Customer-Driven Development for Rapid Production of Assessment Learning Objects

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Abstract: Customer-Driven Development is a technique from the software development method called extreme Programming (XP) where customers (most importantly including end users of all levels) are closely involved in the software design and redesign process. This method of producing software suitable for customers has been adapted to help in the production of e-learning material, in particular, Assessment Learning Objects (ALOs) consisting of multiple-choice questions. Asking undergraduate students to produce multiple-choice questions as part of their formal assessment processes facilitated this.

The outcome shows two distinct benefits to this process. Firstly, the students who took part in this project benefited from the encouragement to participate in reflective learning, both on the specific topic on which they chose to produce a multiple choice question, and in the methods and purposes of multiple choice questions (which form a significant part of their self-assessment regime and summative assessment exam). Secondly, of the questions produced by students a significant number of them were of suitable quality to be used for future cohorts and to be made available to the wider community. This gives two important benefits to staff: developing a wide range of questions is difficult and time consuming; student insight into misunderstandings of material can often be greater than that of staff. Resources for the development of ALOs are scarce and given that students benefit directly from being asked to develop their own questions, the year-on-year expansion of a question set produced by students can be a very useful resource.

Keywords: Learning Objects, Multiple Choice questions, Extreme Programming, Computer Aided Assessment

1. Introduction

Learning Objects (LOs Wiley 2000a) is a design concept for creating e-learning that can be reused in multiple combinations. Where an LO is designed for assessment it can be called an Assessment Learning Object (ALO). This approach to online learning material is based on the programming concept of object-orientation. Given that authoring high quality (A)LOs requires significant effort, it is reasonable to consider methods for their production also drawn from programming methods. Such methods obviously cannot be directly applied to the production of LOs, but the reasoning behind the approach must be considered and re-applied to the new task at hand. Earlier work (Adams et al, 2004) presented the application of the Pair Programming method of software development to the task of developing ALOs. Pair Programming is one of a suite of “agile” programming methods collectively known as “eXtreme Programming” (XP, Beck, 2000). Given the successful evaluation of Pair Programming, it is an obvious step to consider other elements of XP for ALO development. In this paper, the Customer-Driven Development software development method is adapted for ALO production.

In “traditional” software engineering (Sommerville 2004) input is sought from the “customer” for a software project only at a small number of explicit points in the development cycle. This corresponds to “traditional” teaching methods, which involve the students in curriculum and teaching material development only in highly constrained ways. In contrast, the Customer-Driven Development approach involves end users in the development of a program at many stages. This approach has parallels in the Student-Centred Learning educational approach. The term “Student Centred Learning” stems from the works of Myers and Briggs, and Cornelius (2000) provides a detailed review of the different types of learner styles.

Taking these two inspirations the authors have trialled the practice of requesting students to create the basic content of ALOs as part of their current course. The ALOs produced by the students have been assessed for quality on a number of measures, and in addition the effect on the students producing the ALOs has been assessed. The results of the initial study case were very positive and further investigations are under way.

Students on a course in Functional Programming (using the language Caml Light) were set the task of producing a new multiple-choice question, with guidance in the shape of existing ALOs available for self-assessment (a set of ALOs produced from the study undertaken in (Adams et al, 2004)). This task was a small part of their assessed coursework carrying a weight of 1% of the overall module. This very low weighting was due primarily...
to the unknown nature of any educational benefits to students of undertaking such a task. The ALOs already available, and the ALOs students were requested to produce, are purely formative in nature: they are available to the students as part of their self-assessment of progress and understanding and to give pointers to associated course material covering material which the students have demonstrated they do not understand.

The outcome shows two distinct benefits to this process. Firstly, the students who took part in this project benefited from the encouragement to participate in reflective learning, both on the specific topic on which they chose to produce a multiple choice question, and in the methods and purposes of multiple choice questions (which form a significant part of their formative self-assessment regime and summative assessment exam). Secondly, of the questions produced by students a significant number of them were of suitable quality to be used for future cohorts and to be made available to the wider community. This gives two important benefits to staff: developing a wide range of questions is difficult and time consuming; student insight into misunderstandings of material can often be greater than that of staff who are generally much more expert in the general and specific topics being taught than their students. Resources for the development of ALOs are scarce and given that students benefit directly from being asked to develop their own questions, the year-on-year expansion of a question set produced by students can be a very useful resource.

2. Assessment learning objects

Learning Objects are a relatively new way of presenting learning content. They are digital entities designed to facilitate reuse. Instructional designers can build small (relative to the course) instructional components that can be reused in different contexts. The term Assessment Learning Object (ALO) is used to describe an object designed to provide a summative or formative assessment of the learning.

The use of the term "object" itself has its roots in Computer Science, where the term object is used to describe an entity consisting of data and related operations. The origins of the term are Kay's work in the late sixties (Kay, 1968 & 1969). Wiley (2000b) states: "Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science."

ALOs are in a number of ways the closest analogue to programming objects in terms of development goals (and therefore appropriate development methods). ALOs are primarily designed to have a functional interface: they must be "executed" in some way in order to produce a "result", i.e. the assessment of the student's knowledge. The requirement for their correctness is very high (100% for many of their aspects and near 100% for the remainder). Whether used for summative or formative assessment, the utility of an ALO is completely destroyed by many of the possible errors.

ALOs have many types, but one of the most familiar is the multiple-choice question. These have been popular for many years as a way of assessing the basic knowledge of students at many levels (Bull and Dalziel, 2003). They are particularly useful for large classes since they present a mechanically marked process that, when well design, can nevertheless provide useful feedback on gaps in student knowledge. While the marking of multiple choice questions is a quick and mechanical process compared to many other forms of assessment (and can be done completely automatically for e-learning systems) the production of useful multiple choice questions for a specific topic is not such a quick process. While creating a question and the correct answer may be relatively easy for an author experienced in the topic to hand, creation of sensible distracter incorrect answers is much more difficult, particularly in focussing the distracters to identify single points of confusion, allowing for the automated production of feedback to students who make mistakes.

3. Customer-driven development and student-centred learning

XP is what is called an agile design method. Incorporating this approach in to instructional design facilitates the introduction of agility into the production of learning material.

Within XP the customer plays a vital role. To quote from Wells (1999) the customer should aim:

"Not only to help the development team, but to be a part of it as well."

With traditional software development techniques the customer is usually kept external to the project team. The customer takes part in initial requirements capture (Sommerville, 2004) and then is not involved in any detail until acceptance testing. This sometimes leads to problems with the software that is produced matching the customer requirements but not actually being what the customer wanted. Customer-driven development incorporates the customer into the
design process. In particular, individual end-users from the customer organisation are engaged in the development cycle during decision points ranging from functionality to interface choices.

Within an e-learning environment, the Customer community contains the students who are studying this e-learning material. Involvement of students in the production of ALOs for the material is therefore the equivalent of customer involvement in interface or functionality development.

Such an approach ties in with the ideas of student-centred learning, where students are encouraged to take overall responsibility for directing their own learning and understanding the purpose of the tasks and information they are presented with by educators. By giving students the task to develop an ALO for possible use by future students they also gain an understanding of the mechanism of assessment implemented by such ALOs. This should enhance their own learning and in particular they’re use of formative ALOs and their performance with summative ALOs. The relationship to student-centred learning is not exact, however, as student-produced content is principally used for other students than those creating them.

4. Student suggestion of ALO content

So, the precise instantiation of the XP method customer-driven development is Student Suggestion of ALO Content. The primary intent of this is two-fold: to reduce the effort needed by individuals or small teaching teams to produce a large set of ALOs; to improve the quality of ALOs by involving students in their development. The burden on students producing the ALOs should not detract from their education, and ideally should contribute to it.

- To demonstrate the utility of this method, it was necessary to experiment with one or more groups of students and to meet the following specific targets in the experiment:
  - A simple explanation of the task should be produced, which the majority of the students submitting coursework understood and were able to make reasonable attempts to complete.
  - Student feedback from the cohort performing the coursework should indicate they did not find the task a burden.
  - The questions submitted by students should provide suitable material which can, or could be, translated into ALOs with less work by the educator than would otherwise be required to produce an equivalent set of ALOs.

5. Functional programming

Functional Programming, for those that are not aware of it, is a different approach to programming from the most familiar concept, imperative programming. As the name suggests, functional programming involves defining functions, which have one or more inputs and produce exactly one output. At the University of Reading, Functional Programming has been taught in the first year of a Computer Science course, in parallel with the better-known imperative programming. The module is taught using lectures, practical classes and non-assessed weekly practical sheets. Online support includes self-assessment quizzes and discussion boards. Summative coursework is set twice per year, the first weighted at 10% of the overall module and the second weighted at 20% of the overall module. The “student suggestion of ALO content” task was set as part of the second assignment, so students had completed classes covering all the major elements of the language by this point and were being taught integrated example projects, which combined elements in various ways. Final assessment of the module was by an exam, half of which was multiple-choice questions of similar style to the online quizzes, although drawn from a separate pool.

