiences and knowledge. Therefore, the maturing of knowledge is contextually bound.

Furthermore, knowledge is not only represented in artefacts, but also in social interaction. Social interaction is usually guided by social norms and rules and is observable. This aspect provides a third instantiation of knowledge, the ***sociofacts***. Individuals, who are communicating with each other, take into account the possible expectations of their counterpart. The generalised other is an abstract concept of normative mutual expectations and perspectives depending on the different roles and attitudes of the communicating partners (see fig. 1). The concept influences the de- and re-contextualisation process by social norms and regulations. Moreover, social interaction leads to the creation of such rules. Since they are individually constructed they are part of the cognifacts while social relevant action and interaction of individuals on the basis of existing rules are assigned to the sociofacts. The unwritten rules of communication are informal, partly imprecise and not sanctioned by law. Nevertheless, assigned social interaction as sociofacts can lead to the maturing of laws and job-related rules. The outcomes of those processes like manifested rules and regulations are artefacts.

As shown above, knowledge maturing is not restricted to personal knowledge or artefacts, but also happens within social collaboration. Moreover, these three elements are firmly interlinked with each other. The technological triangle [5,6] shows the connection between the three knowledge instantiations: artefacts, sociofacts and cognifacts (see figure 2). Unlike Engbring [6] we consider attitudes, norms and rules as parts of the cognifacts. Cognifacts may lead to new artefacts and sociofacts, whilst these on the other hand influence individual knowledge in form of cognifacts. As individuals are co-operating in communities and organisations, cognifacts may also be assigned to communities and organisations as an abstraction from the individual perspective.

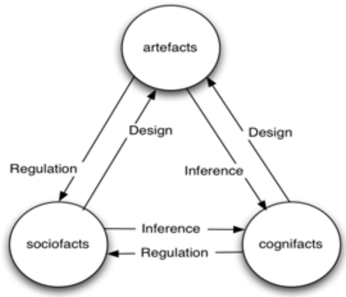

Fig. 2. Dependencies between knowledge instantiations

We will examine these mutual dependencies by means of a Learning Management System (LMS). The increasing availability of LMSs has led to more computer-based communication and collaborative learning as a relevant sociofact in the area of E-learning. Individually achieved competences and qualifications are cognifacts and basically describe the ability to change one's behaviour as a result of sociofacts and the re-contextualisation of artefacts. Finally, on the content level, a LMS provides access to learning objects as a relevant instantiation of artefacts. Occuring mutual dependencies between the three instantiations might be: Good quality learning materials (artefacts) provided by the LMS may increase it's usage by students, which may also mean that communication facilities of the LMS are more intensively applied. The artefacts help to gain new competences (cognifacts). Sociofacts are created by more intensive use of the communication facilities. Furthermore, by mutual dependency the creation of sociofacts also regulate the creation of cognifacts. This accounts for student's competences (cognifacts) as well as their social interaction (sociofacts). Students' feedback to the tutors, given via the LMS, may after all contribute to the improvement of the quality of the learning objects (cognifacts). This approach seems to offer a proper explanation for the relevance of individual and collaborative learning within the process of knowledge maturing. Furthermore, it provides a concept for knowledge maturing that includes not only a personal perspective, but also takes community-related and organisational perspectives into account. The following section of the paper associates the model's personal dimension of knowledge maturing with the perspectives of the community and the organisation.

3 Social Perspectives of Knowledge Maturing

As the model shows, knowledge maturing and informal learning depends not only on individuals, but also on societal influences and co-operation. Co-operation is an important fact within communities and organisations like universities. But working and learning in such co-operative environments shifts the perspective from the individual to the community and the organisation. Therefore, in this section the process of knowledge maturing from these three different perspectives by the means of the emerging transformation of a university study course is explained. In contrast to the personal perspective, which focuses on the acting person itself, the community perspective describes the results of informal (and probably not pre-defined) inter-personal interaction and more specified workflow processes. Furthermore, the organisational perspective focuses on interaction and processes aiming at the achievement of organisational goals. This includes organisational guidelines, well-defined processes or regular vocational trainings. These three perspectives do not include grading. They are equivalent, but provide different levels of knowledge maturing description. The process of change-management for a study course will give a more concrete example for these perspectives.

Table 1. Impact of the knowledge instantiations on the different layers

		Levels		
		Personal perspective	**Community perspective**	**Organisational perspective**
Knowledge instantiations	**Artefacts**	(1) Personal documents, learning materials	(4) Co-operatively created, compileddocuments, e.g. E-mails, Blogs, Wikis	(7) Authoritative documents, e.g. study guidelines
	Cognifacts	(2) Personal knowledge, experience, attitudes, norms, beliefs	(5) Individual perspective on communication and co-operation networks in a community	(8) Individual perspectives on communication and cooperation networks in an organisation, HRM
	Sociofacts	(3) Individual action with regard to social norms, realised learning strategies	(6) Activities of community members according to co-operatively created (non) formalised rules	(9) Interaction for change management, application of exam regulations

Assuming, a professor has realised that his course is not up-to-date concerning the content and that some procedural aspects lead to disadvantages for the students. Therefore, he initiates talks with his colleagues, which results in a change in process and in a restructuring of the whole study course.

Table 1 shows a matrix, which depicts the different knowledge instantiations from the three perspectives. A starting point can be the set of personal cognifacts. A professor has gained experiences with his courses and understands the different positive and negative aspects concerning the structure of the study course (field (2) in table 1). He has gained this knowledge in talks with other lecturers that made him aware of other concepts organising a study course (3). Consequently, he starts to change his course material with new research findings and, therefore, creates personal artefacts (1). Then, he starts talking about the assets and impacts of possible changes of the study course with fellow researchers or colleagues (mainly) from other universities. By expressing these ideas, he conveys his opinions and new ideas into the community. This can be done by writing e-mails ((4), creating artefacts) or during a round table discussion (sociofacts). As one possible result of the exchange of experiences and the discussion about the problems, the community may develop rules to handle the known problems (artefacts). While the talk and social interaction in the university are sociofacts (6), the emergent knowledge and its internalisation by the participating staff is described by cognifacts (5). As an abstraction, the community builds upon this knowledge as it emerges in its context. Consequently, every person builds his own knowledge. This is for cognifacts the same as for sociofacts and, therefore, these fields are greyed in the table. During this process of 'learning' within the community new artefacts can emerge. These might be e-mails or a common application to the administration, which represents a new concept and asks for a change process of the existing study course. On this level, also a personal generation of cognifacts and artefacts (1,2) will take place, but these processes of knowledge achievment are included in the co-operatively created document, which describes the concept of the revised study course (4).

After having made the application for changing the study course, the knowledge and experiences of the community have to be conveyed at the organisational level. Its members need to communicate with the responsible administration and present their problems and possible solutions to convey the knowledge (8). For example, the IFIP provides a recommendation like the UNESCO curriculum for the use of ICT in education and the community uses this to achieve their objectives in negotiations with the administrators. Those administrators have to decide in which way, with which capacity and budget, the new study course could be organised. The maturing of knowledge at the community and organisational level does not show much difference. Both create experience and cognifacts in the minds of the participating people. Therefore, the two boxes (5,8) are accented and assigned with a special role. But they differ in their objectives of knowledge creation and types of learning. At the community level most of the topic-related aspects can be discussed within the social network without any consequences. However, at the organisational level decisions must be put into practice considering the consequences for the organisation.

Once, the project has been accredited by the administration, all stakeholders have to develop plans and strategies for implementing the change process (9). The emerging artefacts at this level are documents, which contain and present the authoritative rules, such as the new study guidelines or examination schedules (7). These documents describe the future interaction and workflow in the future study course and are, thus, related to the sociofacts at the organisational level.

The knowledge maturing process affects different elements at different stages of the matrix shown above. With the lessons learned and newly achieved knowledge, cognifacts are created at the personal level, aggregated and improved at the community or organisational level. Sociofacts at the personal level may mature as results of interaction within the community level. Furthermore, sociofacts at the organisational perspective change with the given manifested rules.

An individual's effect on co-operatively generated cognifacts and sociofacts at the community and organisational perspective depend (besides his or her precognition) also on the persons role in a community or within an organisation. For example, a professor can act for change in the community in a different way. However, as he participates in change management at the organisational level, he is also part of the administration and has to consider different aspects. The study guidelines for the new study course will not be completely new, because positive experiences of former guidelines will be adopted. Knowledge maturing and process maturing is clearly recognisable at all these levels.

The example of an emerging change process in an organisation shows the dependencies between the different levels and the impact on the knowledge instantiations at the same, or adjacent, levels. The importance of informal learning for the generation of artefacts and sociofacts at the personal and community level emphasise the need for support by a Personal Learning and Maturing Environment. Based on this example section 4 derives requirements for the implementation of such an environment.

4 Resulting Requirements for a PLME

The idea of a PLME is drawn from further research in the field of Personal Learning Environments (PLEs) [7]. Personal Learning Environments should support and foster informal learning in social networks. Furthermore, the concept of PLEs concentrates on a self-organised learning environment and so the PLME will, too. This results in an implementation of loosely coupled tools and services that the user can organise and accomplish as he or she likes, or as his or her current task requires. Working with widgets in iGoogle is one example of a possibility to create a PLE. Some disadvantages of this application include persistence and sustainability. To overcome such barriers, a framework has to be designed, which is able to serve as a container for the tools and which supports interconnection and communication. The expected functionalities of such a set of tools are not only useful for teachers or tutors, but also in many cases will be important for the learners. Table 2 depicts functionalities that support the creation of the knowledge instantiations described above.

At the personal level the most important aspect is the personal knowledge achievement. For example, the creation of slides for a course requires the aggregation of knowledge from different sources (see table 2, field (1)). The challenge for a PLME is providing instant access to contextually relevant documents. In this way, a professor for learning design needs fast access to media objects dealing with various educational concepts he or she has to convey to his or her students. This can be achieved by a personal ontology, which serves for purposes of storing and organising the individually available material in a knowledge base (1). This ontology can be the result of an evaluation of customised cognifacts generated and used by the professor. The construction of the ontology should not only be the task of the user, but a semiautomatic process. This can be realised by an automatic metadata extraction and a semantic analysis of the artefacts, which are of relevance to the user. The semantic analysis could end up in a classification for a contextualized ontology. Together with the classification of documents, an efficient search engine has to be provided. This can be based on the extracted metadata combined with the information of the ontology. When enhancing the private desktop for knowledge achievement in this way, the search for information in

Table 2. Derived functionalities for a PLME

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Levels</th></tr>
<tr><th>Personal perspective</th><th>Community perspective</th><th>Organisational perspective</th></tr>
<tr><th rowspan="3">Knowledge instantiations</th><th>Artefacts</th><td>(1)
- Personal databases, individual lightweight ontologies</td><td>(4)
- Collaborative tools (chat, wikis, blogs)
- co-operative authoring tools</td><td>(7)
- Task and process related database, personalized FAQ</td></tr>
<tr><th>Cognifacts</th><td>(2)
- E-portfolios
- unified online profile or CV, APML</td><td>(5)
- Visualisation of expertise, social networks
- expert recommending</td><td>(8)
- same as (5), competence management, HRM systems</td></tr>
<tr><th>Sociofacts</th><td>(3)
- ToDo list, diary, PIM</td><td>(6)
- Evaluation of group behaviour in order to derive unwritten rules, interaction structures</td><td>(9)
- Tools for support of process and change management</td></tr>
</table>

the internet should be contextualised also. Thus, the user will be provided with further and more concise artefacts he or she is looking for.

As shown above, artefacts are not static over time, but mature. Therefore, a permanent versioning of the artefacts should be available (1). This function can serve several aspects. First, this would preserve the state of the artefacts. Furthermore, sustainable access is given, which provides the possibility to analyse the data within the overall database and might show connections between several artefacts. It would also be possible to support ontology maturing by assigning tags and logical rules to the cognifacts. Moreover, the creation and change of cognifacts can be achieved by developing a representation of the user's competences and attitudes (2), for example with an e-portfolio and the Attention Profiling Markup Language (APML) [8]. Supporting sociofacts on the person-oriented perspective can be achieved by fostering the interaction with people of the community or organisation. Thus, a to-do-list and a diary help foster this. Endowed with these functionalities, a PLME provides knowledge maturing mainly at the personal layer.

Regarding the community layer, the main challenge is to provide access to the user's social network. The most important aspects are realising the connection between artefacts and their authors, plus providing communication channels. For example, searching for a specific topic in e-mails is often undertaken by searching for an author we define to be an expert in this topic area. Once the e-mail has been found, it is easy to get into contact with the author in order to obtain more information about the subject (5). In the same way the possibility to get in contact with the author (or editor) of a document can support discussions and, therefore, fosters learning (4). For example, this can be achieved by starting a chat session or a phone call about the document. Additionally, the user needs some kind of visualisation of these networks. On the one hand, the visualisation of a social network and the topic-related communication (e.g. via e-mail) between its members can indicate knowledge about experts and expertise within a community (5). On the other hand, combining a topic network (which exists between the artefacts) with a social network helps to get new comprehension of the knowledge and the relations of members of the social network.

Tracking the behaviour of the users in various situations can support the sociofacts on this level by detecting unwritten rules. For example, a community agrees to use a special tag in the subject of the e-mails concerning a special topic for faster recognition of the e-mail's context. By analyzing the e-mails of the community, this rule could be detected. In order to support these sociofacts an e-mail client could recommend this tag every time the user writes to this community (6).

The organisational level includes the view on the aspects and processes of the overall organisation. This comprises mainly the support of formal processes, tasks and workflows, e.g. in the community perspective, the cognifacts on the organisational level can be supported by visualisations of social networks and expert recommending systems (8). This information can be used to get support e.g. when writing an article, but may also be integrated as an extension of a competence management system that allows to classify the knowledge workers according to their competences. The artefacts of the organisational level mainly consist of all formal documents an organisation, like a university has to manage (7). This includes information material for the students and lecturers, but also those related to the finance department and others. A process and task related management of these types of documents and an individually role-dependent view on these artefacts might ease the access to relevant knowledge. A lecturer, for example, only needs to have access to the study guidelines or rules for executing exams. However, an employee in the finance department needs access to different sources for processing the job. Therefore, a PLME has to provide a role-dependent personalized view of the artefacts at the organisational level and thus can contribute to the improvement and acceleration of tasks and workflows by triggering them to obey the lessons learnt. Sociofacts at the organisational level are represented by the organisational processes and change management (9). In our example, it could be supported by a tool that allows a view on the current status of the implementation of the new study course. Moreover, the lecturers that are involved in this process should have the possibility to (collaboratively) change the process. Communication facilities are also needed for this purpose to support tools for the negotiations between stakeholders.

Although we provided a list of functionalities, which shall support and foster informal learning within a PLME, there is not always a clear distinction between the separate fields of the matrix of social perspectives and knowledge instantiations. On the one hand, this is because the different perspectives depend on the context and the role of a knowledge worker. On the other hand, the transition from one perspective to another is not always strict and, therefore, the impact of such functionalities may affect several fields of the matrix in table 2. Nevertheless, some fundamental services, which should be provided by a PLME, were identified.

5 Conclusion and Outlook

Obviously, this is not a complete list and especially the connection between these functionalities has to be investigated further. Furthermore, the realisation of some of these functionalities is critical and hard to implement. For such sophisticated functionalities, it is indispensable to provide a capable server structure. However, this theoretical founded concept of a PLME depicts a roadmap for fostering and supporting informal learning within (educational) organisations. Furthermore, we have to state that PLME-supported informal learning can initiate and accelerate organisational changes. Moreover, it might help to transform them from a traditional structure into a learning organisation. The illustrative case of a PLME used in this paper provides one approach in which to achieve these goals. Nevertheless, it is noted that the role of the organisational perspective has to be explored in more depth. The most important next step will be the implementation of prototypes to evaluate user acceptance.

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Growing a Peer Review Culture among Graduate Students

Vinícius Medina Kern[1,2], Osmar Possamai[1], Paulo Mauricio Selig[1], Roberto Carlos dos Santos Pacheco[1], Gilberto Corrêa de Souza[1], Sandro Rautenberg[1,3], and Renata Tavares da Silva Lemos[1]

[1] Universidade Federal de Santa Catarina (UFSC), Programa de Pós-Graduação em Engenharia e Gestão do Conhecimento (EGC), Brasil
{kern,possamai,selig,pacheco,gilberto,srautenberg}@egc.ufsc.br, renata.lemoz@eletrocooperativa.org
www.egc.ufsc.br
[2] Instituto Stela, Brasil
www.stela.org.br
[3] Universidade Estadual do Centro-Oeste (Unicentro), Brasil
www.unicentro.br

Abstract. Usual processes for pursuing education excellence in a graduate[1] program are candidate selection, coursework, research, and thesis defense. This paper is an experience report on a complementary approach: the growing of a peer review culture among graduate students. We instruct first-year masters and doctoral students on principles for preparing a thesis proposal. Students present their proposals in collective discussion sessions with feedback from professors. The students then submit their proposals through a web interface and are instructed on the role they will play next – of anonymous referees of their peers' proposals. The referee reports and general statistics are made available to all participating students and advisers. Updated proposals are submitted to an annual workshop open to all participating students and advisers. About 60 students take part in this annual series of seminars with peer review and workshop, generating individual thesis proposals and 180 referee reports, 3 for each proposal. Students and their advisers receive detailed feedback on individual participation as author and referee. The main strength of this experience is the opportunity to assimilate the techniques of objective criticism and to reflect about the quality of own and others' work. The paper outlines future research and development issues.

Keywords: Research, Culture, Assessment, Knowledge Society, Higher Education.

1 Introduction

A graduate program is a school system that conducts research and educates new researchers – the graduate students. Common processes for pursuing education excellence are candidate selection, teaching and coursework, research (conducted by

[1] We use the North-American terminology 'graduate', the same as the British 'postgraduate'.

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students under supervision), and thesis defense. Those processes require individual efforts from the students (such as in the writing of a proposal for candidate selection) and also establish vertical relationships (as in advising and defending in front of a committee) and horizontal relationships (as in student teaming for coursework). In this paper, we introduce our approach to a complementary process aimed at the collective level: the growing of a peer review culture among graduate students.

The research object of our Graduate Program in Knowledge Engineering and Management (KEM), started in 2004, is “knowledge as a production factor”[2]. KEM confirms the predictions by Angelov, Melnik, and Buur [1] that “an increasing number of very strong students will look for a multidisciplinary education”: our annual admission has attracted between 322 and 423 candidates for about 60 no-scholarship openings, since 2004.

Given the intrinsic interdisciplinary character of the research object, our program runs the risk, as pointed out by Bunge [2], of being “multidisciplinary, hence potentially dispersive, rather than interdisciplinary, hence cohesive”. Interdisciplinarity requires excellent communication.

The need for enhancing communication was one of the motivations for our first annual workshop in 2004, after only 6 months of existence, in which the students were asked to present their thesis proposals. From 2005 on, we established research seminars in preparation for the workshop, including the peer review process discussed in this paper.

In the next sections, we analyze our graduate education system under the systemism of Mario Bunge and we give a concise account of the method used for the method used for the peer review of thesis proposals. Results of this approach are presented. Finally, we discuss the outcomes and open research and development issues, including instrumental ones, for instance automating some knowledge-intensive tasks, and also methodological issues such as connecting the seminars with a new mandatory course on the scientific method in order to strengthen students’ preparedness to provide objective, professional criticism.

2 A Systemic View of Graduate Learning

According to a systemic worldview [3], “systems have systemic (emergent) features that their components lack” and everything is a system or an actual or potential component of a system. We outline our graduate learning environment using the CESM model [2], according to which any concrete system σ can be modeled as $\mu(\sigma) = \langle C(\sigma), E(\sigma), S(\sigma), M(\sigma)\rangle$, i.e., the list of the system’s composition, environment, structure (bonds among components and between those and items of the environment), and mechanism (the process(es) that makes the system tick).

Figure 1 illustrates our model of graduate learning system: the components (inside the ellipse) are students (S) and professors (P). The environment includes (clockwise from upper right) the laws and regulations that affect the graduate program (R), the academic community of the Brazilian graduate education system (A), the host university, its departments and staff (U), funding agencies ($), other organizations (O), and the culture in which the program is immersed (C).

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[2] In: Interaction of the Program’s research areas in search of the research object (in Portuguese), http://www.egc.ufsc.br/htms/vermais_index.htm

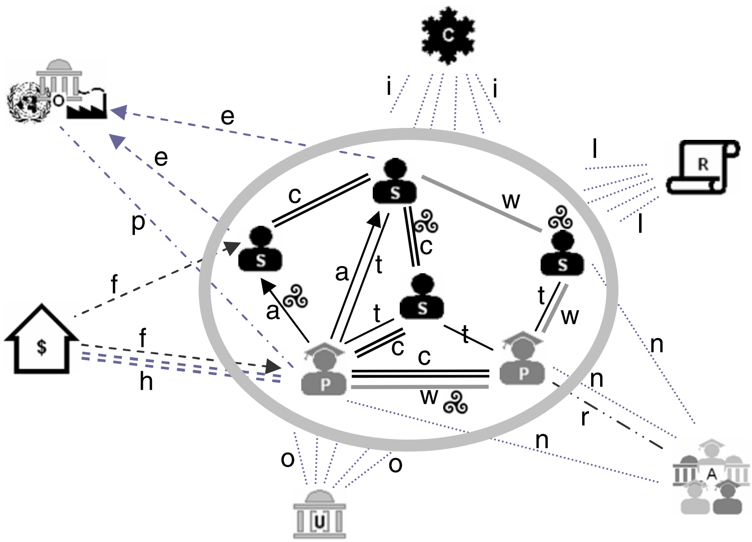

Fig. 1. A CESM diagram for a graduate education system

The endostructure – the bonds between components – are chiefly relations of advising (a), teaching (t), cooperative work in publications and projects (w), and communication (c), including messaging, conversation, collaboration, argumentation, feedforward (coaching), and feedback. The exostructure – the bonds between components and environment – comprise the subjection of all components to law and regulations (l), the reputation (r) and networking (n) relations of some components with the community, organizational ties between all components and the university (o), the funding from agencies to components (f) and their service as experts and ad hoc referees for the agencies (h), partnership (p) and employment (e) relations between components and several organizations, and the cultural influence (i) that flows to and from the academic community.

The mechanism is a process that generates qualitative novelty [4], i.e., a process that drives or blocks its transformations, including the emergence or submergence of the system or some of its properties. As Bunge teaches, most mechanisms are concealed and have to be conjectured. In our current conjecture, we devise four main mechanisms for graduate education excellence, each one represented by a triskelion in Figure 1:

1. Study and research. This seems to be the most important mechanism of all, performed by each student under influence from and communication with adviser, professors, and colleagues.
2. Advising. This establishes a vertical relationship – the student, who has research interests and passions, is supposed to learn from the adviser, who also has interests and passions, but more experience.
3. Cooperative work in publications and projects. This sets a horizontal relationship in which the student is expected to learn from others through the sharing of knowledge and good practice, besides establishing a reputation

about his competence to deliver research results – something beyond pure cognitive learning.
4. Communication. Not any communication, but the exchange of scientific ideas grounded in strong directives of objective criticism and argumentation, thus establishing a culture, at the collective level of the graduate education system.

Note that, by this choice of mechanisms, we leave out other alternatives such as candidate selection or thesis defense (considering that we don't rely on these processes to 'make the system tick'), or the obtaining of funding (not a mechanism, since funding per se doesn't operate the transformations we look for). Note also that the first mechanism works by transformations at the component level (student), while mechanisms 2 and 3 depend on transformations in small groups of components and their bonds. The fourth mechanism, as we stated it, is a communication culture involving all students and their communication bonds.

The first three mechanisms are object of deliberate action by most if not all graduate programs. The fourth is usually taken for granted like a consequence of individual and small-group actions, a "Hidden Hand" that we little can do about. We decided to deliberately approach the enhancement of scientific argumentation and feedback among the graduate students. This approach is presented next.

3 Approach to Growing a Peer Review Culture among Students

Peer review in education has been practiced by the first author of this paper since 1997[3]. Kern, Saraiva, and Pacheco [5] discuss its motivation in terms of collaboration, written expression, critical thinking, and professional responsibility. Several other scholars around the world have also practiced it in engineering and computing settings, e.g., [6-14].

Our graduate research seminars started in 2005 as a series of 8 four-hour meetings along the school year, with a peer review of thesis proposals, culminating in a workshop in which all first-year students present their proposals. The seminars are mandatory for first-year students, with no credits or grades. The peer review has been conducted in a double-blind manner, in a single round (although we may experiment with more rounds if funding becomes available). The seminars have the following objectives:

- For the students:
  - To know the essential parts of a thesis proposal, then re-elaborate the proposal presented for entrance in the graduate program and participate in a peer review round.
  - To develop competence to give and receive professional, objective critique of scientific work.
- For the graduate program:
  - To create and disseminate a culture of objective, interdisciplinary scientific criticism.

[3] An account of the objectives, publications, and practice is given in "Project PAR: Educational Peer Review", in http://kern.ispeople.org/par_en.html

- To serve as catalyst of the advising process.
- To stimulate interdisciplinary scientific interchange.

In order to fulfill those objectives, students needed individual guidance for writing and critiquing the proposals; otherwise the peer review process would be just an exchange of opinions and uneducated guesses. In our young, *multi*disciplinary graduate program, the worldviews and methodological approaches among advisers are very heterogeneous (i.e., we are not *inter*disciplinary yet). The building of an agreement over our interdisciplinary methodological approach is still in its early stage. Therefore we adopted *one* set of guidelines for the introduction of a proposal that had been successfully in use by the second author of this paper.

That set of guidelines was turned into a template for use by the students to write their proposals, although we decided to omit any methodological aspect since this issue was seen as conflict-prone in a setting of about 40 advisers with varied backgrounds and very little time to work out an agreement that could serve all. The elements of the proposal had minor changes in these 4 years; the basic structure is: Motivation, Problem statement and/or question, Objectives, Relevance, Scope, and Main references.

Another challenge was to choose the software to support the peer review process. Following personal experiences with conference management interfaces and the summaries of Snodgrass[4] and CommunityWiki[5], we've found that all conference systems were too ill-adapted for the task. We chose the Open *Journal* System (OJS[6]) for two main reasons: it is a very successful and widespread interface, and it permits attaching a file to the referee report. This allowed us to build a spreadsheet template of a referee report with some fixed parameters and data ranges – for instance, we included in the template self-declarations of (i) expertise in the topic of the proposal (to give a sense of how sure is the critic about specific remarks made), (ii) research area of the referee – Knowledge Engineering (KE), Knowledge Management (KMa), or Knowledge Media (KMe), and (iii) graduate level (doctorate or masters).

Student preparation involved instruction on proposal writing during the first seminars. Additionally, students are required to discuss their proposals with their advisers. Following that, we run a series of seminars (typically three 4-hour sessions) in which about 1/3 of the students have the chance to present and get instant feedback from usually 2 professors (frequently this paper's authors, but with more participants in 2007 and 2008) and occasionally also from colleagues. The feedback focuses on the internal coherence of each proposal's items (e.g., whether the research question is indeed a research question) and on the relational coherence between them (e.g., whether the objectives are compatible with the research question).

The professors who give instant feedback pledge not to judge and not to advise (that's the adviser's work, after all). They only address the form, not the merit of the proposal (because the conditions to engage in a collective, profitable debate on merit

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[4] Summary of Conference Management Software, by Richard Snodgrass, 1999. http://www.acm.org/sigs/sgb/summary.html

[5] ConferenceManagementSoftware, software to help organize a conference, last edited 2006-01-18. http://www.communitywiki.org/cw/ConferenceManagementSoftware

[6] Open Journal System, an open source initiative from the Public Knowledge Project from Canadian and American universities. http://pkp.sfu.ca/?q=ojs

are still far from ideal). The discussions are limited to some student proposals, with scarce time, but the goal of these sessions is not to achieve a complete analysis of each proposal. Instead, these sessions should allow students to grasp the principles of objective, rigorous, professional criticism.

With the experience gained in presenting and receiving feedback, or merely in watching colleagues in that situation, the students refine and submit their proposals through OJS. The next step for the students is to give feedback to their colleagues on their thesis proposals. There is instruction on the task of the referee [15]. The first author shows the referee reports for his first actual international submission for illustration, to give the students a sense of the concrete experience of receiving feedback.

The individual thesis proposals are allocated to referees, therefore each student gets also 3 proposals to review. Referee allocation follows two rules: the referees are colleagues at the same graduate level (either doctorate or masters) and each proposal receives a mix of 2 referees from the same area (KE/KMa/KMe) and one from a different area.

Two weeks are allowed for the students to read and fill in a referee report for each of the 3 proposals assigned. The anonymous reports (spreadsheets) are collected from OJS and processed in a relational database (MySQL). This allows us to compose a document with all anonymous referee reports and publish it for all participating students and advisers.

4 Results and Discussion

4.1 Results and Opportunities for Reflection

From 2005 to 2008, we had 49, 67, 54, and 62 student authors, respectively. A few additional students are allowed to take part only as referee, occasionally, allowing for the allocation of 4 referees for some proposals. Table 1 gives the numbers of proposals in 2008, for illustration. Four extra referees took the number of participants to 66, with 198 referee reports. From those, 192 were delivered.

Table 1. Thesis proposals by research area and by graduate level

Graduate level → ↓ Research area	M.Sc.	Dr.	total
Knowledge engineering	8	14	22
Knowledge management	11	13	24
Knowledge media	8	8	16
total	27	35	62

Commitment of referees and depth of feedback vary. Although this might be related to a culture of reciprocity in which some students don't put reasonable effort in the refereeing task because they won't get an A, we prefer not to change the "mandatory, no credits, no grade" character of our research seminars. We prefer, instead, to continue working on communication issues that lead to culture consolidation – for instance, raising awareness of the importance of the peer review process, giving fuller feedback to student and adviser about timeliness, frequency, and quality of participation of the student in both of his roles.

The general feedback report published for students and advisers right after finishing the review process shows:

- For each proposal
  - For each referee report (typically 3 for proposal)
    - Research area of the referee
    - Referee's self-declaration of expertise
    - Grades (0-10) and comments on the topics reviewed

This general report allows each student to:

- See the full referee reports about his proposal, study and compare the reports, and reflect about the quality of his work.
- See details of other referee reports to the same proposals he reviewed, therefore getting information to reflect on his abilities as referee and on the quality of communication bonds (as stated in section 2, a kind of scientific communication guided by principles of objective criticism and argumentation).

The raw data calls for the building of statistics and other summaries and analyses for the comprehension of our graduate learning system. Our approach is a work-in-progress and only recently (2008) we begun to publish aggregates. For instance, data on referee self-declaration of expertise rendered the figures in Table 2. The obvious conclusion – several students don't have an accurate appraisal of their expertise compared to colleagues' – calls for an explanation of why is that so (although common sense points to a culture of false or mandatory modesty). This lack of balance may be evidence of poor communication among the students, who nevertheless spend their first year meeting one another in at least 3 mandatory courses and in the research seminars.

Table 2. Distribution of self-declarations of expertise in 2008

I belong to the third part of students who…	# reports	% reports
know the most about the proposal's main topic	28	14.6
have average knowledge of the topic	92	47.9
know the least about the proposal's main topic	71	37.0
[did not declare expertise level]	1	0.5
total	192	100.0

Most resources employed in our approach, up until now, were devoted to making the peer review system work smoothly and profitably. We are now ready to take steps in research and development associated to our approach, as discussed next.

4.2 Opportunities for Improvement and R&D Issues

There are instrumental and methodological opportunities to improve our approach. The instrumental issues include, besides providing better computer systems to process the bureaucracy of peer review, the automation or semi-automation of several knowledge-intensive tasks. Some of these tasks, as defined by Schreiber et al. [16], are open to a knowledge engineering approach that involves understanding the business context, identifying knowledge assets and knowledge-intensive tasks, taking a strategic decision for task automation, adapting knowledge model templates, and implementing knowledge systems. Some of the candidate tasks for automation are:

- Referee allocation – using, for instance, text mining techniques to match concept clouds from proposals to referees'.
- Rating of referees – for instance, using the approach proposed by Riggs and Wilensky [17].
- Reliability and validity measures (statistics).
- Process evaluation using nonlinear dynamics [18, 19] applied to asynchronous environments – as in the case of a trial by Araújo [20].

There are, also, two wide methodological issues at hand: the articulation of the graduate research seminars with a new mandatory course on the scientific method, and the study of the mechanisms that create emergent properties in our graduate learning system. As for the articulation, our approach has been seriously limited by omitting the assessment of methodological aspects. We need to build an agreed-upon (or at least accepted) set of methodological directions for our theses if we want our program to be interdisciplinary – hence cohesive – instead of multidisciplinary – hence potentially dispersive [2].

Up until now, our students and advisers only count on their scientific or technological background for methodological issues. The new course on Method will deepen the understanding of methodological issues and allow for better communication of those aspects. The research seminars will be able, then, to build on that understanding, including the assessment of Method in the reviews.

Regarding the study of a system's mechanisms, we need to evolve from our current mere assumption that the growing of a peer review culture improves our graduate education system (a sort of "Hidden Hand" mechanism hypothesis; only a conjecture) to a proper explanation of how the mechanism works. Bunge [2, 4] has directions for that – for instance, the use of multilevel analysis (micro-macro systems) to uncover the mechanism behind some correlations.

5 Concluding Remarks

We presented our approach to grow a peer review culture among graduate students of Knowledge Engineering and Management. The students experience the main scientific method for quality control and have an opportunity to sharpen their knowledge and strengthen their (scientific, rigorous, objective) communication bonds with their peers and professors, adviser included.

The approach is part of our quest for interdisciplinarity through strengthening communication bonds. No single discipline can deal with our research object – knowledge as a production factor – and a mere multidisciplinary approach is bound to fail [2]. Our work aims at contributing, as well, to establish peer review as a replicable, scalable educational approach [21].

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Part VII

Teaching and the Role of Teachers

Computers in the Teaching of English as a Foreign Language: Access to the Diversity of Textual Genres and Language Skills

Roberto-Márcio dos Santos and Jerônimo Coura Sobrinho

Centro Federal de Educação Tecnológica, Brazil

Abstract. In the area of language teaching both language skills and textual genres can be worked with simultaneously (thus responding to the *Brazilian Curricular Parameters* and to the trends in contemporary education, which emphasize contextualized teaching) by means of computers. Computers can make the teaching process dynamic and rich, since they enable the access to the foreign language through virtual environments, which creates a larger number of learning contexts, with all their specific vocabulary and linguistic features in real communication. This study focuses on possible applications of this kind of approach. The computer online is a resource of diverse textual genres and can be an important tool in the language classroom as well as an access to authentic material produced in contextualized practice close to real-life communication. On the other hand, all these materials must be appropriately used without ever worshipping the technology as if it were a miraculous solution. After all, the professional pedagogic skills of the teacher should never be forgotten or taken for granted. In this study, a series of interviews with teachers was carried out – both with Brazilian teachers of the public sector (basic education) and language institutes (private English courses) as well as teacher trainers (university professors), in order to verify if the teachers were prepared to work with informatics in teaching practices, and check the professionals' views on the subject. The ideas of Maingueneau and Marcuschi about *textual genres* are a theoretical base in this work, besides the concept of *cognitive economy.* The text and its typology are focused here as the basic material for teaching English, through digital technologies and hypermedia. The study is also based on Sharma and Barrett's notion of *blended learning* as a balanced combination of technological resources and traditional practices in the classroom. Thus, this is an attempt to investigate the relevance of information and communication technologies in the education and professional practice of English teachers in Brazil in the context of the 21st century.

Keywords: Computers in the teaching of English, learning English with computers, technology and language study, language teacher training.

1 Introduction

Depending on how it is used, the computer may be a great support for the pedagogical practice of the teacher of foreign languages. It is not the solution for every problem, nor is it a miraculous resource that has come to replace teachers, but on the contrary,

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if the computer is taken as a support at the right time in the right way, then it becomes a unique help in the process of teaching/learning. The use of technology may accompany the guiding principles of contemporary education, like contextualization and communicative approach. In foreign language teaching, one can simultaneously deal with language skills (i.e., *listening, speaking, reading, writing*), as well as with a diversity of textual genres, thus corresponding to the “National Parameters of Education” in Brazil and to the trends in today’s teaching. Through the virtual environment, the use of computers can make the process rich and dynamic, therefore creating new pathways to real language situations. This is a study about the accomplishment of such educational practices in the foreign language classroom (English, in this case) inside the Brazilian educational system. The researcher carried out interviews with Brazilian English teachers of the public and private systems, as well as with university teachers who are teacher trainers, so as to verify their possible beliefs related to teaching with technology and whether prospective teachers are acquiring actual preparation or training in dealing with technological resources. As theoretical background, the ideas of Maingueneau [8] and Marcuschi [9] upon textual genres and the concept of *cognitive economy* as a strategy for genre recognition support this study. Texts and their typologies are focused here as the basic material for language teaching through digital technologies and hypermedia provided by the computer. In addition, we also take Sharma and Barrett’s notion of *blended learning* [12] as the balanced combination of technologies and traditional practices in the classroom. Thus, it is taken for granted that *blended learning* would make the ideal “dosage” for such combination.