6. Experience of using customer-driven development for the development of ALOs

6.1 The coursework

As part of the coursework for the functional programming module, the class of 2004/5 were set the following assignment:

Select one of the topics:
- Values and Expressions
- Records, Constructed and Enumerated Types
- Lists
- Simple Functions
- Pattern Matching Functions
- Recursive Functions

Create one multiple-choice question suitable for helping students to learn Programming in Caml Light. The multiple-choice question should have three incorrect answers and a correct answer. Incorrect answers should be “distracters”, that is plausible wrong answers which demonstrate a specific misunderstanding of an element of the language. Each incorrect answer should have a one or two sentence explanation of what a student who chose incorrectly needs to learn. You may wish to view the online quizzes available on Blackboard as inspiration.
The question represented only 5% of the coursework mark. This represented a maximum of 1% of the marks for the module. Nevertheless, 44 students, of the 52 who submitted the coursework, attempted this assignment. The allocation of marks is as shown below:

Table 1: Shows the allocations of marks

<table>
<thead>
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<th>Mark</th>
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<td>3</td>
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Only a few students produced ideal questions (those three marked at 5 out of 5), i.e. those that could be copied into a learning environment and made available with only correctness, spelling and grammar checking applied. Many, however (those thirty four marked at 3 or 4 out of 5), produced questions, which were very usable as source material for question production. The commonest failing for these was the lack of explanations for the distracter answers, or a poor presentation of such explanation. The upgrading of these questions for use required less than half the time needed to produce such questions from scratch. In addition, the production of questions on the same topic by multiple people removes the boredom factor for an educator in coming up with “yet another variant on pattern matching for lists” or other commonly misunderstood topics. Only seven of the forty-two questions submitted (those receiving 1 or 2 out of 5) were not usable as ALO source material.

6.2 Sample work

The best questions produced could be used immediately, for example one student submitted the following:

Which of the following will assign a list containing 1, 2, 3 and 4 to the variable x?
1) Let x = [1::2::3::4];
2) Let x = (1,2,3,4);
3) Let x = 1::2::[3;4];
4) Let x = 1,2,3,4;

1) Incorrect. In order to use the “::” constructor the list must be bound to an empty list at the end. Also, the square brackets around the list will make this a list of a list if it is corrected.
2) Incorrect. This is a type int*int*int*int, not an int list.
3) Correct, the “::” constructor can be used to add numbers to the front of an existing list.
4) Incorrect, this is a type int*int*int*int, not an int list.

This piece of work could be directly transformed into an ALO that could be immediately deployed. The answers are all realistic within the context of programming with CAML light and the explanations of why an answer is a distracter are correct and appropriate.

Other good questions could not be used directly because of the way the student provided feedback. For example in this question:

Which of these evaluates to [1;2;3;4;2]?

a) conc([1;2;3], [4;2]);

b) [1;2;3] @ [4;2];

c) [1;2;3]+[4;2];

d) [4;2]::[1;2;3];

Answer a indicates that the student is probably guessing, assuming the non-existent conc function is used to concatenate lists.

Answer c probably means the student is confusing list concatenation in CamlLight with string concatenation in Delphi.

Answer d shows that the student does not fully understand the construct:: as this can only be used to add an integer value to a list of integers.

The correct answer is b.

The student provided an explanation that was aimed at a marker, not at the person attempting the question. To convert this question into an ALO it would be necessary to rework the explanations into a format that could be used immediately as feedback. However, the question itself is useful and the distracters are suitably chosen.

Poor questions came from students who had a lack of understanding of the technical material and so were unable to devise questions or answers. These students needed additional coaching so that they could master the subject.

7. Future work and conclusions

The module on which this project was initiated was a specialised module that is only taught in a small number of institutions. The results were promising, some of the material produced was immediately usable and much more provided inspiration to aid the design of new material. Three goals were set above, each of which was achieved:
A simple explanation of the task should be produced, which the majority of the students submitting coursework understood and were able to make reasonable attempts to complete.

Thirty-seven of the forty-four students submitting the coursework produced usable material and achieved good marks for their contribution.

Student feedback from the cohort performing the coursework should indicate they did not find the task a burden.

Student feedback indicated that the students found the task interesting and different. A number of them indicated that they had gained a significant amount of understanding of the purpose and structure of multiple-choice questions while performing the task. Far from being a burden they found that it was a useful educational exercise.

The questions submitted by students should provide suitable material which can, or could be, translated into ALOs with less work by the educator than would otherwise be required to produce an equivalent set of ALOs.

Thirty-seven questions provided such source material. Previous work (Adams et al, 2004) indicates that this would represent hours of work by educators working in a Pair Development method.

A second study is under way, using the same technique in an online imperative programming module for the C language (a language taught in a significant number of courses). In addition to the online course run over the summer term, this language will be used for teaching first year programming to over two hundred students starting this autumn. The production of suitable online self-assessment ALOs will be a necessary task in preparing for this, and it is expected that student suggested ALO content will provide excellent support for this task.

When the ALOs are deployed a more detailed evaluation of the work will be able to be undertaken. An approach will be used that applies data mining techniques to the log data collected on responses selected by the students (Lubega and Williams, 2004).

Acknowledgements

The 2004/5 classes of students taking CS1H2 – Functional Programming provided the example of customers described here. They originally used ALOs that were devised as part of earlier work. They then contributed to generating a larger pool of ALOs by attempting and assessment that required the production of an ALO.

Thanks to these students, their predecessors and our colleagues for their support of the work described here.

References


MyGfL: A Lifelong Learning Platform for Malaysian Society

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Abstract: MyGfL which stands for Malaysian Grid for Learning is a One-Stop-Center for quality assured online learning content, tools and services with the aim to promote and support the lifelong learning agenda in Malaysia. It is a platform that enables anyone to learn, unlearn and relearn from anywhere at anytime through any web browser so as to accelerate the growth of K-Society. The main objectives of MyGfL are to enhance discoverability of e-learning content from heterogeneous sources through the use of metadata, to develop e-learning standards to ensure conformance and adoption of best practices in e-learning content and systems, to provide e-Learning systems and tools to enable and support e-Learning activities and processes for the purpose of lifelong learning, and also to encourage the sharing and development of local/indigenous content. Pilot programs have been conducted at different levels of the Malaysian society where processes and factors involved in implementing e-learning to the community and observations of societal acceptance of e-learning were noted. Utilization of MyGfL by the pilot groups has furnished vital information regarding acceptance/perception of use, current standards of computer literacy and skills. This case study will depict the impact of MyGfL with regards to its objectives and public perception towards MyGfL as a platform for lifelong learning.

Keywords: e-Learning, Lifelong Learning, Malaysian Grid for Learning, MyGfL, Learning Content.

1. Introduction

In line with Malaysia’s Vision 2020, the Third Outline Perspective Plan (OPP3) has set a target to develop Malaysia into a knowledge-based economy, where the generation and the utilization of knowledge will contribute to a significant part in economic growth and wealth creation. One of the characteristics of a knowledge-based economy country is highly educated labor force. (EPU, 2001)

A highly educated and better-informed labor force will create new values, ideas, skills, and knowledge that will enable Malaysia to remain competitive in the global arena. In order to achieve the goal, the National Information Technology Council (NITC) has launched the Strategic Thrusts Agenda with five strategic thrust areas. One of the areas is e-Learning with the focus on cultivating a lifelong learning culture amongst Malaysian citizens through the use of ICT.

Under the e-Learning strategic thrust, NITC together with Ministry of Education has initiated a project called Malaysian Grid for Learning (MyGfL) in March 1999 that was later endorsed by the Deputy Prime Minister of Malaysia. The main objective of this project is to enable Malaysians from every walk of life to continuously learn through the use of ICT from anywhere at anytime, promoting the lifelong learning agenda and accelerating the creation of a knowledge-society.

MIMOS Berhad has been given the mandate by the NITC to develop the core components of the project which are the integrating platform, content and standards for e-learning, MIMOS will conduct pilot programmes to assess various aspects of the project before the full scale nationwide rollout. This paper will describe the initial findings and observations from the pilot programmes conducted. This study is still in its initial stage and the final results of the pilot study will determine the accuracy of these initial findings.

2. MyGfL initiative

2.1 Objectives

The MyGfL initiative aims to promote and support the lifelong learning agenda in Malaysia to accelerate the growth of K-Society. Its objectives are:

- To enhance discoverability of e-learning content from heterogeneous sources
- To develop e-learning standards to ensure conformance and adoption of best practices in e-learning content and systems
- To provide e-Learning systems and tools to enable and support e-Learning activities and processes for the purpose of lifelong learning
- To encourage sharing and development of indigenous content so as to preserve Malaysian values and cultural heritage
- To stimulate the growth of digital content industry in Malaysia

2.2 MyGfL framework

The goals and objectives of MyGfL could only be achieved given the right match of info-structure in its framework. Figure 1 shows the three critical components of the framework that are addressed
through MyGfL initiative; content, standards, and technology. The access infrastructure component will be addressed by other initiatives such as the National Broadband Plan. MyGfL will only leverage on the readily available infrastructure.

As shown, each component of the framework identifies solutions to address the goals of MyGfL. Each of the components will be discussed in the following sections.

![Figure 1: MyGfL framework](image)

#### 2.2.1 Content

Content is king (Nielsen 1999). The availability of relevant and engaging content is critical to the success of MyGfL. The content on MyGfL is targeted at a wide range of learners from all ages, focusing on non-formal learning. The categories of audience that MyGfL provides content for are:

- Children
- Teenagers
- Higher learning
- Adults

Educational resources in MyGfL come in the form of web resources and learning objects. Web resources may come in the format of web pages, portable document files, or any other file that can be viewed or downloaded through the internet browser. Another type of educational resource is the learning object. MyGfL considers a resource to be a learning object when it is centred on a learning objective, has instructional content that promotes the achievement of the learning outcome, and performs practice and feedback to ensure mastery. This content could either be developed in-house, bought off-the shelves, aggregated, syndicated or outsourced, or perhaps through collaboration with content partners. Some content would be provided for free while others are chargeable. MyGfL publishes this content either through their metadata records or by hosting the content at its repository. A metadata record describes and indexes the educational resources using a set of data elements and controlled vocabulary to ensure uniformity.