2 Textual Genres

The digital era has brought genres which never existed before. *E-mail*, for example, is a textual model with communicative purposes (like the former *letter*, *message* or *telegram*) but one that has its own format and language structure pattern. Motta-Roth *et al* [10] defend the idea that the new electronic discourse genres motivate knowledge construction. Therefore, if today’s students are much more familiar with e-mails rather than letters, it is essential that e-mails are included in the students’ linguistic scene from the very start of their schooling. According to Marcuschi [9], today’s “electronic culture” has brought about a boom of new genres and forms of written and oral communication. So, *blogs, wikis, e-mails,* and *chats* are part of real communication in any modern language, where other genres (*reports*, *contracts, poems, essays* and so on) were, long before the new genres existed. There are even new terms and ways of writing which are generated from the digital media and the Internet channels. Goodman *et al* [6] assert that key changes include variations of existing words using some of the following linguistic processes: existing words are given a new context, as in *camping*, ‘hovering in one place in an online game’; abbreviated forms are introduced, such as *thnx* for ‘thanks’, and acronyms, such as *TTFN* for ‘ta-ta for now’; and greater use is made of visual symbols, for example, the use of @, numbers and punctuation marks for emoticon …

How does the computer provide material of various textual genres? What virtual environments does it offer for language practice? The web or the Internet makes it all possible – through wide, comprehensive access. It is up to the teacher to find the appropriate materials and use the electronic texts in the right way, with a critic spirit and clear, well-determined teaching objectives, rather than taking the technology for its own sake. According to David Crystal [4], today there is more language on the Internet than in all the libraries of the world together. It has never been so easy to access textual material of every sort, considering that the text– written or oral – is the language teacher's basic working tool. Among the so many virtual learning environments, *Second Life* is an innovative, state-of-the-art way to create diverse and otherwise impossible situations where activities like *role-play* become easier to do. Any context may be brought into the classroom by means of *Second Life*.

When working with genres with pedagogical purposes, one automatically deals with the development of the skill of recognizing each text type or category, which has to do with *cognitive economy,* a factor focused by Russian linguist Bakhtine [1]:

> *... whenever we hear the others' speech, we can find out its genre, from the first words, (…) the compositional structure that is being used, foreseeing the end; in short, ever since the start we are sensitive to the discourse as a whole (…). If the discourse genres did not exist and we did not master them and had to invent them each and every time in the speech process, (…) verbal exchange would be impossible.*

So, *cognitive economy* is a kind of process through which people, being able to recognize textual genres, acquire more easily the ability to produce them in situations of real communication. This is naturally conditioned to linguistic and psycho-social factors, such as to language knowledge and the rules of human communication.

Some authors mention the relation of textual genres and language teaching, as in Marcuschi's [9:35] and Pereira's (Winch [14]) conceptions. Marcuschi says that the use of genres is a way to deal with language in its everyday situations, and Pereira asserts that genres are aids for the understanding of how people interact by means of language.

Bearing in mind the contemporary trend that foreign languages should be taught through communicative approaches, the situations that students go through in their learning must prioritize real communication (which is made possible by e-mails or chats, among others possibilities) by means of social interaction or activities which demand acting and improvising such as *role-play* (made possible by *Second Life*).

3 The Demands of the 21st Century

Some years ago Levy [7] warned society about digitization as a trend in every area, including education. Education is linked to the contemporary contexts created by the digital revolution. Apart from new resources and applications, we are facing a new kind of student – one with more demands, considering all the hypermedia and new technologies in the society in which he/she belongs to. Thus, when including supporting resources in education, we should always, in the words of Coscarelli [3], take into consideration that we need to work with relevant, consistent proposals which involve some sort of challenge to the student, stimulating his/her interest and curiosity, never underestimating his/her potential. Nowadays one can say that "reading the world is virtually possible", according to Xavier [15], and for the current generation of young people such reading has become easier, more spontaneous and natural, given their familiarity with technological devices. Veen & Vrakking [13:29] describe what today's students are like: "they surf the Internet and click until they find what they want, searching for icons, sounds and movements rather than mere letters. (…) Physical distance doesn't represent any restriction to communication". This generation of students was born into this virtual world and therefore is familiar with so many media and technologies. Unlike most of their teachers, they are part of the generation known as "iconic" or, according to Veen & Vrakking [13] "*homo zappiens*" – today's typical youth, who "was born with a hand on a mouse, already knowing how to handle the TV remote control at the age of 3, and having a mobile phone at the age of 8".

4 Language Teaching Mediated by Computers

Language teaching has always been pioneering in the use of technology, due to the nature of this area of knowledge, which involves communication in all its forms, writing texts, speaking, recording, listening, watching images, - thus enabling an easy and flexible inclusion of resources. Nowadays some conventions in the area of language studies are changing. For instance, although a workbook still refers to a book for practice exercises or homework, now some authors offer an electronic version, apart from the printed one. Audio used to mean only recordings on cassettes for listening, however now one can listen to lessons on an audio cd, cd-rom, MP3, iPod and so forth. Dudeney & Hockly [2] present in their work plenty of explanations, suggestions and possible applications for English language classes, such as chats, blogs, wikis, podcasts, e-learning,etc., as well as the interactive board and how to work with Internet-based projects. Goodman et al [6] discuss in their work the position of English on the Internet, digitalization and e-books as a new genre, hypertext fiction, and the artificial language generators.

It is now possible to mix pleasure with work when teaching or learning a foreign language, since there are available resources which allow that technology comes accompanied with communication, making the entire process more fun. Winch [14] mentions the need for teaching without a focus on grammar, but rather with "the comprehension of how language is used through daily routine situations". Winch refers to the Brazilian legislation to emphasize the association of this kind of practice:

Instead of starting from grammatical rules, one can start from a passage inside a usual context. For new language practices, like those mediated by the computer, teachers should ideally analyze the structuring rules of language in that new context.

5 Research Data

The research was carried out with Brazilian English teachers working in the city of Belo Horizonte. There were 34 participants altogether, from three different groups: public education (15), language institutes (10), and university professors (9). All of them answered questionnaires about computers and other technologies in teaching

The first questionnaire was directed to teachers from public schools and English courses. Hereafter *EP* stands for public school respondent, whereas *CL* represents English course respondent. In Brazil it is usually said that people don't learn a language properly at regular school. In general, people think that language institutes (or courses) have more quality and better learning conditions. So in a way, dividing the questionnaires into two groups will be a contrastive strategy. The question *"Have you used technological resources in your classes? How often?"* brought the following answers:

Table 1. Technologies used by teachers in the classroom

PARTICIPANT	RESOURCES USED	HOW OFTEN?
EP01		*Every 2 months*
EP02	*Overhead projector, computer, datashow, TV, videos*	
EP03	*Audio, videos, computer*	
EP04	*TV, DVD, radio*	*Always*
EP05		*Every 2 months*
EP06	*Television, VCR*	*Used for 6 months*
EP08	*TV, videos, DVD, Internet, games*	*Always use it*
EP09	*Videos, CD player*	*Rarely*
EP10	*TV, videos, DVD, CD player, overhead projector, computer*	*Very often, except for the computer*
EP11	*DVD, CD player*	*As often as possible*
EP12	*TV, DVD, computer*	*Once a month*
EP14	*TV, stereo system, DVD*	*Not very often*
EP15	*Educational videos, films, music, audio cd of the textbook*	*Whenever it's necessary*
CL01	*Multimedia*	*In every class*
CL02	*DVD, sound system*	*Constantly*
CL03	*Audiovisual computer program*	
CL04	*Laptop (newspaper articles, etc.)*	
CL05	*Multimedia, Internet, DVD, CDs, etc.*	*Almost always*
CL06	*Internet, computer*	
CL07	*Multimedia, Internet, videos*	*Constantly*
CL08	*Multimedia, DVD, Internet, CDs, etc.*	*Always*
CL09	*PC*	*Few times*
CL10	*Multimedia (it's part of the method used)*	*In every class*

The other group, - the university professors - was interviewed (from a different questionnaire) to inform the researcher about English language teachers' training, and whether the curriculum is being adapted to the contemporary changes. There were 9 respondents in this group (identified above as *FP*), whose answers are described here.

As for whether the teacher thinks he/she is prepared in terms of technological training, the results were as follows:

Table 2. Teachers' views on their technological training

PARTICIPANT	PREPARED TO WORK WITH TECHNOLOGIES?
EP01	*Yes.*
EP02	*I am prepared.*
EP03	*In the State schools we lack materials and training...*
EP04	*More or less, I'd like to know more.*
EP05	*Yes, but I'm not up-to-date in informatics .*
EP06	*As long as I'm given the training...*
EP07	*No, (...) the school doesn't have all the multimedia equipment...*
EP08	*Yes. (...) the teacher who doesn't fit becomes an illiterate, (...) the knowledge gets obsolete.*
EP09	*When there is available equipment, I guess so.*
EP10	*Yes, except for the computer. For me it's not so easy to use it in the classroom.*
EP11	*Yes, but I still need training.*
EP12	*Sure!*
EP13	*Yes.*
EP14	*Yes, though I feel I need to improve.*
EP15	*Yes.*
CL01	*Yes.*
CL02	*Yes, but I still need improvement, like in how to use Power Point...*
CL03	*Sim.*
CL04	*Very much. I'm addicted to technology and spend money on it…*
CL05	*Yes.*
CL06	*Yes.*
CL07	*Yes, I get constant training...*
CL08	*Yes and no! Equipment change a lot and it's hard to follow.*
CL09	*I need better training.*
CL10	*Not much. I'm not too familiar with it...*

– Is the current university training in the area of Humanities/Languages preparing future teachers to work with modern technology? If so, how?

FP01: < ... in a way, yes. (...) the students already have Phonetics classes in the lab, where they access sites and study by monitoring their speech and practice (...) following their individual pace (...) I cannot tell if they are ready to teach through those resources. >

FP02: <Yes, leaving the students away from technology would be an exclusive attitude.>

FP03: < Not always. (...) few courses in Brazilian universities reserve part of their curriculum for technologial education. >

FP04: < ... it depends on each institution and who is involved. I have seen institutions that promote lectures or mini-courses (...) inside graduation events, include optional courses on the referred topics, and some have offered on-line courses. But this is still very little ... >

FP05: < I don't think this concern exists. It's more like each individual has to take his/her personal initiative. >

FP06: < At the college where I work, that's a reality for the students, who have specific courses about those topics. >

FP07: < Not directly. But students can take specific on-line courses, where they'll be dealing with that sort of thing, for their academic tasks or presentations. >

FP08: < No. At the Federal University there are courses on digital literacy, however the vast majority of students don't take them. >

FP09: < Yes, though it's still very little. There are several courses that involve ICT or are about language teaching mediated by computers. >

– Do the new digital language and hypertext contribute to English teaching and learning? Justify your answer.

FP01: < ... an English learner is, above all, a citizen of the contemporary world. Being inside this globalized context, (...) it's a natural consequence that the language teacher makes use of new media resources (...). Studying the new textual genres – e-mails and blogs – is necessary to integrate learners with the new media realities. I see hypertext as a research strategy independent of language. (...) it's up to the teacher to teach students how to research by using that tool. >

FP02: < Very much. Through the Internet the students' universe expands and their autonomy grows. >

FP03: < No doubt. Besides promoting autonomy in learning, the digital language and hypertext offer learners a variety of discourse linguistic resources which enrich their knowledge of the English language…>

FP04: < ... It helps as long as you know how to integrate your teaching objectives with the students' digital literacy... >

FP05: < ... they're tools that are contributing to teaching (...). I've done a research (...) and found out that computer communication helps students that are shy or afraid of making mistakes (...) Hypertext allows deeper textual analysis, because it presents so many links to other texts/discourses. (…) >

FP06: < ... New language and technologies can potentially contribute to the learning of diverse subjects. In the case of languages, there are a number of resources for self-teaching and planning classes (…). The contribution is related to the kind of use one makes and not for the technology alone. >

FP07: < ... The variety of resources and the easy access and communication enrich the quality of interaction and learning. >

FP08: < Yes, very much, because of the choices of resources on-line (hypertexts of newspapers, magazines, articles, multimodal texts such as vídeos, movie trailers, podcast, etc.) ... >

FP09: < I believe that depends on the lesson objectives. It may either contribute or cause confusion. >

6 Final Considerations

These answers to the questionnaire certainly lead to reflections and points to a few potential issues. In general, the teaching professionals are aware of the importance and demands of information and communication technologies in the learning process. It's clear from some of the answers that public sector schools need more financial and material resources, and they lack professional training. The teachers from public schools and English courses have acquired different technological backgrounds, so it varies a lot. Some of them don't know very well how to combine the computer with their pedagogical approach. Also, most professionals seem to be aware of the relevance of digital language and hypertext for language teaching and learning. Although there is already some bibliography on the subject, many Brazilian English teachers need actual training. That's why the use of computers in the classroom is still limited, apart from the fact that in the public sector apparently there is not available money. Some private language schools already have interesting initiatives in terms of innovated methods including all the new media.

As for the graduation courses in the area of Humanities/Languages, some institutions have made attempts to offer technological preparation to prospective teachers, though according to some professors the results come slowly and there is much more to be done. Another interesting point is that, in several answers, it is said that technology for its own sake will not generate results in learning. On the contrary, its use must be well-planned and grounded on clear, solid pedagogical purposes. It must be more than mere fun, though fun may very well be part of learning too. Brazilian education has much to gain as long as there are more investments on both physical and human resources.

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A Study on Pedagogical Requirements for Multi-platform Learning Objects

Patricia Alejandra Behar, Liliana Maria Passerino,
Ana Paula Frozi de Castro e Souza Frozi, Cristiani de Oliveira Dias,
and Ketia Kellen Araújo da Silva

Universidade Federal do Rio Grande do Sul – UFRGS
pbehar@terra.com.br, nanafrozi@yahoo.com.br

Abstract. This study presents the development of a proposal of pedagogical requirements for multi-platform learning objects (LO). It aims at providing a debate on the importance of such pedagogical requirements in the development and construction of LOs. It also demonstrates an analysis of these requirements performed with a built learning object operating in the Web, digital TV (DTV) and cell phone.

Keywords: Learning Objects, Pedagogical Requirements, Object Interoperability, Multi-Platform.

1 Introduction

Production of digital educational material as learning objects[1] (LO) has been a good option to present concepts and contents more dynamically and interactively in the current educational setting. The main characteristic of such resources is being self-explanatory, modulated, digital, interoperable, reusable, and able to be aggregated. As reusability becomes an increasingly more present reality in times of Web 2.0,[2] the establishment of minimal requirements for these objects has proven to be very important to ensure their quality.

This study is part of the OBAA Project (Agent-Based Learning Objects[3]), which aims at creating a standard of interactive learning objects operating in the Web, digital TV, and cell phone. The study is focused on the establishment of pedagogical requirements to build Learning Objects. Thus, it intends to establish a system of parameters that represent, explain and guide the project and development of learning objects that materialize in pedagogical practices and in teacher-student-object knowledge interactions.

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1 To Behar et al. [1], Learning Object is any digital material, such as texts, animation, videos, images, applications, individual or combined websites with educational purposes.

2 It is characterized by use of services and applications through the Web, operating individually or collaboratively. It is based on the content produced by users themselves.

3 Project of the Interdisciplinary Center of New Technologies in Education (CINTED) of Universidade Federal do Rio Grande do Sul (UFRGS), funded by Studies and Projects Financing Entity of the Brazilian Department of Science and Technology (FINEP/MCT) and supported by the Brazilian Department of Education (MEC).

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To do so a discussion on the pedagogical models for distance learning was held with the aim of conducting a parallel study on the pedagogical requirements for LO construction/analysis. In the second stage, existing standards for their development were investigated. Afterward, cards of minimal requirements for interoperable LOs were created.[4] Use of cards facilitates visualization and use of these requirements by anyone developing an object. For its validation an analysis table was built based on the pedagogical requirements. Finally, a pilot study was carried out based on this table with an interoperable LO in three platforms: Web, digital TV, and cell phone.

2 Learning Object Standards: Current Scenario

Studies on the main existing standards in the international scenario were performed in search of a requirement standard for the pedagogical model of interoperable LOs. Among the standards searched were SCORM, IMS-LD, LOM (meta-data standard), IEEE P1484, and W3C (accessibility requirements). The search was for common elements in these standards, making comparisons with the aim to decide which best meets the needs for the development of pedagogical requirements for an LO.

The IMS-LD (Learning Design), according to Dutra, Tarouco [2], is a modeling language to define learning objects and activities specified by IMS based on the EML (Educational Modeling Language), which allows describing pedagogical models that are advanced, reusable, collaborative, multi-actor, and with personalized teaching routes.

The SCORM standard consists of a reference model, that is a unified set of specifications to make e-learning contents and services available [2].

The LOM specifies syntax and semantics, allowing for a catalogue of teaching materials (meta-data), grouping useful data in a standardized format. It aims at ensuring efficient identification, (re)use, management, interoperability, sharing, integration, and retrieval.

This study used the LOM because it is the most complete and widely used. In the educational area meta-data are used to describe LO, i.e., resources can be reused by several environments, allowing presentation and fast retrieval according to the needs of the educational context. In addition to facilitating object sharing and exchange, use of this standard allows for the development of catalogues, while considering the diversity of cultures and languages in which learning objects and their meta-data will be explored.

In these specifications there were similarities between some elements present in both SCORM and IMS-LD. Therefore, because the IEEE LTSC P1484 met the needs, it was chosen to guide the definition of pedagogical requirements. Objectively, it can be said that the IMS-LD standard uses meta-data elements found in the LOM, writing it in XML, and the SCORM adopts the description in XML from the IMS (called Meta-Data XML Binding). However, in the IEEE LTSC P1484 it was possible to find the same elements, better elaborated and more complete.

It is worth stressing that, although such standards have educational specifications, none of them presented minimal pedagogical requirements for LOs. In this context the

[4] Interoperable LOs are designed to be used in different platforms; in this case, digital TV (DTV), mobile devices (cell phones) or Web.

necessary theoretical framework regarding objects was searched for in the current literature.

3 Pedagogical Requirements for Objects: Searching for a Theoretical Background

The development of learning objects has characteristics that, among other factors, depend on educational objectives, pedagogical methodology and strategies, on the content that will be approached and on the technological possibilities for their implementation. There is an increasing demand for educational material that accounts for this new context. It demands the participation of professionals with a quite open, preferentially interdisciplinary formation and that are able to move freely across knowledge areas implied in the development of learning objects.

According to Silva & Fernandez [3], building, developing, and using this type of material, from an interactionist perspective, is valuing action, critical thinking, curiosity, demanding questions, restlessness, and uncertainty. Therefore, it is possible to enhance the potential of teaching and learning processes, divergent thinking, confrontation, analysis, ability to compose and recompose data and argumentation, which requires a teacher that encourages doubt. Hence, action becomes an exchange instrument, building knowledge through action schemes and coordination [4]. In this line of thinking, organizational, content, methodological and technological aspects of learning objects (LO) were defined to form a pedagogical model.

Among organizational aspects the types of team (disciplinary, multidisciplinary and interdisciplinary) to build objects, definition of educational objects and types of browsing an LO were investigated.

Aspects relative to content were defined based on Zabala [5], namely, (1) Factual Contents – regarding learning of facts through more or less literal copying activities, such as repetition exercises; (2) Conceptual Contents, which allow for recognition of previous knowledge, assuring significance and functionality that are adequate to the development level; (3) Procedural Contents concern the need of performing sufficient and progressive exercises of the different actions forming procedures, techniques or strategies; finally, (4) Attitudinal Contents, which have a conceptual nature of values, norms and attitudes. These elements have a direct influence on teaching strategies, which were studied to define pedagogical requirements (see item 4).

Most frequent types of activity, types of interaction/interactivity and evaluation were investigated in terms of the methodological aspects of LOs. In an interactionist epistemological background, it is believed that the individual knows the world by interacting with knowledge objects, whether they are situations, animals, objects and/or other individuals. Thus, such requirements may indicate learning situations in which the educational paradigm of LO can be developed. Their importance lies in the possibility of opening new forms of using an object according to the user's learning style and the teacher's epistemology. Hence, it can be stated that the definition of minimal pedagogical requirements can subsidize construction of LOs that are more open to different pedagogical practices.

4 Proposal of Pedagogical Requirements for Multi-platform Learning Objects

Based on the existing studies on such standards, pedagogical requirements were defined using cards, as shown in figure 1. Each card has a description of the requirement, as well as a pedagogical justification of its importance and reference. There are 46 cards, divided into six categories, which are used to define which elements may be present in an interoperable LO. Next, the categories are also described.

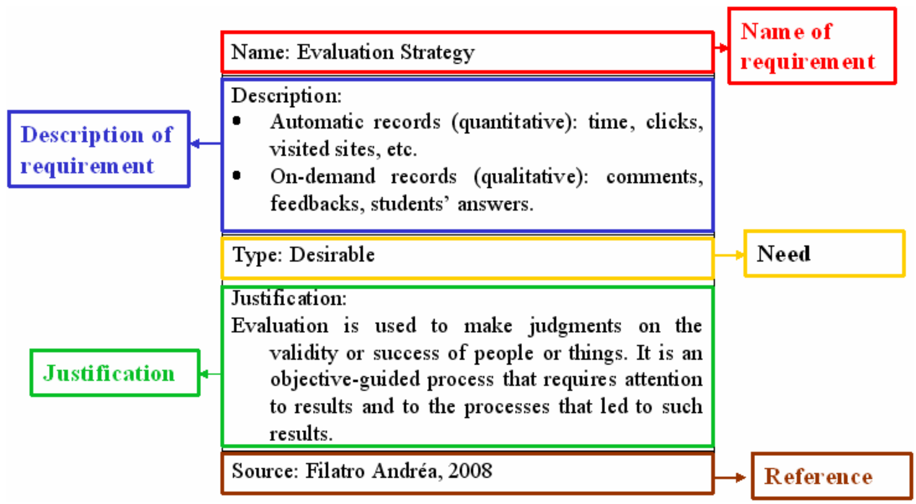

Fig. 1. Card of pedagogical requirements

4.1 Identification/Meta-data

These requirements aim at identifying LOs for further cataloguing of the learning object. This category should contain enough information, so that the user identifies whether or not the LO is relevant for him. Thus, users can search it according to their interest. Minimal requirements for meta-data are subdivided into five subcategories, based on the definitions for meta-data in standard P1484:

1. General - groups general information describing the object.
2. Life cycle - gathers items describing the characteristics related to the history and current status of objects.
3. Technique - illustrates minimal technological requirements for using the object in a given platform.
4. Educational - describes educational, didactic and pedagogical characteristics of LO.
5. Licensing - clarifies the rights of use and reuse of LOs, as well as the terms of intellectual property.

4.2 Technological

Technological requirements set the minimal and maximal parameters relative to the media used in the learning object. Resources are optional in the LO as they concern didactic tools and methods. However, this parameter is considered mandatory due to its importance for good object usability. Parameters were established based on studies on interaction design [6] and content organization [5].

4.3 Educational

The educational category deals with the requirements regarding didactic strategies, types of content, strategies of collaboration/cooperation and evaluation. According to Zabala [5], there are four types of contents, which may be used by teachers as they wish. Interactions concern people's behavior toward other people and systems. It is possible to provide significant learning experience if the designed educational solution is, above all, interactive. This means providing an interface that demands students' interaction with contents, tools and other people. Finally, evaluation is used to judge the validity or success of people or things. It is an objective-guided process and required attention to results and processes.

4.4 Communication Object Content and Data Auxiliary

These requirement categories refer to the possibilities of using LO in association with Virtual Learning Environments (VLEs). Such parameters were based on the SCORM standard, which sets norms to the encapsulation of LOs for integration in VLEs and in the P1484 standard, which develops a framework of LO creation. Therefore, they provide independence of VLEs in which LOs will be used, facilitating migration between them, as long as they are compatible with this model.

4.5 Accessibility

Based on the recommendation of W3C regarding accessibility, this category defines parameters so that LOs can be accessible by any user in any platform. Such recommendations suggest content adaptations according to the need of those using the LO.

In such a fragmented market as that of devices and browsers, standards are the best guarantee of interoperability. Predicting support to many devices will result in a higher number of product users. Thus, it is important that tools have a support for Assistive Technologies since it facilitates interaction of users with special needs.

5 Pilot Project: Validation of Requirements for Analysis of a Multiplatform LO

After definition of requirements, an analysis table of LOs was developed based on cards for methodology validation. The table was used in the evaluation of learning objects. It includes the name of the requirement, its subdivision and a description.

Using this table for evaluation required an adaptation of an LO so that it could be executed in three different platforms (digital TV, cell phone and Web) because an object that met the needs of this study was not found. The LO "Other Childhoods," developed by the Center of Digital Technology Applied to Education (NUTED/UFRGS), was chosen to perform this adaptation because it has an open source code, facilitating its modification/inclusion. There was the need of adapting the LO, both visually and in terms of content, so that it was possible to meet the highest number of requirements in interoperability. Changes were mainly in layout, text organization and activities, which had to be reformulated. The colors were programmed to change automatically according to the platform, with the aim of meeting usability requirements. Figures 2, 3 and 4 present the adapted LO.

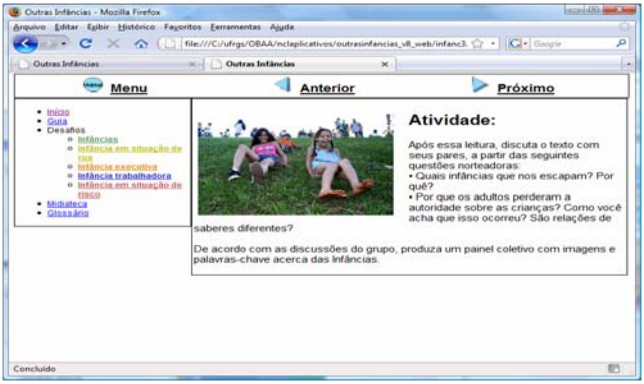

Fig. 2. Interoperable Web LO

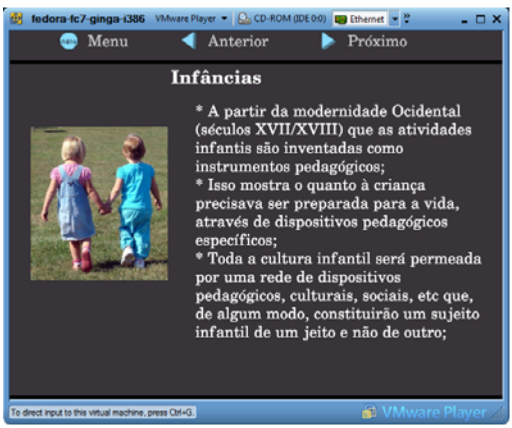

Fig. 3. Interoperable DTV LO

This first LO evaluation was a pilot project, aiming to analyze whether the requirements proposed could be supported by available technologies. An evaluation was performed to verify whether the table provided all the indicators for analysis of a multiplatform LO; therefore, it was possible to propose new pedagogical requirements based on what was empirically observed.

Fig. 4. Interoperable Cell Phone LO

6 Final Considerations

Evaluation of LOs based on requirements allowed for analysis of the possibilities each platform has of meeting the initial proposal. The next step is to build and apply a multiplatform LO in an extension course at UFRGS to investigate how users interact with LOs in DTV, Web and cell phone.

Afterward, scenarios to apply such multiplatform LOs will be studied to define the types of users and their cases of use. Therefore, the intention is to develop objects that are increasingly closer to users' needs.

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Podcasts in Higher Education: Students' and Lecturers' Perspectives

Ana A. Carvalho, Cristina Aguiar, Henrique Santos, Lia Oliveira, Aldina Marques, and Romana Maciel

University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal
aac@iep.uminho.pt, cristina.aguiar@bio.uminho.pt, hsantos@dsi.uminho.pt, lia@iep.uminho.pt, mamarques@ilch.uminho.pt, romana.serra.maciel@gmail.com

Abstract. This paper reports the use of podcasts in blended-learning at the University of Minho, in Portugal. Six lecturers created their own podcasts with different purposes in order to support their undergraduate and graduate courses and their students' (n=318) learning. The reported study belongs to a broader project about the impact of podcasts in blended-learning and it reports data from two semesters. Results give evidence of students' acceptance regarding podcasts although they do not yet make use of the advantages of media and mobile technologies. The lecturers considered podcasts worthwhile for teaching and for students to learn, but they are time-consuming and there is no institutional recognition. In spite of this, they intend to continue using podcasts in their courses.

Keywords: podcast, higher education, students' reaction, lecturers' reaction, blended-learning.

1 Introduction

Podcasts are audio or video files that can be subscribed to and downloaded by users via RSS (Really Simple Sindication). Due to the facility in editing and distributing they have become popular as radio shows [1] and rapidly evolved to different uses. Some universities were sensitive to the audio power of easy online access and motivated for its use [2], [3], [4]. For example, at Duke University ipods were offered to freshmen in order to encourage them to listen to podcasts [5]. Research about the use of podcasts is being conducted [6], [3], [7], [8], [9], integrating projects such as: in Australia at Charles Sturt University [10] in the UK through the IMPALA project [11], and in Portugal at the University of Minho [9].

Podcasts may be used for different purposes, such as vocabulary revision, listening exercises, interviews with native speakers, key point summaries of a lecture or group of lectures, sharing announcements, describing homework assignment assessment, giving feedback, guidelines, reducing the effects of isolation and promoting inclusivity, developing students' study skills through collaborative learning, providing

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guidance on student practical work, etc. The most common podcast is a lecture recorded in the classroom. We think that this kind of podcast may be useful for an absent student but it is too long and has a lot of background noise. Lane [3] reported that students found it difficult to hear questions and discussions on the podcasts, thus they required visual aids. Podcasts were limited to how much of classroom experience they could capture.

The reported study describes the results achieved at the University of Minho, during two semesters, and describes students' reaction to the podcasts used in their courses and lecturers' opinions about podcast creation and its benefits towards the learning process. Besides focusing on the advantages of audio, we propose a podcast taxonomy based on the following variables: type, medium, length, author, style and purpose.

2 Podcasts in Higher Education

Most of the studies about podcasts use audio files [10], [11], [12] but some also use video files particularly in veterinary education and GIS Software [11], microbiology and biochemistry [13]. Video podcasts may also be named vodcasts or vidcasts. The screencast, a new category that is a screen capture with audio [4], is particularly useful for demonstrating a task or tutorial on a computer screen.

Some authors claim that it is a renaissance of audio for learning [14] or of the power of audio.

Students at the University of Washington found the audio records (of lectures) helpful when preparing for homework or exams [3]. Students used podcasts as study aids, to clarify materials covered in lectures, thus enhancing their comprehension of complex concepts or to fill in gaps in their notes.

Kaplan-Leiserson [15] and Lane [3] propose to consider podcasts as a way to change classroom practices. Students can listen to a lecture via podcast before class and the lecturer can devote part of class time to other activities.

2.1 The Power of Audio

Durbridge [16] emphasises the pedagogical advantages of audio compared to printed media, stating that the spoken word can influence both cognition (adding clarity and meaning) and motivation (by conveying directly sense to the person creating those words). On the other hand, voice is personal and the frequencies of the human voice allow to adjust intonation, inflexion, phrasing, pacing, volume, loudness and timbre [3]. Students like to hear their lecturers' voice [16], [1], [11], [9].

The Scottish Council for Educational Technology [17] reports that audio is a powerful medium for conveying feelings, attitudes and atmosphere. However, it is less effective at conveying detail and facts if listened to for more than 30 minutes.

Audio is a great way to deliver information, especially for auditory learners [15], [18]. The ability to stop, start and replay also makes it appropriate for students with special needs or challenges.

2.1.1 Podcasts Length

The podcast length must be related to its content and purpose. However, Cebeci and Tekdal [19] recommend podcasts no longer than 15 minutes, because there is generally a loss of attention in listening and a decrease in comprehension after this period of time. Lee and Chan [19] created podcasts that were structured as talkback radio-style segments of 3 to 5 minutes. In the IMPALA project most of the podcasts lasted 10 minutes [11]. Walch and Lafferty [20] stated that a 10 minute podcast full of information that is quick and snappy is far more enjoyable than a 30 minute show with only 11 minutes of material.

Based on a literature review, we may conclude that the recommendations point to a short length [6], [10], [11]: 3 to 5 minute podcasts [10] or 10 minutes [11].

We classify podcast length as short (1-5 minutes), moderate (6-15 minutes) and long (more than 15 minutes).

2.1.2 Podcasts Recommendations

A podcast should have technical quality. It is important to avoid background noise, tinny-sounding, and verbal mistakes that interrupt the flow of the podcast. To develop a good vocal technique it is important that the speaker is relaxed [20]. It is also important that a certain level of energy is maintained so that listeners remain engaged.

The podcast should have a beginning, a middle and an end. For example, Fothergill in his module of Optical Fibre Communication Systems used podcasts with the following structure: news, announcements, feedback and a fun ending (joke or rap) [21]. It is important to plan the content and "flow" of the podcast. When using music it should match the podcast's style and spirit [18]. Lee and Chan [10] recommend keeping podcasts short, lively and entertaining.

3 Podcast Taxonomy

Podcasts are used in education with different purposes [7], [10], [11], making a podcast taxonomy in teaching and learning useful and necessary.

Salmon et al. [11] created a classification of podcasts which they stated as "a transferable model of podcasting". This model has ten variables: Purpose, Convergence, Developer, Medium, Reusability, Structure, Length, Style, Capacity, and Frequency.

We agree with most of the listed variables but we did not feel comfortable with this model of classification. Particularly the words and the categories chosen for podcast Structure (single or multiple sessions) and Capacity (large student cohorts or small groups of students) do not seem appropriate to characterize the number of sessions or the target audience. Moreover, the role of students as producers of podcasts is either included in the purpose or in developer categories. We think that it is important to have the general type of podcast and then its purpose among other variables.

We are developing a podcast taxonomy that is based on a literature review and takes in consideration the following assumptions: podcasts are not used in classroom; podcasts are not lectures recorded in the class during face-to-face sessions; podcasts should be reusable although some types, such as those giving feedback, for instance, are not. The taxonomy has six variables, as follows:

[1] *Type*: we consider four types of podcasts - Informative (concepts, analysis, synthesis, reading of texts, poems, description of tools or equipments, etc.); Feedback/ Comments (to students assignments and group work); Guidelines (to field work and to practical work); and Authentic Materials, such as interviews, reports, news, and so on.
[2] *Medium*: Audio or Video (including screencast)
[3] *Length*: Short (1-5 minutes), Moderate (6-15 minutes) or Long (>15minutes)
[4] *Author*: Lecturer, Student and other (experts, local community and representatives)
[5] *Style*: Formal or Informal
[6] *Purpose*: described as an action verb (inform, analyze, develop, motivate, etc.)

4 Research

This research describes the results of a study conducted at University of Minho, in Portugal, focusing the use of podcasts and its implications for learning in higher education. The project goals are the identification of podcasts types used by team members, the evaluation of students' acceptance to podcasts and the analysis of teachers' reactions to the integration of podcasts in blended-learning.

A total of 56 podcasts, of variable length and different purposes, were created during the first and second semesters of 2007/ 2008. The study integrated 6 lecturers and 318 students - 253 undergraduate and 65 masters - enrolled in 13 courses.

4.1 Data Collection Instruments

Data was collected by two questionnaires. A Digital Literacy Questionnaire (DLQ) was filled in by students at the beginning of each course and was set to characterize students' knowledge and uses of Web 2.0 tools. The second questionnaire - an Opinion Questionnaire (OQ) – was filled in at the end of the semester to inquire students' reaction to the use of podcasts.

Lecturers wrote a Teacher Diary of Podcasting and were interviewed at the end of each study.

4.2 Sample Characterization

4.2.1 Students and Courses

The study involved 318 students, the majority of them female (65%) (Table 1). Only in the courses of Operational Systems (OS) and Usability Assessment (UA) males were overrepresented, with respectively 77% and 62%.

The 253 undergraduate students were enrolled in 8 courses belonging to different programs such as Biology (3), Engineering (1), Sciences Communication (1), Applied Linguistics (1) and Education Sciences (2), and almost all of the 65 graduated students were teachers enrolled in 5 Master courses, of Education (4) and of Digital Art (1) (Table 1).

Table 1. Students enrolled in the study and respective courses

Cycle	Program	Courses	Students		
			Female	Male	Total
Undergraduate	Applied Languages	Conversational Analyzes (CA)	6	0	6
	Education	Multimedia Educational Materials (MEM)	14	0	14
		Technology and Educational Communication (TEC)	23	0	23
	Applied Biology	Heredity and Evolution (HE-AB)	29	18	47
		Genes and Genomes (GG)	29	18	47
	Biology and Geology	Heredity & Evolution (HE- BG)	20	10	30
	Computer Science	Operational Systems (OS)	10	33	43
	Sciences Communication	Research Methods (RM)	31	12	43
Master	Educational Technology	Multimedia Systems (MS)	16	9	25
	Pedagogical Supervision	Education & Multimedia (EM)	7	3	10
	Technologies & Digital Art	Usability Assessment (UA)	5	8	13
	Adults Education & Communitarian Intervention	Learning and Social Network (LSN)	10	1	11
	Educational Mediation & Supervision	Groups' Dynamics & Leadership (GDL)	6	0	6

4.2.2 Mobile Technologies Owned and Used by Students

Besides studying in a wireless university *campus*, Internet access at home is a facility for the great majority of students, no matter if they are from undergraduate (82%) or master (91%) study cycles.

The majority of students (96%) owned a laptop and/ or a desktop computer, 66% had a MP3 player, 11% had a MP4 and 42% also had 3G mobile phones.

Despite having the necessary technology to listen to podcasts, whenever and wherever wanted, students preferred to use their personal computer when listening to their courses podcasts (64%), an option also found by other authors [3], [11]. Actually, only 1 student from Operational Systems (OS) course, 3 from Education and Multimedia (EM) and 4 from Groups' Dynamics and Leadership (GDL) courses used their 3G mobile phone to listen to podcasts. The popular MP3 mobile device, owned by great part of the students, seems to be preferably used for leisure and not in this learning context, except for all GDL students (6), 4 EM students and 2 OS students.

4.2.3 Podcasts Characterization: Type and Length

A total of 56 podcasts were created (35 for undergraduate programs and 21 for the master courses), varying in type, purpose and length for each course and lecturer (Table 2).

According to the podcasts taxonomy proposed, all types (Informative, Guidelines, Feedback and Authentic Materials) were used, and 4 of the podcasts were long but the majority was short, as recommended by several studies [19], [6], [10], [11]. All podcasts were audio files, mainly of formal style and covering different purposes (inform, analyze, develop, motivate, explain, comment, assess) and all were created by lecturers, except the interview.