Most of the content in MyGfL is populated by content aggregation through metadata tagging. Some of the content is meta-tagged by our cyber librarians and some content partners share their metadata in our metadata repository. MyGfL provides content hosting for content partners who wish to contribute free content to MyGfL. A commercial model for chargeable content is yet to be established. Some of the content in MyGfL is developed by MIMOS and others are outsourced to the content development industry.

#### 2.2.2 Integrating platform

The integrating platform consists of the portal, a learning support system, and various tools and services to support learning activities. The MyGfL portal is a One-Stop-Center for quality assured online learning content that enables anyone to learn from any web browser at anytime convenient to them. The Learning Support System is integrated within the portal to promote collaborative learning among the learners through the use of online discussion or forum, chat tools, web-based email, online bookmarks, and online notes. Other tools and services include a Metadata Management System (MMS) which facilitates the metadata tagging process which
conforms to the international standards of Dublin Core and SCORM 1.2. The metadata tagging process utilises a database of bi-lingual and localised thesaurus based on the UNESCO thesaurus to enhance content indexing and searching. A harvesting engine is in place to harvest metadata records from various international sources but is yet to be fully implemented as the quality screening process of the harvested records are yet to be established.

2.2.3 Standards
Another crucial component in the MyGfL framework is the standards for e-Learning content and systems development. The MyGfL Guidelines on Web Resources, Learning Objects, and e-Learning Systems aims to ensure the quality of the content, tools, and services provided are met by observing the guidelines based on certain practices and principles for e-learning. The standards also aim to guide MyGfL content providers to conform to a set of standards and guidelines for content development, as currently there is no single point of reference to all relevant e-Learning standards in Malaysia. The standards are currently in the process of being accredited as the national standards on e-learning technologies in hopes to achieve Interoperability, Reusability, Manageability, Accessibility and Discoverability of MyGfL content and systems.

2.2.4 e-Learning community
MyGfL e-learning community comprises of the learners, enablers, and providers. The learners encompass the learning community at large ranging from preschool to adult learners, who can access MyGfL through its portal. The enablers are individuals who facilitate the delivery and implementation of e-learning such as lecturers, tutors or facilitators. Meanwhile the e-learning providers are generally individuals or organizations that own, provide or sell e-learning content to learners.

2.3 Strategy
Among the strategies to promote and sustain the MyGfL initiative is through the use of open source software in developing the MyGfL platform, providing incentives for the digitization and development of indigenous content, forming partnerships with content owners to channel their digital content through MyGfL, providing affordable access to MyGfL, and conducting seminars and workshops to create awareness on the importance of digital content and metadata.

2.4 Value proposition
It is expected that through MyGfL, the discoverability of e-learning content from heterogeneous sources via a single interface is enhanced, where learners should be able to find learning content that is relevant to them through the MyGfL portal. MyGfL will facilitate easy identification of content through a systematic indexing of content by application of the metadata framework. Learners may easily search for relevant content through the use of bi-lingual, Bahasa Melayu and English thesaurus and metadata description. Relevant and localised content is prepared for learners by adopting best practices in the development of digital content with the latest in instructional design and pedagogy. MyGfL aims to provide a platform for affordable e-Learning solutions to entice learners to the culture of lifelong learning.

The local content industry is expected to benefit as MyGfL helps to create demand for local content and reduce investment risk in content development by providing a content marketplace and generating market demand.

2.5 Progress to date
The MyGfL portal (http://www.mygfl.net.my) has been made available to the public since September 2004. In April 2005, a six month pilot program was started for the rural community focusing on skill-based learning, Basic ICT, Basic English and entrepreneurship. Subsequent pilot programs have been conducted for deaf children and their family focusing on storytelling and sign-language.

To date, there are more than 14,000 registered MyGfL users with more than 60,000 hits monthly and a significant increase in hits was recorded after the start of the pilot program and road shows. Currently, various content partners from the government agencies and industries have contributed digital content to MyGfL for target groups such as children, teenagers, adults and students in higher learning. MyGfL as an initiative is scheduled to be officially launched by the Prime Minister of Malaysia in the first quarter of 2006.

3. MyGfL pilot program
MyGfL pilot program aims to investigate the adoption of e-learning approach by specific learners, with the course material replaced or supplemented by on-line content. Specifically the program will focus on the response of the intended learners to MyGfL and its content. One of the program's intentions is to gauge the impact of MyGfL content on learner's learning process
and strategies as well as to explore how e-learning content helps with a particular problem or issue.

The MyGfL pilot program is currently being held targeting three pilot audiences, starting with deaf children and their parents, the rural community, and youth. The pilot program with deaf children will attempt to address some of the issues faced by these children especially communication issues between them and their family members; whereas the pilot program with the rural community will seek to enrich their skills and create opportunities to supplement their income by providing online training on tailoring and sewing of traditional garments through the use of online learning objects in MyGfL. Pilot programmes have been planned for youth focusing on language, ICT, and entrepreneurship. Realizing that the e-learning strategy needs to be driven by the needs of the learners, rather than by the technology (HEFCE 2003), the learning objects for each pilot program were developed together with subject matter experts of the pilot groups to ensure the learning needs of the learners are addressed. The pilot programmes operate with the following objectives:

- To create awareness by promoting the services offered by MyGfL
- To measure uptake of e-learning approach by a specific target group of learners
- To assess how e-learning content helps with a specific problem or issue
- To gauge the processes and factors involved in the implementation of e-learning to the community
- To test the model of MyGfL framework: integrating platform, standards, and content

3.1 Rural community

The rural community was chosen as a target community for the MyGfL pilot as they account for 38% of Malaysia’s population (APCD, 2005). Among the issues surrounding the rural community is the lack of opportunity and empowerment of skills and knowledge regarding the potential of ICT to enhance their lives. In terms of internet connectivity and access they have limited access to infrastructure and limited affordability to connectivity. Content for the rural community is also limited as there is a language barrier with international content, insufficient relevant content and lack of skills and knowledge to access and utilize content. (Songan, Hamid, Yeo, Gnaniah, Zen, 2004)

Five MyGfL pilot programs were conducted by MIMOS and the Department of Community Development (KEMAS) under the Ministry of Rural and Regional Development. Traditionally, KEMAS has been conducting various skill-based classes and workshops to the rural community through its centers nationwide. The classes are facilitated by KEMAS trainers who teach the students through face-to-face learning method. One of the skill-based classes that are very popular among the rural women is the sewing classes. Through the pilot programs we introduced online learning to these women on tailoring and sewing of traditional garments through the use of online learning objects in MyGfL. This program was held at the rural community tele-centre called Medan Info Desa (MID) in Sungai Gulong-Gulong Village, Tanjung Karang, Selangor where each of the rural women is equipped with a sewing machine and a computer. All of the computers in the MID are connected to the internet using a shared 512 kbps satellite broadband connection.

The selection criteria of the participants are as follows:

- They must have basic ICT skills (know how to operate a computer)
- They must have basic sewing skills
- They must not have experience in sewing the Malay traditional garments (Baju Kurung and Baju Melayu)

During the participants’ selection process, it was a great challenge to get participants who have basic ICT skills. In Malaysia, the rural community at large is still digitally divided and lacks ICT skills. Acknowledging the issue, the pilot programs still accepted participants without the required basic ICT skills. Out of the 85 participants, 38 of them (44%) had never used a computer before. Some of them do own a computer at home, but it is mainly being used by their children.

In terms of participant’s age, the majority of the participants (57%) were above 40 years old. Table 1 describes participant’s age group distribution and knowledge in basic ICT.
Pilot groups 1 and 3 were introduced to the learning object on sewing of Malay women’s traditional garment or Baju Kurung, whereas pilot groups 2 and 4 were presented to the learning object on sewing of Malay men’s traditional garment called Baju Melayu. Pilot group 5 was targeted at the KEMAS trainers themselves to use the learning objects when they conduct their sewing workshops after the pilot programs have ended.

Despite the lack of ICT skills and no experience in sewing the traditional garments, all participants from pilot group 1 and 3 were able to sew a complete Baju Kurung in 3 days solely using the learning object. In a traditional sewing class, it will normally take 5 days to sew a complete Baju Kurung. The learning object has managed to reduce the sewing class duration by 40% as the learners were able to learn independently and at their own pace as compared to the traditional sewing class. A trainer from KEMAS was present to facilitate the program but offered little or no help in the sewing steps and methods.

For both pilot groups 2 and 4 the participants were separated into two groups which we will call Group A and Group B. Parallel sessions were held in two separate rooms where Group A learned using only the learning object whereas Group B depended very much on their teachers. As a result 100% of the participants in Group A managed to complete their Baju Melayu but none of the participants in Group B managed to finish theirs on time. This further enforced that self paced online learning is more effective given the appropriate and effective learning material. Observations on pilot groups 2 and 4 revealed that the Baju Melayu learning object is an effective learning material, and the teacher who insist their students to always refer to the learning objects becomes the key factor in promoting the use of the learning object.