Table 2. Podcasts characteristics: type and length

Cycle	Lecturer	Course	Number	Type	Length (minutes)
Undergraduate	A	CA	7	- Informative (exercise of orthographic transcription, course content) - Guidelines (for individual paperwork)	1'04''-9'42''
	B	MEM	1	- Informative (Instructions for using the Blackboard forum)	1'17''
	C	HE-AB	4	- Informative (Learning outcomes)	0'45''-1'
		GG	6		1'- 3'
		HE-BG	8	- Informative (Course content, extra contents) - Feedback (to students assignments)	1'27`'-7'06''
	D	OS	1	- Informative (Course content)	15'5''
	E	TEC	7	- Informative (course assignments; books excerpts) - Guidelines (for team work assignment)	0'59'-3'01''
	F	RM	1	- Authentic Material (interview)	37'
Master	B	MS	4	- Feedback (group presentation, students assignments) - Informative (orientation for the session)	1'08''-5'15''
		EM	9	- Informative (instructions to analyze multimedia software or e-games) - Guidelines (for report assignment, to individual assignments) - Feedback (to personal websites)	1'01''–3'09''
		UA	2	- Feedback (about students assignment) - Guidelines (for paper review assignment)	0'36'-1'57''
	E	LSN	3	- Informative (course assignements, course content, books excerpts) - Guidelines (for team work assignment)	0'59''-3'01''
	F	GDL	3	- Informative (course content)	1'53'-22'

4.3 Students' Reaction to Podcasts

4.3.1 Podcast Listening and Podcast Quality

The majority of students stated to be unfamiliar with podcasts whether they are undergraduate (57%) or master students (57%). The few exceptions belonged to OS (Operational Systems, 88%), MS (Multimedia Systems, 60%), UA (Usability Assessment, 54%) and HE-AB (Heredity and Evolution of Applied Biology, 53%) students who knew what a podcast was.

The majority of students listened to the podcasts delivered by their lecturers (Fig. 1). GG students were the less receptive to the listening of the audio files, probably because they also had access to the podcasts content in a written format, which they asked for, though given after the delivery of the audio file.

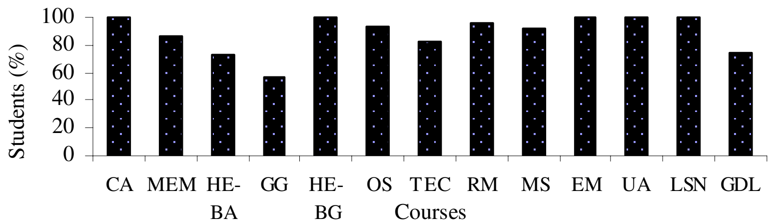

Fig. 1. Students listening to podcasts

When analyzing the defined podcast quality parameters, students pointed its audibility and referred, almost without exception, that they had clear information and a friendly voice (Table 3).

Table 3. Podcasts quality (%)

Cycle	Lecturer	Course	Podcasts quality (%)			
			Audible	Friendly voice	Too long	Clear information
Undergraduate	A	CA	100	100	17	100
	B	MEM	100	100	0	100
	C	HE-AB	100	100	8	100
		GG	100	85	22	78
		HE- BG	97	93	13	93
	D	OS	93	95	15	88
	E	TEC	100	95	5	100
	F	RM	98	76	56	80
Master	B	MS	100	100	0	100
		EM	100	100	0	100
		UA	77	77	8	77
	E	LSN	91	73	0	73
	F	GDL	100	80	60	80

These results seem to illustrate that students liked to hear their lecturers' voices. In the interview, some of them mentioned that they felt a sensation of proximity with their lecturers. Again these results are in accordance with several authors' conclusions [16], [1], [11] about the power of spoken word and the human voice in podcasting.

However, 60% of the students from Groups' Dynamics and Leadership (GDL) and 56% of the students enrolled in Research Methods (RM) found podcasts too long but these were precisely the courses with the longer podcasts (Table 2), once again reinforcing the importance of keeping podcasts short.

4.4 Lecturers' Perspectives on the Use of Podcasts

This study integrated 6 lecturers from different Schools (Humanities, Social Sciences, Sciences and Engineering, one from each, and 2 from Education), 1 male and 5 female, ranging in their forties.

All the lecturers had a very good impression about the use of podcasts and they recognised the potential of this pedagogical resource. However, creating podcasts and using podcasts in an effective way is a difficult and time-consuming task, which may limit its implementation. Table 4 synthesises the opinions of the lecturers concerning their experience using podcasts.

Table 4. Lecturers' perspectives on the use of podcasts

Parameters	Categories	(n=6) f	%
Acceptance	- very positive	6	100
Planning	- write the podcast text and read (rehearsal)	6	100
	- live recording (no rehearsal)	1	17
	- reading a text (from a book)	2	33
	- podcasts already available	1	17
Advantages	- pedagogical novelty (students' motivation)	6	100
	- availability and flexibility (anywhere and everywhere)	6	100
	- effective in delivering course content, information, guidelines, feedback, and so on	2	33
Constraints	- time consuming	6	100
	- lack of institutional recognition	6	100
	- ICT students' literacy (lack of familiarization)	1	17

Using podcasts as a pedagogical resource was considered by all lecturers a very positive experience. Podcasts were perceived as a very useful and powerful strategy for improving classes and motivating students, regardless of the type of podcast implemented and of the specific course.

Regarding podcast planning, most of the teachers preferred to write the podcast text. Most of them referred to the necessity of rehearsing the podcast in order to make it more clear and effective. This leads to one of the recognized difficulties of podcasting: the time required for its production. There are some exceptions, for example: lecturer A recorded a live speech (intentionally, for students to practice orthographic transcription); lecturer F used an available interview; and lecturer E read excerpts from books.

Lecturers considered podcasts worthwhile, mainly because they see them as an opportunity for pedagogical innovation, which can positively influence students' motivation. Besides this advantage, podcasts are permanently available allowing students to listen to their content at any time, whenever they need or want it.

Podcasts may also provide extra material related to the course or even course contents, giving time for the development of other pedagogical activities in class.

However, all lecturers pointed out that producing podcasts is a very time-consuming task. The information to be read must be carefully chosen and rehearsed in order to achieve the aimed result. Then it is necessary to create the record conditions, including a soundproof and isolated environment. Moreover, it is necessary to become familiar with the required software which, despite not being very complex, is not that simple and is not error free.

Most of the lecturers also mentioned that the time spent and the effort made are not recognized by the institution.

Despite the drawbacks identified, lecturers plan to continue using podcasts, introducing modifications to the process, trying to minimize the required production time, and enlarging the experience to other contents and other podcast types. Reusability seems to be a key issue in recovering from the effort made.

5 Conclusion

Podcasts are being used in higher education. Lecturers are using them with different purposes and applying different production approaches. They considered the introduction of podcasts in their courses a very positive experience, as they are an effective tool in delivering content, feedback, guidelines, etc. Most of the students accepted quite well the podcasts, but they did not take the advantage of listening to them in their mobile devices.

Lecturers considered that podcast production is time-consuming and there is a lack of institutional recognition of their teaching effort. However, they intend to continue using podcasts in their courses.

Due to the positive results achieved, a study in a distance learning course will be conducted to analyze the effect of podcast types (informative, guidelines and feedback) in students' motivation to task achievement.

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Design Patterns for the Use of Technology in Introductory Mathematics Tutorials

Christine Bescherer and Christian Spannagel

University of Education Ludwigsburg, Reuteallee 46, 71634 Ludwigsburg, Germany
bescherer@ph-ludwigsburg.de, spannagel@ph-ludwigsburg.de

Abstract. Learning mathematics actively, oriented at mathematical processes, in a technology-enhanced learning environment differs widely from learning in traditional mathematics courses. The traditional lecture – an expert presents the knowledge the learners have to acquire – usually doesn't activate the students' thinking. This article introduces three didactical design patterns which describe how university students can be enabled to use technology in order to explore and solve mathematical problems in open learning scenarios: TECHNOLOGY ON DEMAND, HELP ON DEMAND, and FEEDBACK ON DEMAND.

Keywords: Integration of ICT, Open Flexible Learning, Problem Solving, Teacher Education, Teaching Methods, Assessment, Didactics, Higher Education, Learner-Centred Learning, Learning Mathematics.

1 Introduction

Teaching mathematics is often understood as presenting solutions to given problems. In universities, many introductory mathematics tutorials which accompany lectures are exactly designed in this way: experts (professors, lecturers or tutors) develop solutions on the chalkboard [1]. Students follow the demonstrations and take notes or – more precisely – try to follow the lecture. This approach to mathematics teaching does not foster active thinking and problem solving. Students at least in the first semesters are encouraged to copy standard solutions and not to develop creative strategies by themselves. In addition, students do not communicate and collaborate – they just listen.

Bescherer, Spannagel, and Müller [2] introduced a pattern for introductory mathematics tutorials in order to foster active, collaborative, and process-oriented mathematics learning: ACTIVATING STUDENTS IN INTRODUCTORY MATHEMATICS TUTORIALS (*Pattern for introductory mathematics tutorials following a constructivist approach*). Students work in small groups (three or four persons) on complex problems supported by tutors. Every week, a set of 5 to 6 new problems is given via a learning management system (LMS). Students are allowed to choose the problems they want to work on. They are encouraged to work on the problems in groups during the tutorial session or at other times.

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Tutors do not give “the correct” solutions. They guide the students doing mathematics by asking the right questions and giving hints on strategies. Furthermore, students are allowed to use every resource they want: they may use books, the internet or computer tools like spreadsheet calculators or dynamic geometry systems (DGS). Especially the use of technology requires the learning scenario to be designed in a special way so that the IT is used as a thinking tool and a medium for exploration and not just to do the complicated math.

In section 2 three aspects using technology in introductory mathematics tutorials are described: TECHNOLOGY ON DEMAND, HELP ON DEMAND, and FEEDBACK ON DEMAND. The structured description format of didactical design patterns is used to support the understanding and the reusability.

The idea of design patterns to describe working solutions to recurring problems originates from architecture [3] and software design [4]. To use design patterns for describing pedagogical problem solutions is not a new idea. On the site www.pedagogicalpatterns.org there are a lot of patterns available. However they describe the pedagogical problems in a very broad way and have to be adapted quite extensively to i.e. introductory mathematics tutorials at university level. Therefore we think that pedagogical decisions in teaching subject matters always depend – among other things – on the subject immanent particularities. That is also why we call our patterns ‘didactical design patterns’ following the German idea of ‘didactics’ as the science of learning and teaching a specific subject i.e. didactics of mathematics or didactics of foreign languages. ‘Pedagogical’ in our view is not related to a specific subject.

The first and the second of our patterns focus on how technology can be integrated into introductory tutorials where students work actively on complex math problems.[1] The third pattern deals with the assessment of the students’ work in order to give them informative feedback on their mathematical processes. Conclusions and remarks about future work are explained in section 3.

2 Three Patterns for Technology-Enhanced Mathematics Learning

2.1 The TECHNOLOGY ON DEMAND Pattern

2.1.1 Problem / Challenges / Motivation

Students solving math problems should learn *when* to use *which* software in *which* context. They should be able to use the software whenever they think it will be useful. Students should experience the usefulness of technology solving mathematical problems and reflect on it.

2.1.2 Forces

- To solve math problems with IT is not always necessary so there has to be created a demand for technology to solve the problems.

[1] Of course technology is not always necessary to solve mathematical problems but there are enough examples of traditional math tutorials so we don’t follow this line of discussion.

- Students have no or low abilities in using related software in itself so they avoid using IT as long as possible.
- Exploring mathematical assumptions using technology requires i.e. systematic approaches of varying specific parameters and keeping track of the changes which are not normally known to students from school.

2.1.3 Solution

Math problems are selected where the use of technology is necessary. There are several ways to achieve this: (1) Problems must be of sufficient high complexity. (2) Problems must induce operations which would be too much work or too monotonous work to be done by hand (for example, always the same calculations with different data). (3) Representations or visualizations of data which can't be created efficiently without the software are needed to solve the problems.

Students get instructions how to use the specific software (s. section 2.2). Math problems should contain hints on which software is appropriate. These hints should be as open as possible. For example, they should not mention specific software packages (as Open Office Calc), but types of software (as spreadsheet calculation programs). Ideally, alternatives are given in a way that students can reflect on the advantages and disadvantages of different tools in the specific context. In addition, students must have access to computer tools whenever they need it.

The phrasing of the problems includes questions, tasks and hints which guide the exploring using the technology without suppressing the possibility to follow own ideas and other paths.

2.1.4 Rationale

The learning of software usage is most effective in contexts where it is necessary to use the software. The need to use a software tool should come before the instruction not the other way around. This is called *just-in-time learning* or *learning-on-demand* ([5],[6],[7]).

Computer applications are cognitive tools when they support people's thinking. "Cognitive tools refer to technologies, tangible or intangible, that enhance the cognitive powers of human beings during thinking, problem solving, and learning." ([8], p693). Cognitive tools allow for creating useful representations, they help to explore a given situation in microworlds, they support deep thinking about content, or they just take away routine jobs from the learner to free cognitive resources [9].

Cognitive tools in the context of learning mathematics can be spreadsheet calculation programs, dynamic geometry systems, computer algebra systems, or simply handheld calculators. The problems have to be posed so that the software i.e. allows to explore an assumption or to falsify the obvious first idea to a solution. If the software can be simply used to avoid thinking then the problems has to be changed.

2.1.5 Examples

A typical geometry problem inducing the need for technology is the following:

*Given the instruction of inversing points with respect to an inversion circle (*without giving away the mathematical term*), explore the following questions:*

- *What is the inverse of a line?*
- *What is the inverse of a circle?*
- *What happens if the circle is moved?*

Hints/Techniques:

- *You can use a dynamic geometry system for exploration.*

A similar example in the field of algebra (cf. [2]):

Make conjectures of several unit fractions concerning their decimal representation.

- *What kind of decimal do you get?*
- *If it is not a terminating decimal: How long are the periods and the delays of the periods? Make conjectures on the base of your data.*
- *Which properties determinate the kind of decimal? Which properties determinate the length of the period and the delay?*
- *Test your hypotheses with other unit fractions.*

Hints/Techniques:

- *You can use the spreadsheets made available in our LMS.*
- *Which of the unit fractions are good indicators for your conjectures?*

2.1.6 Related Patterns[2]

Activating students in introductory mathematics tutorials, help on demand, feedback on demand

2.2 The HELP ON DEMAND Pattern

2.2.1 Problem / Challenges / Motivation

Students differ in their computer fluency and in their previous knowledge regarding software used in the math tutorials. All students should be enabled to use the tools for problem solving without spending too much effort in learning the tools.

2.2.2 Forces

Often the software is taught before students really need it. This may result in lengthy demonstrations of complex procedures. But normally some students already know how to use the tools. For those the demonstration is unnecessary and boring. For novices, it can be too much information in advance, and afterwards they don’t remember what to do.

2.2.3 Solution

Help on technology must be right at hand *when the information is needed*. In the first place, peer support should be fostered. Students can help each other when working together at the same computer. Tutors may also give hints on how to use the software.

In cases where students use the software alone at home, or where all students are likely to be novices regarding a specific tool, instructions should be given where the

[2] This section lists all related patterns and is also an inherent part of a didactical design pattern.

core procedures are described. Procedures explained should be analogue to those needed by the students and not step-by-step explanations of how to solve the given problem. The worked example should be a mathematically simpler example where all the essential procedures are mentioned that can be used in the current problem situation as well. This approach is part of LoDiCs – methodical structures used to learn IT use and fundamental principles of information technology while working on subject matter problems – which were introduced by Bescherer [6].

Instructions for using software can be text manuals, interactive worksheets or screen videos. These can be provided in the LMS for download. Thus, students can access them on demand.

2.2.4 Rationale

The use of an analogue example to introduce all the necessary software features for solving a specific mathematical problem is derived from the modelling and scaffolding parts of the cognitive apprenticeship model introduced by Collins, Brown, and Newman [10] and discussed in detail in Bescherer [6].

Users of software applications do not read the documentation in advance; they access it when they face a problem ([11], [12]). They need *just-in-time help*. Although integrated help is often ignored by users, research shows that accessing on-demand help may lead to better learning outcomes [13].

Manuals should be modular, task-oriented, contain as little text as possible, and should include information about error-recovery ([14], [15]). In addition, screenshots may help to build mental models and to identify interface elements ([16]).

Screen videos should be accompanied by simultaneous spoken text (*modality principle* and *temporal contiguity principle*; [17]). Although initial research regarding the effects of animated demonstrations was disillusioning [18], there is evidence that carefully designed screen videos may lead to a better performance compared to text manuals ([19], [7]).

2.2.5 Examples

Given the geometry example of section 2.1.5, screen videos can be produced which show the basic procedures needed to explore the *inversion with respect to an inversion circle*: how to draw a circle, and how to draw a perpendicular line.

The algebra example of section 2.1.5 is part of the LoDiC ‘Decimal Fractions’ which can be found online at www.lodics.de.

2.2.6 Related Patterns

Activating students in introductory mathematics tutorials, technology on demand, feedback on demand

2.3 The FEEDBACK ON DEMAND Pattern

2.3.1 Problem / Challenges / Motivation

To support learning processes informative feedback shouldn’t be given only on the resulting products i.e. the mathematical solution but also on the mathematical processes like algebraic transformations, comparing different sequences of solution steps up to higher level processes like reasoning, representing, problem solving, and the learning process itself. This is a challenge not only in large introductory lectures with many participants but also in small tutorial groups, because tutors cannot monitor all processes performed by 10 or 20 students simultaneously. Students should be able to get process-oriented feedback when they need it (*demand claimed by the student*), and lecturers should be able to select interesting (correct or wrong) mathematical processes for discussion in the lecture sessions (*demand claimed by the professor or lecturer*).

2.3.2 Forces

Students need feedback on their mathematical processes in order to improve them and on their learning process to know 'where they stand'. Tutors can only monitor the process of one student or one team of students at the same time. Feedback on mathematical processes can be complex and time-consuming: especially learning processes must be observed over some time. Once a process is diagnosed, feedback must be carefully chosen to be informative, encouraging, and not intimidating.

2.3.3 Solution

Processes are recorded and analyzed by specific software tools. Normally there are many different processes involved leading to the correct solution of a complex mathematical problem. And there are even more 'wrong paths' followed in solving mathematical problems by students. It would be impossible to implement algorithms which record and classify *all* processes correctly. Instead it is often sufficient to detect standard solutions and standard mistakes. Processes which cannot be automatically categorized can then be forwarded to the tutor or lecturer to be assessed (*semi-automated assessment*, [20]). This means:

- There must be tools which are able to record and analyze processes performed in applications like DGS or spreadsheet calculators. These can be generic tools which are able to analyze user-program interactions (like *Jacareto*; [21]), or analysis features directly implemented in the applications (like the theorem checking technique in *Cinderella*; [22]).
- Students must be able to ask for process-oriented feedback, for example by clicking on a "feedback"-button. If the analysis tool is able to classify the process, feedback can directly be given. Otherwise, the record of the process can be send to the tutor or lecturer for assessment.
- The lecturer must be able to browse the recorded processes and select interesting (correct or false) ones to be presented in the next lecture session. Thus, there must be a repository of processes submitted by the students (cf.[23]). In addition, process records must be stored in a manner that they can be replayed for demonstration. This can be done with capture & replay tools like Jacareto [24].

2.3.4 Rationale

To give adequate feedback, theory on feedback and assessment must be considered (i.e. [25]). Assessment is the "systematic evaluative appraisal of an individual's ability and performance in a particular environment or context" ([26], p. 474). It is normally based on artifacts (papers, written tests, portfolios, …) as well as teacher observations, oral contributions, or learners' presentations. It becomes *formative assessment* when it is used to improve teaching and learning which means "the evidence is actually used to adapt the teaching work to meet learning needs" ([27], p.10).

Regarding assessment in learning mathematics there is a worldwide discussion going on that changes in teaching mathematics are connected strongly to changes in assessment of mathematical knowledge. The *Assessment Standards for School* were published by the National Council of Teachers of Mathematics in 1995 with the emphasis on *assessing student's full mathematical power* instead of *assessing only students knowledge of specific facts and isolated skills*, or the demand to regard assessment as something continual and recursive and not something sporadic and conclusive ([28], p.83).

It is important that process-oriented feedback is informative and does not create negative emotions. It should strengthen the perceived competence of the students which is an important factor for motivation [29].

Semi-automated assessment reduces the claim to automatically interpret *all* processes. Instead, it combines the ability of computers to detect standard solutions or mistakes and the professional skills of the tutors and lectures to understand exceptional solutions. For further background on intelligent assessment where semi-automatic assessment is a part of see [20].

2.3.5 Examples

The three year project SAiL-M (semi-automated assessment of individual learning processes in mathematics), started at the end of 2008 and funded by the German Federal Ministry of Education and Research is working on implementing just this kind of semi-automatic feedback. We are currently working on several examples which will be implemented in the summer term 2009.

In the algebra example of section 2.1.5 a checking-system can be developed which checks whether a fraction is terminating or periodic with or without delay and gives feedback on the learners' assumptions. This can be done with an underlying computer algebra system and would be an example for feedback claimed by the learner.

Process-oriented feedback can be given if the student hasn't checked out all types of fractions. Then it can be assumed that he can not form a hypothesis yet, the feedback will be something like "There are still more types of fractions. Check them out before you hypothesize."

2.3.6 Related Patterns

Activating students in introductory mathematics tutorials, technology on demand, help on demand

3 Conclusion and Future Research

The three patterns introduced here are dealing with aspects of active, technology-enhanced, and process-oriented learning in introductory mathematics tutorials. It has been emphasized that the problem should create a demand to use technology, the help and feedback should be provided on demand only. This follows the philosophy of open learning scenarios – a radical change in lecturers' as well as students' thinking about learning mathematics.

Process-oriented feedback is very task-specific and must be implemented for each class of problems separately. Therefore it is useful to have frameworks which facilitate the implementation of process-oriented feedback (cf. [21]). Concerning semi-automated assessment there are still many open research questions.

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Learning by Peers: An Alternative Learning Model for Digital Inclusion of Elderly People

Márcia Barros de Sales[1], Ricardo Azambuja Silveira[1], André Barros de Sales[2], and Rita de Cássia Guarezi[3]

[1] Federal University of Santa Catarina (UFSC), Brazil
marciab@inf.ufsc.br, silveira@inf.ufsc.br
[2] University of Brasília (UNB), Brazil
andrebds@unb.br
[3] Institute for Advanced Studies, Brazil
ritaguarezi@iea.org.br

Abstract. This paper presents a model of digital inclusion for the elderly people, using learning by peers methodology. The model's goal was valuing and promoting the potential capabilities of the elderly people by promoting some of them to instruct other elderly people to deal with computers and to use several software tools and internet services. The project involved 66 volunteering elderly people. However, 19 of them acted effectively as multipliers and the others as students. The process was observed through the empirical technique of interaction workshops. This technique was chosen for demanding direct participation of the people involved in real interaction. We worked with peer learning to facilitate the communication between elderly-learners and elderly-multipliers, due to the similarity in language, rhythm and life history, and because they felt more secure to develop the activities with people in their age group. This multiplying model can be used in centers, organizations and other entities that work with elderly people for their digital inclusion.

Keywords: Learning by peers, third age digital inclusion.

1 Introduction

Population aging is a worldwide phenomenon. Developing countries are going through an accelerated demographic transition process, due to the gradual increase of life expectancy and the decrease in the birth rate. These factors are associated to urbanization, nutritional quality of food, improvement in work conditions, sanitation and dwelling, with a relative improvement in quality of life. Besides those factors, new scientific advances and discoveries in the health and technology areas contribute to the population's longevity.

According to the Institute for Applied Economics Research [1], the number of elderly people in the population has been growing and will still grow worldwide. In Brazil, this increase has modified significantly the profile of the populational pyramid,

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causing what the scholars call rectangularization. These demographic projections indicate our elderly contingent in 2025 will rise to 32 million, putting Brazil in sixth in the world [2].

According to [3]; [4]; [5]; [6] the elderly person has the interest and the possibility to achieve a certain autonomy with the computer, and the contact with computers can propitiate some benefits, such as better social interaction and mental stimulation. However, promoting the elderly inclusion in the digital world context demands, above all, considering their language, life history, cognitive, emotional and physical alterations, among others. It is also imperative, besides the mentioned characteristics, to mold accessible teaching methodologies and to map the guiding and facilitating pedagogical principles for the elderly learning.

Cognitive and emotional alterations come from age advance and manifest in several forms. After the identification of these changes, there must be more directed studies that assure the accessibility to the computer and its communications and information tools by the elderly user.

Aging defies easy definitions, at least when it comes to biological terms. Aging is not the mere passing of time; it is the manifestation of bio-psycho-social events that occur during a period of time, as [7] comments. There are significant evidence of decline related to aging, and alterations in the cognitive process are the most relevant. As people age, there might be alterations such as: decrease in retaining short-term memory, visual acuity, hearing, fine motor coordination, locomotion and others. Aging cannot be associated only to chronological age. According to [7], to define this stage in life it is also necessary to consider the different rhythms in biological aging, which vary from person to person, as do potentials for each person in advanced age.

Comprehending the cognitive perspective as to the elderly user infers directly on the building time of a knowledge, since aging may or may not be accompanied by the decrease in some cognitive functions. Some life habits might interfere and accentuate the decrease in those functions, such as contact/life in stressful environments, lack of physical fitness, excessive workload, isolation, depression, stress, improper use of medication and emotional or nutritional problems [7]. Although in the fourth or fifth decade of life the cognitive alterations do not compromise the individual's daily life, they evolve extremely variably among people. At that age, the responses to stimuli become slower and less precise. Those effects tend to appear as tasks become more complex. Elderly people may also present difficulty in focusing, retaining information in the work memory, rapidly processing information, formulate conclusions and make interpretations, especially when encoding and understanding certain speeches [7], [8].

In elderly people that do not present the risk factors mentioned for cognitive deficit and compromising of their activities, [8] and [7] highlight that the cognitive functions remain intact and suffer virtually no decrease. They stress that the performance related to the ability to read and write remains unaltered, and the vocabulary may even increase.

Researches [9]; [7] point out memory alterations as the most frequent complaint from the elderly, an obstacle usually associated to the difficulty in remembering names, phone numbers, texts and places where objects were put, which does not imply in significant decreases. Associated to the issues above, for aging people, there are also the ones related to self-esteem and digital inclusion.

2 Self-esteem and Digital Inclusion

For the elderly person, self-esteem might oscillate constantly. Among the factors that promote self-esteem is, mainly, good physical and psychological health, since it works as a defense and confrontation mechanism. Retirement can favor isolation and loneliness, in a moment when feelings of loss, insecurity and sadness penetrate the individuals. For the elderly, this change brings with it a reduction in daily life activities, and can make them unmotivated, apathetic and with a reduced self-esteem, favoring social isolation. This attitude may cause future focus, reaction and coordination problems [10].

According to [11], there is an important relationship between self-esteem and technology, since becoming autonomous in a new skill can increase self-esteem, defended by the author as a factor that plays a powerful part in the process of appropriating new technologies by the elderly. Thus, it is fundamental to consider all the aspects that might influence the elderly person's interaction with the communication and information tools available on the Web as ways to digitally include that public. Communication is a fundamental factor to keep and increase the social circle and, therefore, to elevate self-esteem. Those factors justify the importance to create interaction alternatives to insert the elderly person in activities such as the use of computers and its communication and information tools, that stimulate, integrate and can expand their life goals, also approaching them to similar technologies, like cell phones and ATM machines, making their utilization easier.

A survey done by the American Association of Retired Persons [12] reveals that the population over 50 years old searches for information on health, life quality, news, finances, retirement plans and education. In the entertainment category there are games, relationships, travel and sports websites. We first understand this contact with the computer allows the elderly person to meet other people and to connect to the cyberspace, and it can offer a new knowledge network and increase their social interaction and independence, through communication, information and interaction tools, further contributing especially to their emotional and psychological welfare.

3 Multipliers: Peer Learning

The multiplier is an individual who acts trying to develop their interpersonal relationships, as to cooperation and motivation [13] According to the author, the multiplier is the student-teacher that performs action roles along wit their classmates (peers), allowing them to also think about their practice in a systematic way.

According to the documents from the Health Ministry [14], the desirable multiplier profile is initially identified with the interest and availability to perform the part of course instructor/facilitator. Previous experience might contribute, but it is not fundamental considering the attributions of most interested people in being multipliers. Another relevant characteristic is initiative, the ability to organize, disseminate and motivate workers to participate in the courses. Good ability for articulation with other areas in the institution and other institutions, and easy interpersonal relationship.

Thus, to achieve this research's goals, the authors propose using, in digital inclusion programs for the third age, the role of the multiplier as a social agent/actor to replicate their acquired knowledge to others, based on the concept of peer learning, in which individuals with similar social-cognitive profiles play the part of facilitators in the teaching-learning process. However, this must be done with a didactic background, that is, with material that gives pedagogical support to a certain theme. Besides, the multiplier must have some attributes, such as: initiative, motivation, good will and selflessness.

We must also consider social and psychological factors that might influence the elderly participation in educational programs and in learning activities, such as: their taste for learning activities that encourage openness and sharing, both essential to the participant's satisfaction; the taste for programs and activities that stimulate their interest in society and provide meaningful discussions in which they can express their ideas and points of view; activities that respect their physical limitations, including sight, hearing and mobility that minimize barriers such as time, place and costs [15].

To complement the exposed, [15] says peer[1] learning has been the base of programs aimed at elderly people, highlighting that these programs have a feature that distinguishes them from other adult education programs: the activities are organized and lead by volunteers.

Peer learning suggests also that educational activities should be done in order to facilitate or encourage the student-student interactions, which require the involvement from all participants in planning and executing the activities.

However, [15] also highlights the importance of diversity, since the elderly are different in several contexts, such as: family, work, health, education, income, social experiences, history and individual abilities. It is hard to describe all elderly people as "peers", and ever harder to fit them into one category, like above 65 years of age or retired. Those denominations only hide diversity, creating a false group identity; that is, if diversity is not acknowledged, the educational activities will not use the various and fascinating ways through which individuals learn and interact.

4 A Case Study

The Center for Third Age Studies at Federal University of Santa Catarina (NETI/UFSC) has as its goal to make available to the community their knowledge about Gerontology, developing studies and researches and inserting those people in the academic world as individuals under transformation and society transformers. It excels in valuing the potential of the socially productive elderly population, the promotion of knowledge-building elderly people and it transmits information to the society, promoting an educational process in which the elderly people themselves are agents in the story. NETI offers several activities and courses aimed at the elderly, such as: training gerontology action monitors; personal growth groups; storytellers and language courses, among others. The center receives today around 600 elderly people.

In the past years, NETI/UFSC registered about 150 elderly people interested in learning computer and Internet skills. They also verified that some students who took

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[1] The word 'peer' suggests individuals similar in position, age and interests, fitting them in the same generation or social level [15].

computer classes outside NETI complained about the rhythm and heterogeneity of the classes, varying from the young to the elderly. Consequently, some of the elderly students could not keep up with the group in which they were inserted, making the situation embarrassing and leading them to abandon classes.

Seeing this difficulty, in March 2003 we started the extension project entitled "Internet workshops for the third age", at the Computer Science and Statistics Department in UFSC, with NETI's support. This project extended for two more years, receiving about 60 students in total.

During the time the workshops were given, we observed some elderly students, by their own, helped each other. That happened when they noticed a class peer was having some difficulty/doubt or when they were asked by their peers, being always ready to support them, regardless of interference from the workshop teacher. This procedure gave the impression that there was a better understanding among them, because of the similarity in their life history, rhythm and language.

The reported experience gave an impulse to elaborate a study, in mid 2005, that intended to work with elderly multipliers and achieve an even larger public. We had the goal to capacitate elderly multipliers because of the ease in communication and learning among peers with the same characteristics and age, since the learners felt more comfortable (less embarrassed) solving their doubts with their fellows. Another relevant factor we noticed during the workshops was the third age group's receptiveness as to volunteer work, seen by some as a way to feel useful and practice citizenship, helping the next person, which matches the fact they have time to do it. For such, we needed to capacitate them with basic computer knowledge so they could be multipliers and disseminate the knowledge learned to other elderly people, a vision that combines with the one from [15], when referring to peer learning.

This research is based mainly on the procedure orientation of action-research, a method that reunites several social research techniques, with which a collective, participative and active structure is established at the information capture level, thus requiring the participation of people involved in the investigated problem [16].

Divided into three stages, the multiplier model was applied from 2006 to 2007 in the Infocenter for the Third Age project (LSC/UFSC). In the first stage, the computer workshops were given by the project coordinator. An accessible learning material was developed for the workshops by the project team, in partnership with approximately 10 elderly workshop participants. This process evolved in three versions until it came to the final format of the accessible learning material, objective, concise and didactic for the elderly. The same procedure was done to elaborate a didactic-pedagogical support material for the elderly multiplier.

To capacitate the first elderly multiplier class, eleven elderly people were invited (two men and nine women), with ages averaging 60 and heterogeneous education levels (from elementary to college education). Of those, nine concluded the workshops and all were invited to become multipliers. However, only six had the interest and the desire to be volunteering multipliers.

In the second stage, other 22 elderly people (four men and eighteen women) were selected, with an age average of 66 and educational level ranging from elementary to college education). The differential in this second stage is that the elderly learners capacitated in the first stage ran the workshops, now as elderly multipliers. To give them more confidence and better assist them, the elderly multipliers were divided into two groups to run the workshops, while they were observed and oriented by the project team. Of the 22 elderly learners, 16 finished the workshops. All were invited to be multipliers, but only eight had the interest to become multipliers.

Because of the help from the 14 elderly multipliers, capacitated in stages I and II, other 33 spots were offered in the computer workshops in stage III, in which five men and twenty-eight women participated, with an age average of 64 and educational level ranging from elementary to superior. 27 people concluded the workshops, of which five offered to be multipliers (18.51%). This figure is considered good by the project team, since in this stage no one was invited among the workshop participants to become a multiplier. In the three stages of the project there was an interest from people under 55 years old to be in the course with the elderly.

Each stage lasted three months and encompassed 28 workshops per class, with two two-hour weekly encounters. The workshops were done in the Knowledge Systems Laboratory (LSC), located in the Computer Science and Statistics Department (INE) of the Federal University of Santa Catarina.

The empirical technique of interaction workshops[2] was used, since it demands the direct participation from users in real or simulated interactions, in which they are observed doing a set of specific tasks. The technical team that followed the interaction workshops in the three stages of the project was composed by an ergonomist and a collaborator. With the purpose of capturing the elderly interaction during the workshops in a dynamic and static manner, the following instruments were used: video camera, photo camera, hand notes and questionnaires with open and closed questions.

Thus, the adoption of research-action in this study took place for its flexibility in the successive adaptations to the events, favoring and legitimating the observation process during the workshops. It is interesting to emphasize that in this work there was no elderly person with severe visual, auditory, cognitive, physiological, psychological or motor impairments, just minor decreases coming with age.

5 The Learning by Peers Multiplier Model

The proposal of developing a multiplier model using peer learning focused on the elderly is funded on a participative process that foresees andragogical, pedagogical, ergonomic, gerontologic and selfless mediation to achieve the social and digital inclusion of this public. For such, a multiplier model was elaborated, structures on five fundamental axis that integrate in a dynamic and flexible manner. They are: elderly multiplier profile indicators, training structure, learning material, methodology and evaluation, as described below:

1. **Elderly-multiplier profile indicators:** those are key elements that must be observed in the elderly-learner to identify them as a potential elderly-multiplier:
2. Volunteer: indicates the wish to do something for the community.
3. Cooperative: likes to help or support their peers.

[2] Workshop as an interaction observation technique, different from interaction rehearsals for their informality and the number of participating users. In the interaction rehearsal, only one user can participate, while in the workshop there can be several users.

4. Engaged: assiduity in the workshops. Misses class only for a reason, since he/she considers participating in the group important for everyone's growth.
5. Motivated: interested in always learning more than is being taught.
6. Self-taught: likes to read, write, research various subjects.
7. Optimist: does not get discouraged facing difficulties, always sees or tries to see the good side.
8. Pondered: always expresses him/herself or explains in a calm manner; does not inhibit or embarrass the peer.
9. **Training structure:** encompasses the teaching approaches that must be met; duration of hours/workshops; number of students per workshop; workshop teaching plan. The teaching approach guideline is andragogy and the constructivist principles from learning theories: affectivity, socialization regarding the person's reality, interest, meaning and previous knowledge are some of the principles that should guide the training structure. Training process also requires the development of memory facilitating mechanisms, such as metaphors and group dynamics.
10. **Learning material:** All the material developed must be based on accessibility recommendations, avoiding the so called cognitive overload. The elderly-multiplier will have the same learning material than the elderly-learner plus the didactic-pedagogical support material. For such, two learning materials should be developed:
    i. Learning material for the elderly-learner: it presents accessible and concise contents that respect the elderly person's characteristics referring to learning
    ii. Didactic-pedagogical support material for the elderly-multiplier: it provides the didactic-pedagogical support so that the elderly-multiplier can guide him/herself when capacitating the elderly-learner (teaching plans; guiding document; workshop metaphors; action plans; role call for the students and reviewing activities).
11. **Methodology:** this model's methodology excels in using group work methods, metaphors, empirical methods through individual exploration (planning projects and steps for the exploration and conclusion process); group exploration for the elderly-learner. The use of animation dynamics with the goal of developing participation and creating a trusting, fraternal and comfortable environment among multipliers and learners. Using introducing techniques to make the elderly introduce themselves and talk about their fears, anxieties and expectations. The methodology adopted here must above all respect rhythm, language, life history, as much as the decreases coming from age, such as: reduction in short-term memory, in psycho-motor skills and increase in response time, among others.
12. **Evaluation:** We propose here the evaluation of the capacitating and process learning, that is, along the process, in order to improve it and support the elderly-learner's learning. Everything the elderly do must be assessed. The model proposes the results are evaluated by the project coordinators, through questionnaires, interviews, videos; having the analyzed results, the teaching methodology and the learning material should be evaluated, to adjust the whole process and improve it to be used in future workshops.