Computer literacy is one of the foundations blocks of technology enhanced learning (Parker 2003). Some participants requested for a full day’s training on how to use the computer and internet prior to the actual program. Some participants were observed to have no idea on how to handle a mouse, and their hands were shaking as we guided them on how to maneuver through the learning object using the mouse. Despite the apparent lack of computer literacy, participants were still very much interested in the program and were willing to learn the skills required.

Following the pilot program, participant’s usage of MyGfL portal was tracked and it was found that 38% of the participants continuously visit the MyGfL portal after the pilot program. Considering the lack of infrastructure in the rural areas this is an appreciable number indicating recurring interest in the participants to continuously learn using online content. Many participants were also interested to contribute content to MyGfL. One of the participants prepared a recipe for a local dish, complete with photos of the preparation and cooking process. Participants from all pilot groups are now willing to share knowledge through MyGfL. This indicates the rural community that has been exposed to our e-learning portal shows keen interests to not only learn online, but also to share their knowledge with others through digital means. The completed Baju Kurung was worn by the participants during the pilot program closing ceremony. This success has encouraged MyGfL team to conduct more community workshops to create an IT literate society.

### 3.2 Deaf community

MyGfL does not only function to provide a platform for the e-learning community, but also serves as a driver to deliver learning to all levels of society in Malaysia. This is demonstrated by the pilot project for the hearing-loss community specifically targeting on deaf children and their families. MyGfL has developed three Learning Objects for these children which are available in the MyGfL portal. These learning objects aim to instill moral values to children by telling stories using flash animation together with audio and sign language videos incorporated into the story. The deaf children will be able to understand the story by looking at the animation and sign language video while their family members can listen to the audio and learn the corresponding sign languages at the same time.

MyGfL aims to help the hearing-impaired children learn online and gradually write some sentences.
on their own. The pilot program also targets the parents and family members of the hearing impaired students. The teachers from various schools are also trained on the material in hopes that they will continue to use the learning objects and other resources available from MyGfL in their classes and propagate the usage of MyGfL as a learning portal.

The learning objects for the deaf students were developed by MIMOS with the Malaysian Federation for the Deaf giving advice as the subject matter experts. Observations and feedback on the usability of the learning object revealed that there was an issue in the selection of the type of sign language to use in the learning objects. There are two types of sign language in Malaysia, the first of which is called Bahasa Isyarat Malaysia (BIM) which translates to ‘Malaysian Sign Language’, which was developed by the deaf for the deaf, and therefore is widely used in the deaf community. The second is called Kod Tangan Bahasa Melayu (KTB) which means ‘Malay Language Hand Code’, which is the formal sign language for learning the Malay language developed by the Ministry of Education, and is not as popular among the deaf community. Two of the learning objects used Bahasa Isyarat Malaysia (BIM). BIM is not suitable for schools because the sign does not include prefix and suffix which are important in learning the Malay language. The teachers have suggested Kod Tangan Bahasa Melayu (KTB) to be used for Bahasa Melayu subjects. Nevertheless, the objective of the learning objects is to deliver storytelling content to the deaf community in an informal learning environment, therefore BIM was used to ease their learning and comprehension.

Some usability issues were revealed about the learning objects for the deaf community. The video playing the sign language for the learning object can be replayed by clicking on the video or right clicking the mouse to show the option to replay. However, most of the deaf pupils are illiterate; therefore, the methods provided were not understood. Even those who can read do not understand the meaning. The subsequent learning objects developed have included a large icon to facilitate the playback of the video. Also, for one of the learning objects the sign language video was too fast for the deaf children. In addition, the color of the narrator’s attire against the background was not appropriate for a clear view. Therefore, the pupils could not capture the sign language clearly.

An impact study is to be conducted where the instruments to measure impact was prepared in the form of questionnaires. While the parents, teachers and family members of the deaf children are able to answer the questionnaires without difficulty, the deaf children themselves face a problem. It was observed that the study process is not viable for the deaf children group as they do not know what option to choose and they circle whatever number they like at random. Although the teachers have explained using sign language and they seemed to understand the teacher’s explanation, they nonetheless circle the answers arbitrarily without even reading the questions. The instrument to measure the impact of MyGfL portal on the deaf children is currently being reviewed.

3.3 Youth

In developing the country towards Vision 2020, continuous effort to develop entrepreneurship among youth needs to be put in to complete their knowledge, skills and sustainability in facing globalization and challenges in information technology and the open market. Youth aged 18-30 years old are prime targets for entrepreneurship programs as they have left school or university and are searching for business opportunities and ventures. Currently about 18% of Malaysia’s population are in this age group (IDB 2003). Pilot programmes for this target group have been scheduled to start in October with the following objectives:

- To give exposure to young entrepreneurs about the opportunities in planning, managing and controlling a successful business
- To provide skills set and to cultivate interest in the field of competitive and successful entrepreneurship.
- To equip young entrepreneurs with the language and ICT soft skills which are necessary to compete globally.

4. Lessons learned

The vision of e-learning starts with the assumption that computers and the Internet have the potential to help people learn by delivering personalized instruction (Bajunid 2001). In order to deliver personalized instruction to Malaysians, the need for indigenous digital content in Malay language is apparent. Unfortunately there is a significant shortage of quality local content. The e-learning content industry in Malaysia is still at its infancy stage, and there is a need to address the multi racial and multi-lingual audience of learners.

Significant to learners’ involvement in e-learning is the notion of e-readiness, that is, their ability to make use of e-learning resources and multimedia technologies to improve the quality of learning. It is observed that the different levels of e-learning readiness for the various learner groups require
policy makers and regulatory bodies have to play a more concerted role in enhancing the image of e-learning programmes so that there is greater engagement in a technology-driven teaching-learning environment (Kaur 2004).

PC ownership, internet and broadband penetration are still low, especially in the rural areas. Multimedia rich e-Learning content demands for high-speed infrastructure for e-Learning to be effective. The Malaysian government is however receptive to the proposals to boost the penetration rate of broadband service in the country to about 40% by 2008, providing a promising avenue for the local e-learning scene.

5. Conclusion

Through the pilot project implementation it was observed that self paced online learning is more effective than traditional instruction, given the appropriate learning material and content which is relevant to the learners. Computer literacy helps the learner proceed with the learning object faster but it is not a critical factor to undertake an online course. Engaging online content will drive the interest of the learner to learn computer skills, and any content can be engaging as long as it is deemed significant by the learner. A wide scope initiative such as MyGfL opens up to tremendous opportunities in addressing the needs and wants of the learning community.

There are challenges that lie ahead especially with the issues of understanding what constitutes lifelong learning in Malaysia. There is also a wide consensus that learning in Malaysia is examination oriented and mostly partial towards certification and employment, thus putting lesser emphasis on personal development, social inclusion, as well as active citizenship.

Perhaps the stumbling block to the initiative could be the lack of funding for content development for priority content area such as cultural and heritage resources. Our current effort in populating and syndicating online learning resources yields more foreign-based content as compared to local. In addition to this, the issue of funding poses as a problem when content partners are engaged. Besides, it is a known fact that content development is expensive as it involves an appreciable amount of investment in the area of intellectual capital.

MyGfL initiative is promoting best practices in e-learning by addressing the issues for all its stakeholders. This is apparent from the holistic perspective it laid out in its framework; content, technology, standards, and stakeholders. The initiative at its current pilot phase has lots of opportunities that could be explored and challenges that have to be addressed.

Acknowledgements

The authors wish to acknowledge the assistance of the MyGfL team, particularly Mrs. Ros-Liza Abdul Rahman for without her dedication and hard work it would have been impossible to conduct the pilot programmes and gather the observations to produce this document. It is hoped that this document will make a positive contribution to the application of community based online learning implementations towards the realization of knowledge based societies.

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Providing Fine-grained Feedback Within an On-line Learning System – Identifying the Workers from the Lurkers and the Shirkers

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Abstract: This paper describes a mechanism developed by the authors to gather student feedback from formative revision Multiple Choice Questionnaires (MCQs) within an on-line learning system. The MCQs provided first year Computer Science students with instant formative feedback, while data was also gathered about student responses, such as the percentage opting for each answer and the time taken to answer the question. We measured how students were using our on-line learning system; whether they were in fact ‘workers’ who provided answers to the MCQs, were ‘lurkers’ who did not provide answers but asked for solutions or ‘shirkers’, who did not access the site at all!

The data indicates that the time taken to answer a harder question was less than that of an easier question suggesting that the workers turned into lurkers strategically when they thought they could not answer successfully. It was not however clear whether the lurker suddenly finding an easier question would change back into a worker. Future work to encourage the shirkers to participate is also discussed.

Keywords: VLE, Formative MCQs, Summative MCQs, On-line teaching, On-line learning

1. Introduction

The emergence of Virtual Learning Environments (VLE) in Higher Education has led to many improvements in student learning experiences as identified by Britain and Liber, (1999) amongst others. However, there are pitfalls in using VLEs and their effect on student learning has been taken up elsewhere. (e.g.Stiles, 2000). One major pitfall of VLEs in the authors’ opinion is that of monitoring student access to on-line teaching material. In the class-room environment tutors frequently monitor student attendance by taking registers. This means that non-student attendance at classes is recorded. Even though most if not all VLEs require authentication, by use of a username and password, to access on-line teaching material, monitoring student access to on-line material is not a simple task. For example, here at the University of Hertfordshire we can monitor the number of student logins, but as lecturers we cannot yet identify who is logging in and using our VLE. This means we have an overall idea of the proportion of our VLE users to the proportion of non-VLE users. In this paper, we classify those students that do not login to our VLE as ‘the shirkers’.

Many VLEs provide tutors with the option of providing students with formative multiple-choice-questionnaires (MCQs) or tasks to undertake and it is common for tutors to provide solutions to such MCQs. Clarke et al (2004) discuss the pedagogical use of MCQs for formative testing in detail. However, this feedback is one-way, from the tutor to the student which we call the tutor→student feedback, since there is no facility for feedback from the student to the tutor.

This has led us to identify a number of problems which we attempt to address in this paper. Namely these problems are: How does the tutor know the proportion of students who are actually undertaking the formative exercises? How does the tutor know if a student is just looking at the solutions and not doing the formative exercises? How does a tutor know how long a student is spending on each formative exercise?

In the class-room, the environment is under the control of the tutor and the tutor gathers feedback from students from a number of sources that help to address these problems, which we call the student→tutor feedback. The tutor can observe, talk and time students as they tackle set exercises and the tutor can adapt and amend his/her teaching approach accordingly. This type of dynamic teaching control is not usually available through a VLE.

We have refined our on-line learning system to address the three questions we have posed and attempt to provide the tutor with the control that he/she has in the class-room. The idea behind our learning system is to monitor in the back-ground what students are doing when they access our formative MCQs or tasks on the University’s VLE. Currently we are monitoring anonymously, that is we do not monitor a username and we cannot
therefore identify individual students. Our approach is that when a student opens a webpage to try one of our MCQs or one of our tasks then a timer is started and statistics gathered. Every MCQ or task requires some form of an interactive answer and this response is captured by our learning system. When the student submits a response or instead requests the solution to the MCQ or task the timer is stopped. In both cases, we provide the student with our solution to the MCQ or task (the tutor→student feedback). From this simple information, we gathered a number of statistics. The statistics are broken down into two types: the ‘lurkers’ and the ‘workers’. The lurkers are those students who view our formative teaching material and do not respond other than to receive the tutor’s solution. The workers are those students that answer our formative MCQs. We use these statistics to tell us the proportion of students that are ‘shirkers’, ‘workers’ or ‘lurkers’.

We gather further statistics from the workers to tell us the proportion of students that correctly and incorrectly answer each MCQ or each task. We also gather statistics about the time taken by each student to answer each MCQ or the time taken to undertake each task. We have now achieved the student→tutor feedback, which we can act on. For example, if the number of students answering an MCQ incorrectly is higher than we expect or it takes the average student a longer time to answer the MCQ than we expected then we have identified an area that students are struggling to understand and we can further adapt our VLE teaching material to address the problem that has been highlighted through the student→tutor feedback.

The layout of the rest of this paper is as follows. In Section 2, we briefly describe the functionality of our VLE, known as StudyNet. In Section 3, we describe our experiences of teaching Computer Science on a VLE. In Section 4, we discuss our on-line learning system and evaluate our feedback results. Finally in Section 5, we provide conclusions and a discussion.

2. StudyNet
The University of Hertfordshire firmly believes that the use of VLEs in learning and teaching is an important tool for both students and staff. This led to the university becoming one of the first UK universities to use a campus-wide VLE with on-line access to modules for all students and staff through its own in-house VLE called StudyNet (Jefferies et al, 2004).

StudyNet enables students and staff to access information through a web-browser both on- and off-campus. This means that all students and staff have access from a computer system on campus or over the internet to their own customised workspace. From the student perspective, this links students to module descriptions, lecture notes, university and module news items, on-line discussions, and group discussions, assessments, the university’s library system, the university’s e-mail system, the Students Union, the Careers Service and other information resources. StudyNet has therefore become the main source of information between students, academics and the university itself (Thornton et al, 2005).

In a recent report McNab (2003) states that from a potential number of StudyNet users of over 21,000 almost 16,000 (72%) of users login and use StudyNet. This means, from the perspective of our VLE, that 72% of our students are workers or lurkers and only 28% of our students are shirkers. In particular, in our Faculty of Engineering and Information Sciences the number of StudyNet users were reported by Macnab to be over 3,700, which is about 90% workers/lurkers and 10% shirkers. Surprisingly, the Faculty of Engineering and Information Sciences was not the highest proportion of users; this was achieved by the Faculty of Law where there are over 1,000 users, which is about 96% workers/lurkers and only 4% shirkers. Perhaps not so surprisingly, the Faculty of Art and Design achieved the lowest proportion of users with over 750 users, which is about 59% workers/lurkers and 41% shirkers. This StudyNet usage range of 59% to 96% of workers/lurkers is extremely encouraging and is indicative of the emphasis that the University of Hertfordshire has placed on the accessibility of on-line learning through StudyNet

3. Student use of on-line revision MCQs
In this study we targeted our MCQs towards first year undergraduate Computer Science students. We chose first year students for two main reasons. First, because we considered that first year students are more likely to be receptive to using our VLE and we wished to capture a true reflection of the ratio of workers, lurkers and shirkers. Second, at least two of our first year taught modules use MCQs as summative assessment to compose student grades.

3.1 Study 1
In our first study, we decided to invite our students to undertake 50 formative revision MCQs ‘which might help them with their revision for their end of year exams’ (ie. an optional aid to help with their revision) in the summer of 2004. We wrote our
MCQs for a double module course called Computer Systems and Networks. The major aims of Computer Systems and Networks are to enable students to appreciate the features of a selection of general purpose computers, computer peripherals and network technologies. The module also aims to enable the students to acquire the technical basis to understand semi-technical evaluations of computer systems and to interpret manufacturers’ publicity about their systems. The final aim of the module is for students to appreciate how hardware and software support High Level Languages. Computer Systems and Networks is therefore a highly technical subject and has a reputation among students for being a difficult subject, which thus rendered it ideal for our trial!

In this initial study, we made the revision MCQs available to a cohort of 214 students. Figure 1 shows the ratio of workers: lurkers for each of our 50 revision MCQs. There were 93 students who initially logged onto our revision on-line learning system, approximately 43% of those who could have logged on. Only 21 (approximately 10%) of the students looked at all 50 MCQs. This means that there were 121 (approximately 57%) shirkers who did not use our revision on-line learning system at all; this deteriorated to approximately 90% by the end of the revision MCQs. Of the 93 students who looked at the first MCQ, 76 (approximately 83%) were workers and 17 (approximately 17%) were lurkers. By the time the students had experienced 7 MCQs the number of workers/lurkers tailed off to about 35 (approximately 16%) students, which continued to decline to 24 (11%). The number of workers/lurkers remained around 24 for the rest of the 50 MCQs.

Unknown to our students we ranked each MCQ into one of three categories easy, moderate or hard. We considered 25 MCQs to be easy, 16 MCQs to be moderate and 9 MCQs to be hard. We also estimated that over 60% of all of our students would be able to successfully answer an easy MCQ within 60 seconds. We estimated that about 50% of our students would be able to answer a moderate MCQ successfully in under 120 seconds. Finally we estimated that less than 50% of our students would be able to answer a hard MCQ successfully in less than 180 seconds.

Overall the percentage of worker students answering MCQs correctly was in the range 41% to 92%. Figure 2 shows the percentage of workers answering each of our three categories of MCQs successfully. Our estimation for the proportion of workers successfully answering each category of MCQs correlated well with the actual percentages from the workers’ responses. Approximately 67% of the workers successfully answered the easy MCQs, approximately 53% of the workers...
successfully answered the moderate MCQs and approximately 32% of the workers successfully answered the hard MCQs.

Figure 2: The percentage of students correctly answering each category of MCQs.

However, our estimates for the amount of time proved to be incorrect, as shown in Figure 3. We expected the student response times to be far greater than they actually were. For example, we expected a worker to successfully respond to an easy MCQ within 60 seconds; the successful response time for an easy MCQ turned out to be within 45 seconds. It is clear that some of the lurkers considered responding because the lurker time was within 53 seconds. For the moderate MCQs, the worker’s successful response time was less than that of the easy MCQ response time and was within 39 seconds. The lurker response time was within 50 seconds. Finally, the successful worker response time was within 29 seconds for the hard MCQs and the lurker response time was within 42 seconds.

Our results suggest that students appraise MCQs quickly, if they consider that they can answer the MCQ they respond, if they consider that they cannot answer the MCQ they may think about it for a short period of time and then request the answer. We also consider that students form a decision quickly and if they consider the MCQ to be too difficult for them to answer they either guess an answer or request the answer and become a lurker for that MCQ.

For five MCQs there were no lurkers. Intuitively, we thought these would be easy MCQs which were answered quickly and correctly by all students. This turned out to be a false premise. We had categorised three of the five MCQs as easy and the other two as moderate. Furthermore, the range of correct responses was 40 – 75% and the response time was 16 – 43 seconds.

We identified a small number of MCQs that caused students some problems. This was because: few students answered an MCQ correctly, the time taken to respond to answer an MCQ was either greater than or less than our expected time. In the case where the time was less than our expected time and the proportion of students answering the MCQ correctly was high then this meant that the MCQ was probably not sufficiently challenging. In the case where the student response time was far less than our expectation and the proportion of students answering the MCQ correctly was low, then this MCQ was either too challenging for the students or we may have taught the material not as clearly as we should.
3.2 Study 2

We decided to re-evaluate our results in a second study. This second study was offered to a new cohort of students in the first semester of this academic year (2004/2005). Again, we invited first year Computer Science undergraduates for the same double module course, Computer Systems and Networks, to participate and we also included MCQs from a second double module course entitled Formal Systems.