6 Final Considerations

The proposed model is a dynamic orientation that allows the generation of activity, dynamics, according to different situations, which may be defined for another situation, goal or context that involves peer learning focused on the elderly. The model stages should be followed in sequence in a recursive manner, to allow adaptations when those are needed.

The work experience with the elderly learners showed to be fruitful: the Infocenter for the Third Age project capacitated 19 volunteering elderly multipliers in the three stages, being four men and fifteen women, with ages from 59 to 77 and heterogeneous educational level. The multiplier model using peer learning made the elderly learning easier and was considered applicable, a fact proved by the results obtained and ratified in the elderly people's reports, both learners and multipliers, and from the technical team's observations, that considered it satisfactory. It was also approved by the elderly people that became multipliers for later classes.

In this study, the computer use is used as an end task, but it is important to emphasize the model is applicable to other contexts that involve elderly people and peer learning. It is very important that the elderly multipliers are motivated with the activities developed, a factor without a doubt important for the success of the peer multiplier model.

The project gave thrust to a deeper research, which was the object of a doctoral thesis presented at the Federal University of Santa Catarina at the end of 2007, developing the final version of the multiplier model, using peer learning focused on the elderly, here presented briefly. With this work, besides contributing to a proposal for elderly people's digital inclusion, we hope to contribute to the aspects linked to their self-esteem, autonomy, legitimacy and, consequently, their social inclusion.

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Teachers' Perceptions about the Barriers and Catalysts for Effective Practices with ICT in Primary Schools

Eva Dakich

Victoria University, Australia
eva.dakich@vu.edu.au

Abstract. This paper presents perceptions of four primary school teachers from two Victorian government primary schools about the barriers and catalyst for effective practices with ICT. Findings of the semi-structured qualitative interviews confirm results of previous studies indicating that access to reliable infrastructure, adequate technical support, and time pressures are still considered to be some of the most significant barriers to successful ICT integration in public schools. Teacher interviews however also reveal that the challenges of integrating ICT in teaching and learning can be counterbalanced by a number of variables, which include: owning a laptop, having access to ongoing professional learning, sharing effective practices, drawing on student expertise and being supported by a whole-school approach to teaching and learning with ICT.

Keywords: Teachers, primary schools, ICT integration, barriers, catalysts.

1 Introduction

Information and Communication Technologies (ICT) have been introduced to schools, yet without fundamentally changing teaching and learning. In most cases they have been adapted to traditional school structures, classroom organisation and existing teaching practices, falling short of facilitating significant educational change and reform [1, 2]. The slow uptake of new technologies has been associated with a combination of the following factors: limited access to ICT infrastructure, lack of technical support, lack of time, insufficient support from school leadership including limited opportunities for on-going professional development [3-5].

Findings of recent research studies reveal that access to current and reliable ICT infrastructure still seems to be one of the major barriers to technology use in schools. For example the results of the 2005 PISA evaluation showed that according to school principals participating in this large scale international study, shortage or inadequacy of hardware and software hinders schools in taking advantage of the promises of ICT [6]. However there are studies [3, 4, 7] that illustrate that even in well-resourced schools, ICT integration lags behind expectations. By observing, interviewing and surveying teachers, students and school staff of two high schools located in Silicon Valley Cuban et al. [4] found that access to ICT does not always guarantee its widespread use in the classroom, and that teachers typically use new technologies to sustain rather than transform their teaching practices. Findings of this study indicated that teachers did not have sufficient time to experiment with new technologies; available

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training was not specific to their needs and was not offered at convenient times. The authors also emphasised the importance of organisational context and the cultural/historical aspects of teaching and schooling over individual teacher characteristics, such as age and gender.

In a mixed methods study of thirty 'tech-savvy' teachers from technology rich elementary, middle and high schools in the United States, Bauer and Kenton [3] revealed that true integration of computer technologies (CT) did not happen, and that even technologically skilled and innovative teachers did not integrate CT consistently into their practices as a "teaching and learning tool" (p. 519). Similarly to Cuban et al.'s [4] findings, one of the key obstacles appeared to be time, along with outdated hardware, lack of software, and discrepancies in student skill level. The authors asserted that the real issue for schools was not so much the number of computers available to students but how they were being used by the teachers. As the evidence from empirical studies demonstrates, digital divide goes beyond "simple binaries of technology haves and have nots" [8, p. 42]. It includes new forms of divide such as mastery and pedagogical understanding of new technologies, and access to relevant and new learning experiences through and with ICT [9, 8, 10, 11].

Wood, Mueller, Willoughby, Specht and Deyoung [12] also emphasised the pivotal role of teachers in successful technology integration. They asserted that most research aiming to understand the barriers to effective integration of ICT drew their conclusions from survey data and occasional observational work. In their opinion such studies do not provide a "context-rich consideration of how these variables are perceived by teachers, and how teachers believe that these variables impact on practice" (p.184). Wood et al. [12] found it critical to allow teachers to reflect and elaborate from their own perspective on what could be the barriers to successful technology integration.

To respond to the gap in contemporary research identified by Wood et al. [12], this paper provides an insight into teachers' perceptions about the barriers and catalysts for effective practices with ICT.

2 Method

Semi-structured qualitative interviews [13] were conducted with four teachers from two Victorian government primary schools located in the western metropolitan suburbs of Melbourne. The interviews were an integral part of a qualitative fieldwork in a mixed methods research project that explored connections between teachers' ICT literacy and pedagogical practices [14]. Participating teachers were selected by purposeful sampling [15, 16], based on professional engagement and innovative practices. Data was collected in 2005. Interviews were audio recorded, and interview transcripts were analyzed by methods of qualitative data analysis [17, 18]. In order to protect the anonymity and safeguard confidentiality, pseudonyms were used [19] when referring to teachers or schools participating in this research.

To ensure the validity [16] or trustworthiness [20, 21] of the findings and interpretations emerging from the teacher interviews, Creswell and Miller's [22] two–dimensional model was utilised. This included triangulation and audit trail or peer review. Findings were triangulated by using multiple sites for data collection, and by using multiple sources and sets of data emerging from the mixed methods project. An audit trail, consisting of peer-review and debriefing by the supervisors of this PhD project, was also used to strengthen the validity of interpretations. While recommended by Creswell and Miller [22], member-checking was not performed, as Boden and Walsh's [23] and Harris' [24] position on this matter was adopted. According to Harris [24] member-checking produces "a new set of data, unable to confirm the original set even though they are likely to be similar" [24, p. 61], and may alter the original findings. However, by some, this could be perceived as a limitation of the study reported on in this paper.

3 Teaching and Learning with ICT

Teachers participating in the interviews (Maria, Kate, Gina and Joanne) demonstrated an acute awareness of the importance of facilitating student learning with ICT. They believed that socialising students into the digital world was one of their responsibilities. Demonstrating a pragmatic viewpoint, teachers thought that empowering students with ICT skills provides them with "skills for work and life" (Gina), which translates into more opportunities for future employment and a better position in the society. Apart from being aware of the social responsibility that comes with the integration of ICT, teachers also realised the pedagogical potential of ICT and perceived it as a "new tool for changing education" (Gina), which offers students more resources and opens up new opportunities for learning. ICT was also viewed as a component of multiliteracies, "a medium for providing students with a range of experiences" (Joanne), and a "powerful instrument for canvassing their learning" (Gina).

3.1 Barriers to Effective ICT Integration

Despite teachers' enthusiasm and genuine intention to provide students with the best opportunities for learning, the effective integration of ICT in learning and teaching encounters many obstacles. Findings of the teacher interviews suggest that some of the major barriers to effective ICT integration are access to software and hardware, unstable networks, issues related to time, and limited technical support.

Kate and Maria are team-teaching grade 3 and 4 students at Kookaburra primary school. In their opinion limited access and technical difficulties prove to be major barriers to successful technology integration: "We have got four computers per classroom. This is in our room, so we've got basically four computers to accommodate 26 students" (Kate). To ensure equitable access Kate and Maria created a timetable to provide all students with equal opportunities of having hands-on experiences with technology. Although this seems to be working well, Maria believes that having more computers would make a real difference:

> *…to be successful, you need every child to have a computer, just like teachers do now. They all have their own laptop, and teachers are using it and learning about it. The only way is hands on. (Maria)*

Technical difficulties often trigger feelings of helplessness and anxiety. Some of the most common technical problems appear to be those linked to unreliable networks. As Maria puts it: "…the problem there which we mainly and always come across is if the network's down ... and I'm thinking: Oh, my God what do we do now?"

At Kookaburra Primary School there is no just-in-time technical support available to assist teachers and students with such glitches. The technician comes in two days per week. Teachers have to register their ICT-related problems into a logbook:

> *....it may take two weeks [for the problem to be solved] - and two weeks is a lot of time wasting for the children. They miss out on opportunities and not knowing so much about computers the both of us, it makes it more difficult ... getting them [computers] working … You can't pull out another teacher from another grade, 'cause it's wasting their teaching time, so it makes it more difficult. That's a big problem that we have. (Maria)*

Gina and Joanne teach grade 5 and 6 students at Platypus Primary School, where in their opinion there are no significant issues with access to new technologies. However, similarly to their colleagues from Kookaburra Primary School, technical glitches and unstable networks often hinder their practices with ICT. According to Joanne such difficulties can be frustrating at times so learning to cope with them is an imperative.

Apart from difficulties related to unstable networks, time and traditional timetables interfere with opportunities for new learning. In Gina's opinion effective practices with ICT are restricted by existing timetables which do not allow time for exploration, research and collaboration:

> *What happens with research - you'd like a bit more time. Once you start getting into it, you'd like to not stop and start. But because of the timetable session of an hour, the children are restrained by time. Say, it was back in the classroom, and the computers could be used quite independently, the students could come and go as needed. (Gina)*

3.2 Catalysts for Pedagogical and Cultural Shifts

Teacher interviews also reveal that there are a number of variables that help minimise the challenges and risks related to integration of ICT and contribute to pedagogical and cultural shifts. Teachers argue that having their own computer and having time to practice their skills help them build competence and confidence in using new technologies. They also believe that professional learning opportunities, collaboration and supportive school culture contribute to effective and innovative practices with ICT.

One of the initiatives that has made a real difference to teachers' use of computers has been the Notebooks for Teachers and Principals Programme, initiated by the Victorian Department of Education and Training [25] in 1998. Since then the Victorian Government has been providing school teachers and principals in Victorian government schools with laptops on a three-year lease period. The results of this initiative speak for themselves. Teachers argue that laptops helped them become more familiar with ICT, and provided them with opportunities to experiment with new technologies in their own time and within their own comfort zone.

> *Before, I knew nothing with these computers. Since having it at home, and having the time (because you never have time at school), I've just learnt so much, and I'm very proud of myself, of what I have learnt, because I was very, very computer illiterate. I was a one-finger, where's-the-A, where's-the-B. (Maria)*

Maria says that having a laptop is very different from having access to a desktop computer at school. Laptops provide flexibility in time and space and convenience, since teachers have no time at school to experiment with technology.

Access to relevant professional development proved to be another important variable. At both schools teacher learning and professional development related to ICT have been supported by the school leadership. However the two schools have nurtured different approaches to ensuring access to quality learning experiences related to the integration of ICT.

According to Kate, at Kookaburra Primary School there is an ICT committee that regularly informs teachers about in-school and out-of-school professional development. Teachers are offered opportunities at staff meetings to attend seminars, workshops, and presentations, which they can choose from. Apart from these formal approaches to professional development, teachers often take the opportunity to share good practices with ICT and mentor each other. According to Kate sometimes a colleague "will come up with what they've done, they'll get a projector ready and we will all go". "Teachers are very good like that here. They are happy to give you time, as long as you can find the time to get together, they are happy to share and teach you" Maria adds.

At Platypus Primary School facilitating student learning with ICT has always been considered important. It is one of the hallmarks of the school. Joanne acknowledges that the school has a vision related the integration of ICT and provides students and staff with resources and opportunities for ongoing learning.

> *It is really important that it just became very much an integrated tool into all areas of the curriculum here, and that we are providing students with the skills that they need, because it is a vital part of their ongoing learning … (Joanne)*

As part of the School's vision, teacher professional development (PD) is a high priority at Platypus Primary. The school leadership facilitates teacher collaboration in order to promote successful integration of ICT in learning and teaching. They offer teachers opportunities to share ideas and learn from each other in the more intimate and comfortable environment of smaller groups referred to as Professional Learning Teams. Working in smaller teams within the school environment reduces some of the pressure and counter-balances anxiety and information overload. It encourages teachers to learn at their own pace and reach beyond their comfort zone without experiencing significant levels of frustration.

> *We PD among ourselves…and [the school] put on a PD for us… trying to keep us all moving forward, but it is in within your comfort zone, it's what you feel capable and comfortable with sticking up and running with. So we have the extremes, and a lot of people in the middle, who are very OK with more common programs like Word and PowerPoint and possibly Publisher. But there are those who are committed to looking into some of the other wider possibilities as well. (Gina)*

Platypus Primary takes a holistic approach to ICT integration. It has an ICT manager that strategically works with students and staff to improve teaching and learning with ICT. Apart from providing teachers with just-in-time professional development and technical support, the school draws on mobilising student expertise in order to minimise challenges such as technological glitches and diverse skill levels in using ICT. The importance of drawing on the expertise of students has been widely recognised by this school through organising a special programme for students interested in ICT or having advanced skills in using new technologies. The programme prepares them for peer-teaching and for co-teaching with teachers. Joanne argues that this valuable initiative enables students to share their expertise and develop their leadership skills.

> *[It] provides an opportunity for students who have a talent in a particular area, to have that talent explored further, and the expert's program enables all children to have an opportunity to develop those leadership roles, and I think if you are encouraging students to take on those leadership roles it is really important to provide the opportunities for them to refine their skills in that area and give them opportunity to use them (Joanne).*

Supportive school culture contributes to significant changes in classroom relationships and teaching philosophies thus facilitating pedagogical and cultural shifts. According to Gina, roles and relationships are changing in the classroom as students are often more confident users of ICT than teachers. She sees a potential for professional growth in this: "Students bring a lot more of the expertise in the area of ICT, they are so much more immersed in it, and I think, as a teacher you have potential to grow" (Gina). Although she is a confident user of ICT, at times she is ready to take up the role of the learner and learn from her students:

> *I often say to the kids: "Well, yeah, you showed me, that's great". And I think if you stay open to the learning, basically they stay open to the learning as well and they feel a sense of achievement and comfort, and leadership too, that they have this knowledge that they can share with you, it's a two-way street, I think the relationship has changed… (Gina)*

Joanne believes that education is about learning from each other. The teacher's role in such a learning environment is to scaffold the learning experiences and student collaboration, as well as to question existing interpretations and look for alternatives. Joanne willingly takes up the role of the learner when it comes to new and emerging technologies.

> *Education, particularly in my classroom, and I think education in general, is a co-learning experience - we learn from each other... Where the children feel confident to develop their leadership skills, where they feel confident to explore new understandings, and question things that are happening, and to offer alternatives to them... From a pedagogical practice idea of co-learners I see myself as learning to use ICT... So quite often I say to my students that I am learning this with you. (Joanne)*

4 Conclusions

This paper contributes to current interpretations of barriers and catalysts for effective practices with ICT by reporting on the perceptions of four teachers teaching in two Victorian government primary schools. While the generalisability of findings may be limited by the small number of participants, results of this study provide important leads for schools and policy developers in maximising their efforts to respond to the challenges of ICT integration in contemporary primary schools.

Teacher interviews reveal that when integrating new technologies operational risk management comes before pedagogical innovation. Findings confirm the results of the 2005 Pisa evaluation [6] according to which access to reliable ICT infrastructure appears to be the most significant barrier to effective practices with ICT. The effects of technical problems are further amplified by the lack of just-in-time technical support, which results in increased anxiety and a focus on risk management [26, 27], hence decreasing teachers' creative capacity to transform student learning with ICT.

Time also appears to be an important variable affecting the integration of ICT. Similarly to Cuban et al. [4], teachers participating in this study argue that lack of time to experiment and learn about new technologies hinders their integration of ICT into the learning environment. More importantly time constraints also appear to influence classroom practices, with traditional timetables interfering with new pedagogies and innovative approaches to teaching and learning.

Teachers also report on a number of variables that act as catalysts to effective practices with ICT. These include owning a laptop, having access to professional learning opportunities, sharing effective practices, drawing on student expertise and by being supported by a whole-school approach to technology integration. Findings of this study indicate the having access to their own laptop eliminates the traditional boundaries of time and space and provides teachers with flexible opportunities for experimenting with new technologies. This in turn increases teachers' confidence and competence in integrating ICT in their professional practices. This finding corroborates the results of the teacher survey (which was also part of this research project), indicating that having access to computers at home has a statistically significant influence on all dimensions of teachers' ICT literacy, including teachers' pedagogical understanding in facilitating student learning with new technologies [28].

Finally, findings suggest that the integration of ICT is more effective when supported by a whole-school approach that draws on teacher collaboration and on student expertise. The example of Platypus Primary School demonstrates that ICT integration is more successful when teachers are provided with relevant, 'just-in-time' professional learning [29] in a familiar environment that allows them to move forward with ICT within their comfort zone. These findings support Demetriadis et al.'s [30] and Coppola's [31] observations according to which "teachers learn better in the real setting of their own workplace when they are not isolated culturally and structurally" [31, p. 37]. In such communities of practice [32, 33], teachers are more likely to engage in ongoing learning related to the integration of ICT, which helps them develop their agency to facilitate pedagogical and cultural shifts.

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Transformative Personal Development: Helping Teachers to Thrive on Discontinuous Change

Maureen Haldane

Manchester Metropolitan University, UK
m.j.haldane@mmu.ac.uk

Abstract. Many professional development opportunities offered to serving teachers address potential performance improvements or responses to change that are essentially incremental in nature. However, some challenges and opportunities particularly those relating to new technologies, involve addressing a more discontinuous change process. The Transformative Personal Development (TPD) model is derived from in-depth evaluations of one such change process, the introduction of digital interactive whiteboards in schools. This provided an opportunity to examine in some detail how teachers who had successfully adopted the technology, had acquired the capability so to do. The paper also refers to work in progress that will assess the applicability of the TPD model to other contexts where the change process also has a significant element of discontinuity, such as the introduction of hand-held devices in the classroom, the design and implementation of new learning spaces and the possible uses of "Second Life" in Higher Education.

Keywords: Professional development, pedagogy, ICT, interactive whiteboards, communities of practice.

1 Introduction

1.1 Responding to Continuous Change

Most Continuous Professional Development interventions are essentially a constructivist process; a considerable depth of existing expertise is usually available within the group providing a resource to draw upon when introducing certain new ideas and perspectives directly applicable to the participants' employment context. In these circumstances a "wiser other" [1] may adopt an essentially instructivist approach to conveying the relevant new knowledge, but the individual and shared reflections of participants can be harnessed to capture its relevance and applicability to the context of each participant. Thus, on completion of the training participants would typically be fully equipped to deploy the new learning in their workplace. However, there are some current and imminent change processes that go beyond taking new ideas and applying them to our existing context.