The aims of the Formal Systems module is to enable students to develop confidence in formal and mathematical modes of discourse, to experience a range of formalisms that are useful in the design of programmed systems and for the students to appreciate the relationships between mathematics, formal (symbolic) reasoning and programmed systems. Similarly to Computer Systems and Networks this course has a student reputation for being a difficult subject, which renders it ideal for our study.

In our second study, we provided 10 formative revision MCQs for Computer Systems and Networks and a further 10 formative MCQs for Formal Systems which, as in the first study, might help the students with their revision for their (in this case) mid-semester summative assessments. There were a number of key differences between this study and the first study. First, we could not offer the same cohort of students MCQs because they would now be in their second year of study. In the second year of study, MCQs are not generally used to assess our undergraduate students. Instead our second year students undertake a number of courseworks assigned at different times throughout the academic year, followed by traditional written exams at the end of the second semester. Therefore, this type of study would provide little benefit to these students. Consequently, we decided to continue our study with first year undergraduates, even though it meant it was a different cohort. The second major difference was that we offered the formative MCQs from two different courses. Third, we reduced the number of MCQs to 10 for each course and fourth, the MCQs were provided as 2 banks of 5 MCQs for each course. We deliberately reduced the number of MCQs because of the rapid reduction in those attempting the MCQs in the first study and because this new cohort of students had only studied for a short period of time. We provided the MCQs as two banks of 5 because we considered students would be more likely to complete the MCQs if they were in short sequences which they could undertake all at once or even by attempting the MCQs on two different occasions. We offered two different courses to investigate if there would be different responses to different courses. A total of 155 students undertook the mid-semester summative tests.
In study 2, Figure 4 reflects Figure 1 of study 1, except in this study there were only 20 MCQs which were divided into two banks of 5 MCQs for Computer Systems and Networks and a further two banks of 5 MCQs for Formal Systems. More students attempted the Formal Systems MCQs than the Computer Systems and Networks MCQs. We attribute this to one major difference; in both cases the students were e-mailed to inform them of the revision MCQs, however the Formal Systems tutors, also, verbally informed their students about the revision MCQs during class contact time, whereas the Computer Systems and Network tutors did not.

Initially 55 students logged onto the first bank of Computer Systems and Network revision MCQs, approximately 36% of those who took the summative MCQ a short while later. By the end of the first bank of MCQs this number had reduced to 36 (approximately 23% of those that took the summative MCQ). 39 (approximately 25% of those that took the summative MCQ) students logged onto the second bank of Computer Systems and Networks MCQs which declined to 26 (approximately 17% of those that took the summative MCQ) by the end of the second bank of MCQs. The number of logons for the Formal Systems MCQs was more encouraging: 138 (approximately 89% of those that took the summative MCQ) of the students initially logged onto the first bank of MCQs. This declined to 83 (approximately 53% of those that took the summative MCQ) by the end of the first bank of Formal Systems MCQs and 78 (approximately 50% of those that took the summative MCQ) of the students logged onto the second bank of Formal Systems MCQs, which declined to 58 (approximately 37% of those that took the summative MCQ) by the end of the second bank of MCQs.

Of the 55 students who initially logged onto the first bank of Computer Systems and Network MCQs, approximately 84% were workers and only approximately 16% lurkers. By the end of the first bank of MCQs the proportion of workers remained relatively high at approximately 80% and this was mirrored with the second bank of MCQs. Similarly, of the 138 students who initially logged onto the first bank of Formal Systems MCQs, approximately 95% were workers and only approximately 5% were lurkers, which declined to about approximately 85% of workers at the end of the first bank of Formal Systems MCQs. Again, this was mirrored in the second bank of Formal Systems MCQs.

As with Study 1, in this second study we ranked our MCQs into the same categories (easy, moderate and hard). We also applied the same time estimation to each category (an easy MCQ
should be answered successfully by 60% of our students successfully within 60 seconds, a moderate MCQ should be answered successfully by 50% of our students within 120 seconds and a hard MCQ should be answered successfully by 50% of our students within 180 seconds), we applied these metrics to both Computer Systems and Networks, and Formal Systems. We categorised 4 of the Computer Systems and Networks MCQs as easy, 4 as moderate and 2 as hard, similarly we categorised 3 Formal Systems MCQs as easy, 4 as moderate and 3 as hard.

Figure 5 shows the percentage of workers answering each of our three categories of MCQs successfully for both courses. Again, our estimation for the proportion of workers successfully answering each category of MCQs correlated reasonably well with the actual percentages from the workers’ responses. Approximately 70% of the workers successfully answered the easy Computer Systems and Network MCQs, approximately 48% of the workers successfully answered the moderate Computer Systems and Network MCQs and approximately 65% of the workers successfully answered the hard Computer Systems and Network MCQs. Approximately 76% of the workers successfully answered the easy Formal Systems MCQs, approximately 53% of the workers successfully answered the moderate Computer Systems and Network MCQs and approximately 52% of the workers successfully answered the hard Computer Systems and Network MCQs.
In study 1, our estimates for the amount of time proved to be incorrect and we changed our Computer Systems and Network MCQs in study 2 to suit our time estimations. We decided to change the MCQs rather than our time estimations, because in summative assessment students have a strict time limit and therefore we did not want to increase or decrease student response time. In study 2, the student response time for those students who correctly answered our Computer Systems and Networks easy questions was within 114 seconds, approximately double our time estimation, as shown in Figure 6: Worker/lurker response time for each category of MCQ for Computer Systems and Networks (CS&N) and Formal Systems (FS). However, our time estimations for the moderate and hard MCQs closely mapped to the student response times (within 127 seconds for the moderate MCQs and within 143 seconds for the hard MCQs).
The successful response time estimations for the Formal Systems MCQs proved to be far greater than the actual student response time, the easy Formal Systems MCQs were correctly answered within 33 seconds, the moderate MCQs within 81 seconds and the hard MCQs within 59 seconds. These results verify our premise from study 1 that students appraise MCQs quickly and respond by either submitting an answer or requesting the solution.

Figure 6: Worker/lurker response time for each category of MCQ for Computer Systems and Networks (CS&N) and Formal Systems (FS).

4. Conclusions and discussion of future work

Our results have helped us to answer the three questions that we were attempting to answer. How does the tutor know the proportion of students who are actually undertaking the formative exercises? How does the tutor know if a student is just looking at the solutions and not doing the formative exercises? How does a tutor know how long a student is spending on each formative exercise?

Using our on-line learning system we can estimate the maximum number of students attempting the formative MCQs. It was interesting to note that more of the Formal Systems students engaged in our on-line learning system than the Computer Systems students, yet they were from the same cohort studying the same subjects. The Formal Systems tutors verbally encouraged their students to attempt our on-line revision MCQs. This indicates that on-line learning is not a substitute for student/tutor contact but should be used in a blended manner to augment each teaching strategy and to improve the student learning experience.

Using our on-line learning system, we can now suggest a classification of students into three categories: workers, lurkers and shirkers. We are disappointed with the high number of shirkers and are now actively considering ways to encourage more students to engage in such blended teaching/learning systems.

We can now estimate the amount of time students spend on formative questions. In our case, this helped us to change our expectations between the first and second study. Since students are often placed under time constraints during summative assessments, we consider that we as academics must provide the students with a fair and reasonable amount of time to answer our summative questions. Our on-line learning system is providing us with good indicators of how this might be achieved and is making us re-evaluate our question timing schedules. Classifying questions into different categories is helpful...
because we can associate each category with a different time metric. It is also in line with similar studies on using MCQs effectively such as the work undertaken at University of Leicester and the guidelines of the University of Cape Town (University of Leicester, 2005).

We would like to identify which student is using our on-line learning system and when they are using it. Currently at the University of Hertfordshire StudyNet does not provide us with the ability to identify individual students. When we are able to identify individual students, we plan to correlate the use of our on-line learning system with class attendance and to compare results of summative assessments from results obtained from our formative assessments.

From this proposed new study we would be able to identify in more detail how students engage with their studies. First, we would be able to quantify the number of occasions and the amount of time each student engages with our formative MCQs. Currently, we cannot quantify usage in an absolute manner. We consider that it would be beneficial for us as academics to be able to correlate the student usage frequency and student frequency usage time that is spent on formative MCQs. We could then use this information to identify areas of student concern with the taught material, and then we could dynamically amend our teaching material to improve the student learning experience. Second, we would be able to compare both individual student and cohort summative assessment results with on-line MCQ formative assessment results. One consideration is to repeat a previously used summative MCQ assessment as a formative MCQ assessment but to a different cohort of students. We could then estimate with a higher degree of accuracy the actual amount of time a student spends on each MCQ without the additional pressure of a timed summative assessment. This would also help us to estimate the number of MCQs that students ‘guess’ the answer to in a summative assessment, since in our own model a student can request the solution to a formative MCQ. In contrast in a summative MCQ assessment a student who does not know the answer would probably ‘guess’ the answer (so long as there is no negative marking employed) or simply ignore that question. Information extracted from this would help us to write our MCQs (both summative and formative).