Some change processes are more discontinuous in nature in that some aspect(s) of the context itself, such as the technology deployed, or the physical or virtual learning environment, also change significantly with consequential opportunities to change the teaching and learning paradigm.

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The first wave of learning technologies represented a significant challenge in that the acquisition of the levels of ICT literacy necessary to deploy them effectively was quite demanding, particularly in the days before teachers were able to acquire the necessary skills through computers available for personal use or as part of their own education. Within an ICT laboratory or workshop the pedagogic and classroom management techniques necessary to make effective use of the technology are, in essence, an extrapolation of those used in familiar contexts such as science laboratories or design technology workshops, in that tasks and problems are set for an individual or small group to resolve. The technology deployed within a typical classroom did not however change in any revolutionary manner.

Imagine for a moment if it were possible to transport people from the workplaces of the late 19th century into the present day. Most of those for whom comparable job functions still existed would be totally bewildered and likely to find the technologies in use today totally incomprehensible. However, there are many classrooms in our schools today that would look very familiar to any 19th-century teacher. It would only take a few minutes to explain that in the 21^{st} century, pens come filled with their own ink and do not need to be dipped in ink wells, or that paper is sufficiently affordable to obviate the necessity of using slates for our rough work. For such a visitor, the difference between a whiteboard marker and a piece of chalk could be explained in a matter of seconds; it would be the curriculum content and the pedagogy rather than the technology that would seem as though it had come from a different planet.

1.2 Responding to Discontinuous Change

Once ICT escapes the confines of the computer lab and impinges directly on whole group teaching then the context within which learning takes place begins to change more radically. For example, when equipped with hand-held devices, students reticent about making a verbal interruption can text a query to the teacher who can choose whether to respond immediately or later when summarising. Without such devices attempting to gauge how much learning is actually happening, either from spontaneous questions or from those posed by the teacher to whoever volunteers to respond, is a very hit and miss process. A whole class response via a handheld device with the results automatically totalised and analysed provides instant feedback that can transform teachers' understanding of how best to communicate specific ideas and concepts and the extent to which all or part of the group is actually learning. Similar scope for transforming interactivity within a whole class teaching situation is also one of the many affordances of the Interactive Whiteboard (IWB) [2].

Changes of this type can be considered discontinuous in that teachers need to rethink pedagogy and deploy skills as reflexive practitioners over a period of time in order optimally to utilise the technology and adjust their teaching style accordingly.

2 The Transformative Personal Development (TPD) Model

During work on case studies of successful IWB implementations, [3], [4], the author observed the emergence of a process for developing new skills and a new pedagogy which does not appear to follow an "undertake training then apply it" model. Successful

IWB deployment appears to rely to a significant extent on incremental episodes of experiential learning over a period of time beyond initial induction; a situated learning model of provision [5].

While recognising that there is a rich and diverse range of learning and teaching strategies deployed within what is commonly referred to as Continuous Professional Development (CPD) the term "Transformative Personal Development"(TPD) was coined to differentiate this model of knowledge and skills acquisition.

2.1 Distinguishing Characteristics of TPD

It is recognised that provision as diverse as the Continuous Professional Development that is available to serving teachers is not easily compartmentalized.

Therefore, in order to help differentiate the TPD model and clarify circumstances where it may be appropriate, its key distinguishing features have been summarised in Table 1 as follows:

Table 1. Distinguishing characteristics of the Transformative Personal Development model

CPD		TPD
Emphasis on enhancing capability within an essentially stable or incrementally modified context	**Context** (Technology, Learning Environment[physical or virtual], Learning Management)	Emphasis on developing the capability to take full advantage of a distinctively changing context
New knowledge input plus sharing of current experiences and shared reflection is largely confined within the defined training programme.	**Knowledge Construction**	Post induction, substantial experiential learning subsequently takes place at the workplace, over a period, involving significant collaborative learning alongside colleagues
New Knowledge is acquired which is directly applicable on completion of training	**Application of New Knowledge**	The construction and application of knowledge occurs simultaneously at the workplace
Continuous Change; Intended Performance Improvements are directed toward excellence as defined by current best practice and/or preparation for new roles and responsibilities	**Change Process**	Discontinuous Change; Learning is directed toward excellence in new practice. Discovering/understanding the "art of the possible" may be part of the learning process

2.2 Transforming Teaching and Learning via the Interactive Whiteboard

Hooper and Reiber [6], observed that teachers may progress through a number of reasonably well defined stages in their use of technology rather than following a two step "learn then apply" model. In two IWB evaluation projects[7],[3], the first at secondary school level, the second in primary schools, the experiential learning curve described by teachers tended to follow a pattern of in-tandem development of skills and pedagogy that appears consistent with the TPD model above.

This progressive development of capability, over a period of experiential learning was illustrated by the typology of IWB expertise development set out in Figure 1 below [7]:

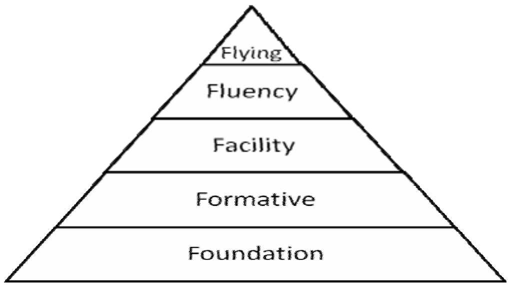

Fig. 1. A Typology of IWB skills and pedagogy development

Descriptors for each of the five levels of IWB skills and pedagogy development illustrated in Figure 1 are set out below:

Foundation (Level 1)
At this level teachers are using the interactive whiteboard primarily as a presentation/projection tool for PowerPoints, videos etc. They are most frequently positioned next to the computer itself, using the mouse and keystrokes to manipulate what is seen. They may make forays to the board to write with the electronic pen but if an old whiteboard is still in situ, or a flip chart is available, they are likely to utilise these.

Formative (Level 2)
At this level, teachers are working predominantly from the board, operating the computer functions via the board and beginning to make more use of the simpler IWB functionalities such as the electronic pen and erasing tool. With growing confidence, they are beginning to have interactions with students based around board-specific functions and, if useful and appropriate, inviting students to utilise the board directly. They are likely to progress to and beyond this level more quickly if no old board or flipchart is available.

Facility (Level 3)
At this level teachers have mastered all the additional functionalities available via the interactive whiteboard and are beginning to use them with greater frequency and facility. They have begun the process of adapting/creating resources and content that utilise and take specific advantage of the unique characteristics of the whiteboard. This would include using software tools specifically created for this purpose such as ACTIVstudio for Promethean boards. They are confident with the technology and tools. They feel pleased with how they have creatively adapted and extrapolated their

established pedagogy and may feel that they have reached the highest level of IWB capability.

Fluency (Level 4)
At this level teachers find that there are still some new horizons to explore. They continue to broaden their repertoire of tools and techniques and experiment with the unique pedagogic potential of the IWB using high levels of creativity. They are making significant use of functionality such as hyperlinks. They are becoming hunter-gathers, actively seeking out and harvesting new ideas, new content, new useful Internet sites etc.

Flying (Level 5)
At this level teachers are true virtuoso performers with a wide repertoire of tools techniques and student interactions. Their lessons are characterised by the variety of techniques deployed, the fluency with which they move between them and high levels of interaction with students. Within well-planned and well structured sessions they also demonstrate the confidence and ability to adapt and improvise in response to students' signs of interest or difficulty.

3 Collaborative Experiential Learning – The "Nuclear" Community of Practice (CoP)

While the above example of the TPD process places emphasis on developing expertise at the workplace over a period this should not be taken as implying that initial preparatory training is worthless in such circumstances.

Induction training can be particularly useful in helping teachers to understand the art of the possible. However, watching what one teacher described as a magician working through a box of tricks can prove either daunting or inspirational. The negative outcome is more likely if the magician in question is focusing on complex ICT functionality rather than emphasising the scope for transforming teaching and learning. It is also useful to avoid any assumption that the expected outcome is for participants to leave the room as competent magicians in their own right. Since such mastery is achieved over a period of time, and through practice, frequent and regular access to the technology is an essential prerequisite.

However, in successful implementations observed [3],[4],[7], teachers did not practice and experiment in isolation, but typically followed a collaborative experiential learning process. The process observed exhibited many of the features of a Community of Practice [8], in particular the informal self-organised nature of the collaboration and the shared sense of purpose in pursuit of common goals.

However, while there was some sharing of know-how within and beyond institutional boundaries, most of the collaboration took place within small and more cohesive groups. If a community of practice could be thought of as analogous to an extended family then much of the learning was taking place within what might be likened to a smaller nuclear family. Within these "Nuclear CoPs" colleagues would practice together and demonstrate to each other specific functionalities and their pedagogic value, thus building a repertoire of "magic tricks" firmly directed toward improving the student experience. While the whole repertoire, once assembled, might prove transformative each individual "trick" was invariably an adaptation or extrapolation of a pedagogic device used in traditional face-to-face teaching. For example, various functions of the software that "conceal and reveal" words, pictures, or the whole or part of a graphic, can provide a number of ways and means of teasing out an answer from the group, offering an engaging alternative to repetitive verbal questioning. This grounding of new and emergent pedagogy in existing practice, ("Pedagogic Exchange") is seen as a providing a rationale for the transferability of the TPD model to other similar contexts.

3.1 Evolving a New Pedagogy within a Nuclear CoP

Teachers' experiences of mastering some limited sub-set of the affordances of the technology, and then gaining some experience of applying it in the classroom before moving on, appeared to follow a four-stage "IDEA" [4]

Inquire: "How can I do this?" A need for skill acquisition and investigation of IWB affordances;

Discover: often some useful functionality over and above the simple answer also emerges.

Explore: considerations and trials of how the newly discovered skills or functionalities of the board can be integrated into existing pedagogy.

Acquire: new ways of working; synthesising and embedding IWB skills with an emerging IWB pedagogy.

Dialogue with colleagues was common at each stage, often leading to shared experimentation with the same functionalities of the technology. Thus teachers did not tend to move from novice to expert as a consequence of formal induction training, but, stimulated by awareness of the possibilities, progressed step by step, through work-based learning, over a period of time.

Being able to tackle the acquisition of technical skills in a series of manageable steps, exploring the pedagogic possibilities of each step is far less daunting than the sense that one needs to become a fully competent "magician" first in order to begin to leverage improvements in teaching and learning. The "just in time" learning that is provided through technology providers' online help facilities often enables the "How do I...?" question to be addressed as and when it arises.

3.2 Key Success Factors

Three success factors were commonly observed in successful implementations and helped to maintain the motivation to progress:

- Regular timetabling to IWB-equipped teaching rooms.
- Mutual support from colleagues.
- The satisfaction derived from an incremental improvement in learners' engagement and interactivity that can arise from a realistic input of effort in mastering some sub-set of the affordances of the technology.

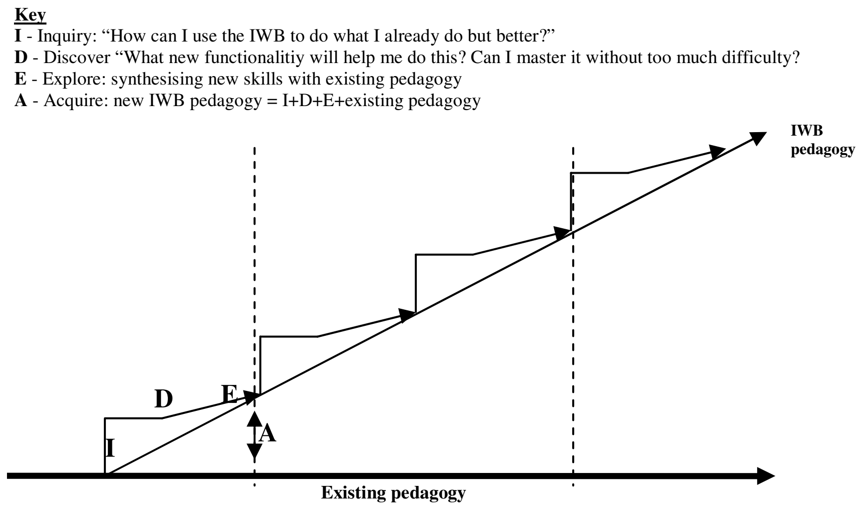

Fig. 2. Incremental steps toward mastery of IWB functionality; the "IDEA" model

The importance of the first of these factors cannot be overstated. Lack of opportunity to practice newly acquired technical capabilities means that advances are easily reversed. The intense frustration of taking some trouble to prepare a session on a particular topic only to find that you cannot re-use the material next time you teach it because you are allocated a room with no IWB can easily result in abandonment of any effort to progress. Indeed anticipation of such a contingency may lead some not to make the effort in the first place.

The mutual support of colleagues (the "nuclear" Community of Practice) tended to occur spontaneously most often within the smaller more cohesive teams found in Primary Schools. It has been suggested [9] that this factor, together with the more regular access to the technology that is often enjoyed by primary school teachers when compared to the more fragmented access to IWBs that may be experienced in partially equipped secondary schools, may provide a possible explanation for some less successful implementations at secondary level have been described by other researchers [10]. The added advantage of being easily able to "nip into my room" at break or lunch time alone or, very often, with colleague(s), to work something out, experiment or demonstrate is also more easily accomplished in a Primary School. An additional success factor at secondary level, which helped to address the more peripatetic classroom allocations of staff typical of secondary education, was the allocation of laptops to all teaching staff. [7] This enables them to transport their personal archive of lesson plans and resources with them, and to undertake their preparation wherever they happen to be. High capacity portable memory devices may provide an alternative solution if providing all teachers with laptops is not practicable.

Above the primary education level, where 'nuclear CoPs' may be less likely to form spontaneously, the formation of action learning sets to support the work-based learning process through which a new pedagogy can emerge may be advisable. Assessment of professional learning outcomes arising from such a process would typically be based upon reflective accounts and tangible learning outcomes, such as lesson plans and accompanying prepared or acquired learning resources.

Where team leaders are actively promoting more effective use of IWBs, the establishment of a team repository of such resources (and a requirement for some measure of equity in terms of input to such a repository) might be considered. Although many academic staff have strong preferences for their own particular approach to presenting a topic the adaptation and augmentation of a colleague's inputs is likely to take far less time than starting from scratch and should serve as a stimulus to continuous improvement of the team's repository.

4 The Scope for Wider Application of the TPD Model

For the purpose of reflecting on the TPD model and its potential for wider application two key foci are proposed:

i. The model was not developed by education researchers or teacher training providers but emerged spontaneously within the schools themselves.
ii. The context within which it emerged was one where the new "art of the possible" lay, to a significant extent, outside the day to day experience of the teachers required to exploit it.

Consider first the circumstances in which a new and unfamiliar "art of the possible" may emerge. In the case of the interactive whiteboard early adopting purchasers could recognise the logic of fusing together the functionalities of a video projector, a video-recorder, an overhead projector, a computer and a static whiteboard. What was less obvious at the time was the additional added value that can be achieved through a seamless switching between the functionalities of the then more familiar devices, and that which can be realised by utilising software specifically designed to exploit the affordances of this new multifunctional medium, the IWB. Those teachers who have become adept in the new pedagogy that these affordances can help realise typically experienced some unveiling of the art of the possible during induction but learned subsequently, through a process of discovery, usually in collaboration with colleagues, how to master the technology and exploit it for the purpose of improving the learning experience.

This poses the question as to whether, in the case of forthcoming educational innovation, we have no need of external expert intervention but can rely on practitioners with a sense of common purpose to coalesce as a Community of Practice [8] and share a journey of discovery together. Before designating education researchers and teacher training providers as superfluous to requirements when implementing innovation it may be worth recalling the particular circumstances in which the TPD model emerged. The term "nuclear" CoP was chosen advisedly. These were existing close colleagues with a sufficient professional bond that they were prepared to expose to each other their initially limited competences and share mistakes, thinking of these as learning opportunities. Where the motivation to learn and the potential for sharing a common purpose is dissipated by fragmentary and infrequent access to the technology and/or where the opportunity for frequent social and professional interaction such as that provided by a school staff room is absent then a more structured and active facilitation may be required. Higher Education Institutions or other providers supporting the TPD process can use work-based learning outcomes such as lesson plans that exploit the potential of a technology, evaluations, learning resources and reflective assignments as a means of recording achievement for assessment purposes.

4.1 Work in Progress Utilising the TPD Model

The writer is actively engaged in a number of collaborations between technology providers, researchers and practitioners in situations where the "art the possible" is being actively explored and validated as a first step in the TPD process. These include exploration of the scope for using Second Life as a virtual learning environment, current and prototype hand-held devices and a platform for student use of moving images as a collaborative learning tool. Colleagues involved in the preparatory phase are designated as "lead practitioners" who can serve as the focus of a nuclear CoP for those innovations that may be rolled more widely within the University. Those directly involved in teacher training also represent a source of academic leadership should the technology be adopted by partner schools. A similar cascade model would be envisaged within partner schools where, during any pilot phase lead practitioners should be given the frequent access to the technology necessary for developing mastery and can later serve a mentoring role within a nuclear CoP.

4.2 Using TPD as Preparation for New-Build Campuses

New build or extensively renovated schools or university campuses are likely not just to lead to discontinuous change, in terms of the nature and extent of the technology available, but also raise issues as to the potential for incorporating unconventional layouts and learning spaces. For example, the author visited a recently opened new build school which has a very large Learning Space that includes individual study carrels, both with and without PCs, an IWB and an area of informal comfortable seating. At present most of these affordances are rarely utilised to the full and this space is timetabled and used primarily as a conventional classroom. No doubt the teachers with access to this space will together discover and evaluate a variety of new ways of using such a facility.

In the meantime, such experiences raise issues as to how designs for new learning spaces might evolve. Architects are not teachers and teachers with many years experience of conventional learning spaces may find it difficult to imagine the possible alternatives and their potential contribution to the learning experience. Opportunities for an informed consultation as to a new "art of the possible" using both real and virtual simulations of learning spaces, together with showcasing of emerging learning technologies potentially provide an opportunity to address this. The commencement of the TPD process (for all, including non-teaching staff) at the early planning stage could serve the dual purpose of both informing and preparing for innovation. It could also help to avoid some more basic and practical design issues. Examples include environmentally-friendly classrooms with large windows intended to make optimum use of daylight where the positioning of the interactive whiteboard in relation to the windows is such that blinds need to be almost permanently closed if the latter is to be visible.

5 Conclusion

Transformative Personal Development is an essentially work-based learning process intended to be applied to situations of discontinuous change such as those encountered when a significant advance in learning technology is to be implemented. In such situations the structured training interventions appropriate to more continuous improvement contexts are seen as an initial induction that provides some insight into the "art of the possible", in terms of impact on learning and pedagogy. These new opportunities for enhancing the learning experience are then fully explored and applied through an action learning/action research process undertaken at the workplace. Collaborative experiential learning, within a small "Nuclear" Community of Practice, is seen as making a significant contribution to the effectiveness of the process. Originally identified within case studies of successful implementations of digital interactive whiteboard technology, the model is seen as offering scope for active support and intervention by teacher training providers in a range of situations where significant innovation is being adopted.

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