Third, the second concept leads to the idea of a building a bank of MCQs as described by inter alia Liechti at University of Paisley (Liechti, 2005). We could use this bank of MCQs to provide us with formative and summative questions to monitor and compare different student cohort responses over a number of years. In this case, we would recommend refreshing the MCQ bank regularly by the insertion of new MCQs and the removal of aged (used repeatedly) or stale (out-of-date, perhaps due to technological subject enhancements) MCQs. We suggest that new MCQs should initially be used as formative questions, which would then help us to identify and correlate whether our questions realistically fall into the categories of hard, moderate or easy. Therefore when an MCQ is used (or amended for use) as a summative MCQ we would have removed any potential timing error of incorrect categorisation. Fourth, we would be able to identify whether non-attending students are in fact engaging with on-line material provided and are at less of a risk of failing than supposed.

In summary, this is on-going work and we have answered some questions but have posed many more. There is a great deal of scope in the authors’ opinion for further development in this area of providing fine-grained feedback within on-line learning systems to support and improve the students’ overall learning experience.

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Delivering What Students say They Want On-Line: Towards Academic Participation in the Enfranchisement of e-Learners?

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Abstract: Sustainable e-Learning holds the promise of enabling higher education to meet the needs of a large and diverse market. Central to this is the response of academic staff teams in meeting the needs of individual learners, in order to enfranchise them within an evolving, enabling learning context. Enfranchisement is underpinned by the management of learner-expectations in the value-added nature of the on-line learning experience. However, learner-enfranchisement demands that on-line interaction is both accepted by academic teams and educationally liberating. Liberation requires meaningful existence, and hence active participation, within a ‘supercomplex’ world, in which both individual identities and the ability to manage information are tested.

This paper assesses ways in which learner-enfranchisement can be encouraged by academic teams. It pivots around the outcomes from student evaluations of a strategic e-Learning implementation in one UK higher education institution. The conclusions that it draws focus upon strategies for adding pedagogic value, increasing academic participation and developing e-Learning sustainability in order to enfranchise e-learners. The argument highlights ways in which academic teams can move from a battery-intensive approach to e-Learning towards one that is more free-ranging. It highlights how academic staff can increase the sustainable, inclusive value of the learning experience at a minimised cost. From this basis, it is argued that any extant disenfranchisement in the delivery of e-Learning can begin to be addressed by increased team-work. A by-product for those teams is that in the very process of engaging their students, there is more hope that they will in-turn become empowered within their own use of e-Learning.

Keywords: Academic participation; Learner-enfranchisement; Teamwork; Sustainability

1. Introduction

Oliver and Trigwell (2005) argue that the project of embedding e-Learning within an overarching learning and teaching ethos should hinge upon variation theory (Oliver and Trigwell, 2005), where the constructed learning space affords ‘the critical patterns of variation in topics… that lead to learning’ (Oliver and Trigwell, 2005: 23). Crucially Oliver and Trigwell (2005: 24) argue for ‘exploring change from the perspective of the learner’, rather than through the focus on teaching as is the case with ‘blended learning’.

However, the need to explore the learner’s view of change pivots around the interventionist roles of academics and the epistemological spaces that they create. In turn, these spaces are being shaped by the corporate acceleration of new technologies and processes that promote sustainability. Littlejohn (2004: 91) defines sustainability as ‘the design and development of on-line courses that could easily be updated or scaled up’, and the Higher Education Funding Council for England’s ‘Strategy for eLearning’ (HEFCE, 2005: 2) endorses institutional, strategic approaches that are sustainable.

The management of innovation is crucial for academic staff, who need to recognise the intrinsic value of any change to be embedded (Lines, 2004; Taylor 1999). However, in the move towards a sustainable, corporate dynamic, there is a risk that disengaged staff may become lost. Thus, a central thread for building pedagogic value through sustainable e-Learning developments is connecting academic participation to learner-engagement. Greener and Perriton (2005: 78) note that

If meaningful learning communities are to be built in e-Learning contexts of this type, then they will demand of their members more than functional, teleological behaviour, and must find ways of harnessing technology to foster greater interactivity. Improvements in technology mean there is great scope for the democratisation of learning.

Taking variation theory’s learner-centred focus, this paper evaluates the theme of academic participation in light of student perceptions of their engagement with e-Learning. The argument highlights the connections between the enfranchisement of e-learners and the development of academic teams, with respect to one UK University. From this basis, it is argued that the sustainability of e-Learning, driven by the creation of shared, enabling learning environments can begin to be addressed by enhanced team-work.
2. Learner enfranchisement

2.1 Notions of enfranchisement

It has been argued that where learners feel enfranchised through their ‘increasing influence… on learning provision’ (EdExcel, 2004) they are more likely to engage in specific activities or scenarios. Freire (1972: 52) argued the same point when noting that ‘Liberation is a praxis: the action and reflection of men upon their world in order to transform it.’ This theme of enfranchisement via increased freedom-of-action requires engagement with the social context in which it takes place, and therefore builds a sense of belonging. It stems from empowerment rather than coercion.

For Barnett (1997), empowerment is rooted in an individual’s critical life, where a framework of rules or values enables a learner to act reflexively. However, in relation to e-Learning and variation theory, the generation of a reflexive approach also demands that individuals have personalised access to collaborative, epistemological spaces, where they feel able to discern and manage difference (Oliver and Trigwell, 2005). This is crucial for Bowden and Marton (2003: 129) who state that ‘students need to experience variation precisely because you cannot predict in advance what they will have to deal with as professionals’.

Central to the management of variation is freedom-of-action within a context where all actors are incorporated with agreed rights and responsibilities. This connects into Sachs’ view of engagement within a civil society (2000: 137).

A strong civil society protects liberty because it diffuses the centres of power. It creates fraternity because it encourages people to work together as neighbours and friends. It promotes equality because it tempers self-help with help to others, and because the help given to others is such as to encourage their participation and eventually independence.

For learners, the mode of incorporation into these social spaces enables them to make sense of the world and therefore become independent.

This ties into Barnett’s discussion of ‘supercomplexity’ within university life (Barnett, 2000), where multiple critical frameworks for the analysis of information and discourse are in competition. The ability to forge innovative and secure approaches to the critique of both knowledge and the frameworks that help us to interpret it, is crucial for the development of learning. Thus, managing ‘supercomplexity’ and promoting enfranchisement requires contextual variation (McKnight, 1977) and the selfless support for each individual’s management of their own learning on their own terms (Illich, 1971), through a process of incorporation into a self-regulating community. However, both learners and tutors have to want enfranchisement.

2.2 Enfranchising e-Learners: Battery-farmed or free ranging?

The UK Government’s Department for Education and Skills presented a positivist view that e-Learning will be a socio-economic panacea for individuals and society through the deployment of radical new pedagogies (DfES, 2003; DfES, 2003b). Zemsky and Massey critiqued this view and argued (2004: 52) that ‘For the most part, faculty who make e-Learning a part of their teaching do so by having the electronics simplify tasks, not by fundamentally changing how the subject is taught.’

The students interviewed by Zemsky and Massey articulated three key components of e-Learning that they valued: ‘They want to be connected, principally to one another. They want to be entertained, principally by games, music, and movies. And they want to present themselves and their work’ (2004: 51). In light of this, the authors highlight successful e-Learning experiences that reflect these everyday, real-world practices. These include problem-based group-work within a ‘physically intact learning community’ (2004: 51), with the close involvement of the tutor acting as a facilitator. Hence, presenting, developing and evaluating a scenario, activity or product that reflects the students’ assumptions and expectations is crucial.

Ip (2004a) agrees and argued that ‘the real promise of e-Learning is not [as] an on-line textbook, but a simulator… My approach would be to build engaging scenarios at critical moments in a role play simulation.’ This builds on the view (Ip, 2004b) that students require a ‘free-ranging’ approach to information-gathering, scenario-building and evaluation, within a structured and safe environment, rather than one that is battery-intensive. In the latter learners are housed within a minimally-engaging context, where structure, tasks and information are wholly defined and made accessible by the teaching team. This dependency culture requires minimal learner-input into the learning environment.

As in a battery-intensive environment, one that is free-ranging has clearly-defined parameters in terms of what it is, why the students are in it, and how they should use both it and their outputs from it. The difference lies in the level of active
participation and involvement by both the learners and tutors in shaping the boundaries of the environment and the available tasks and information. This is important for Ip (2004c): ‘When all the learners (or trainees) are exchanging meaningful stories related to the theme of the training, I would say we have a [sic.] rich e-Learning experiences’. A free-ranging learner has more autonomy in acquiring, utilising and publishing learning materials. Moreover, the learner has a negotiated freedom-of-action over her/his approach to task-work, and, freed from an inflexible confinement, will tend to feel enfranchised.

This ‘free-ranging’ model has three implications for curriculum management. The first is that students still cannot escape or change the environmental boundaries directly. They can only alter it through the actions of their tutors, and only where the students’ educational health is perceived to be adversely affected by the extant learning context. The second implication is that where a new type of environment holds the promise of increased productivity or achievement it may be deemed appropriate to migrate delivery towards it. The final implication is that students who are experiencing one approach to learning on a specific unit, may favour or fear different approaches on other units. It is equally possible for students to be happy and productive in free-ranging and battery-intensive arenas. Where the overall student experience involves a mixed economy in the delivery of e-Learning, academic teams need to explain the overall value.

This is important in light of the view that e-Learning, being the ability to ‘make it possible for anyone to learn who wishes to learn, at a time and place of their choosing’ (Bourne et al., 2004: 2), can be procedural rather than radical and still have worth. The ability of learners to access courses at cost and with an assured level of quality can promote enfranchisement. Pedagogically radical or not, ‘the demand for online learning continues to grow - and not just for convenience but because it works and because working adults find it necessary’ (Bourne et al., 2004: 3). Where this necessity is not addressed, possibilities for disenfranchisement are multiplied. Thus, empowerment demands the development of an enabling social context, where students feel connected to their curriculum and understand why they are engaged in specific activities.

2.3 Enfranchising e-Learners: The role of team-work

Innovation and change tend to increase the overall levels of psychological, work-based stress, especially where individuals feel a lack of control (Bordia et al., 2004; Kinman and Jones, 2003). One way of mitigating these effects is through clearly defined and inclusive team-work (Hertel et al., 2004). Ingram and Desombre have defined teamwork as ‘organised co-operation’, pivoting around the cohesive achievement of a common goal (1999: 18). This accords with the outcomes of the UK Health Care Team Effectiveness Project (Department of Health, 2002), which also noted that the ‘Quality of team working (having clear objectives, high levels of participation, commitment to quality, support for innovation and reflexivity) is positively related to team effectiveness.’

Ingram and Desombre’s paper is important for academics because the authors focus upon the nature of teams in complex industries. Far from being the province of the lone academic, the shaping and delivering of the curriculum is now likely to be a shared experience, with a unit leader co-ordinating a team that may involve both full and part-time staff from multiple departments (Ramsden 1998); with multiple modes of delivery. The 25 modules involved in the evaluation below had 103 academic staff involved in their delivery. In one vocational, distance learning module that relied on mentoring, four academic staff and 133 external mentors had access to the on-line module.

Moreover, the make-up of these teams tends to shift over time, in terms of both personnel and their confidence with e-Learning. At the start of the implementation noted below, only 27 of the 103 academic staff had previously engaged in e-Learning. Therefore the learning curve for these staff was steep and this has complex management implications, not only because team approaches have to relate to educational design and delivery that is fit-for-purpose (Lomas, 2002, pp. 72 - 4), but also as teams are responsible to the wider organisation for meetings its goals (West et al., 2004).

In building sustainable academic participation in e-Learning, staff teams need to focus upon organised co-operation, in order:
1. To understand how to use institutional e-Learning systems;
2. To see models of good practice for engaging with those systems in the curriculum; and
3. To recognise what students value from e-Learning, and thereby review their collective approach.

Through co-operative review, academic teams can build complexity into their use of e-Learning.
3. Evaluation

3.1 A note on context

The discussion below focuses upon the impact on the learning experience of deploying an integrated e-Learning system within one UK university, which supports approximately 20,000 students on its programmes, distributed across two centres and six faculties. Ahead of the 2003-04 academic session it moved towards a sustainable and interoperable e-Learning structure, which by the close of the 2004-05 sessions supported 905 academics and 13,254 students on 927 on-line modules. The complexity of the integration means that the overarching risk from staff and/or student non-engagement is increased.

The evaluation is based upon:
1. Snapshots of the implementation by means of evaluation questionnaires delivered to 968 students by 25 module teams at Levels 1 (n = 420), 2 (n = 153), 3 (n = 226), and post-graduate (n = 169); and
2. Analyses of interviews and focus groups with 61 students and 48 academic and support staff.

It was driven by the impact of the systematic implementation of e-Learning upon learning and teaching, rather than by specific theories. It utilises Zuber-Skerritt’s CRASP model (1992, pp. 14 - 17), which aims for the critical, reflective, accountable, self-evaluative and participative improvement of practice, in order to provide staff teams with some pragmatic enhancement opportunities.

Unless otherwise stated, the percentages given in the sections, which follow, are for respondents to specific questions. Due to the nature of the nominal data in the questionnaires, chi-squared tests were carried out in order to analyse associations between factors. A p-value of .05 was selected in order to minimise the risk of Type 1 errors whilst reducing the likelihood of Type 2 errors.

3.2 The impact of e-Learning on the student learning experience

In all, 728 students (78.0 per cent) felt that e-Learning was helping them to achieve their module learning outcomes. The number of students who felt that this was not the case was especially high amongst post-graduates, where it was 40.4 per cent (n = 74). Here tutors were using the system simply, to provide additional resources like handbooks and lecture notes, with minimal interaction, little signposting and no co-ordinated deployment. Moreover, the IT literacy of the teams involved was low, with one academic in each demonstrating best practice with no team-based implementation plan.

Overall the questionnaire outcomes showed a highly significant association between the students’ achievement of the unit learning outcomes, and their access to each of:
- Module information ($\chi^2 (2) = .001, p<.01$);
- Learning materials ($\chi^2 (2) = .001, p<.01$);
- Assessments ($\chi^2 (2) = .001, p<.01$); and
- Opportunities for personal interaction ($\chi^2 (3) = .001, p<.01$).

The associations suggest that the provision of these types of materials and experiences, some of which were procedural, underpinned the students’ achievement of the module learning outcomes, at all levels-of-study and all ages.

There was also a highly significant association between the achievement of the learning outcomes and whether the system was felt to be dependable ($\chi^2 (1) = .001, p<.01$) or easy-to-use ($\chi^2 (1) = .001, p<.01$). For instance, 501 of the 713 students who claimed that e-Learning was helping them to achieve their learning outcomes also felt that the system was dependable. A postgraduate student felt that ‘Access has been great. I am hard of hearing – this is great to be able to communicate without worry of them hearing me. I hadn’t foreseen this.’ However, 125 (62.8 per cent) of the 199 students who claimed that the system was not helping them to achieve their learning outcomes also felt that it was not dependable. This was particularly the case for those learners who were older than 30, for whom there was a significant association between dependability and the achievement of the learning outcomes ($\chi^2 (3) = .29, p<.05$).

It can be inferred that those student’s whose online experience was comfortable with few problems felt that it added value to their learning. This highlights the need for staff to negotiate and then articulate clear, agreed structures for student support, especially in terms of part-time and mature students, and those working at a distance. For instance, one student argued that ‘the tutor was unclear about the set-up – he was learning and it was a new course for him with a new e-Learning system’. A second stated that ‘it was a worry when the system went down close to a deadline – I did not know who to call. I would like clearer technical advice as my tutor doesn’t really understand.’ A lack of academic engagement with issues and opportunities that arise frustrates and ultimately disconnects learners.
3.3 Managing expectations: Towards cohesive rules of engagement

One six-strong teaching team, who focused their provision on distance learners, noted their overarching vision for on-line engagement.

As we cannot see them reading and using materials, we have to try to engage in the process of the conversation, to move the students forward. We try hard not to interrupt the flow of their conversations – they need to know that we are there and listening but those we will not interfere.

This team had run on-line distance learning for three years and believed that clarity was crucial because student expectations vary. Elsewhere, a level one student reported that ‘I had never used e-Learning before and so I used it as it comes. I had no expectations, but these are now rising, especially in use for research on this course and using the Internet.' This heightened expectation was reiterated by a level three learner who argued that ‘it needs more integration into other modules. All tutors should encourage more use'.

Twenty-seven student interviewees saw a need for the explicit clarification of the teaching team’s expectations for them and their work, whilst 28 highlighted their own expectations of the tutor and the system. One student working at a distance noted that ‘Tutors all use it in different ways and some not at all, and therefore there is not much support.' This was more important for 23 of the 61 student interviewees who stressed the need for more feedback on their work. One stated that ‘I anticipate more guidance and contact – especially feedback'. The key here is building a consistent on-line student learning experience.

In generating consistency, socialisation and the creation of shared operational norms are crucial and need to be planned. One student felt that this element was poorly handled: ‘I was left confused from induction – there was too much and too many people were involved.' A second felt that there was ‘poor training and a lot of assumptions were made about people's learning'. Clarity of introduction and on-going, cohesive support are central themes that connect into time-management. A dyslexic student indicated that time was a huge issue for students with specific, diagnosed impairments who may need extra support, or more careful planning of the delivery of on-line task-work or assessments. As the stress of managing multiple new environments can affect individual engagement, students rely on the ways in which staff teams are supportive of them.

A final expectation is the demand for more on-line contact. Of the 894 students who responded, 84.6 per cent (n = 756) felt that they would like e-Learning to be used to support their other modules. A further 14 mentioned this issue in their interviews, with one Level 2 student stating: ‘In order to spend time [on-line], it would be beneficial for all modules to use it. It is, in my opinion, [an issue for me] to spend time using it for only one module and still have to manually research and interact with all other modules'. This view was reinforced by a focus group of Level 1 and 2 tutors who noted that the variation in use of the system within programme teams was a disadvantage to embedding it within learning and teaching. However, it can be argued that rather than variation in use, it is consistent communication about that variation which matters. A more interactive, free-ranging approach requires organised co-operation.

3.4 The value of currency and interactivity

Interaction is fundamental in enhancing the role of e-Learning in the curriculum, and 25 student interviewees specifically talked about its impact on their learning experience. Overall the student questionnaires revealed a highly significant association between having both enough interaction and enough learner support and feedback (x² (3) = .001, p<.01). However, for Level 3 students (x² (2) = .620, p=.05), and students over 30 (x² (1) = .984, p>.05) the data infer that these students had not found interaction very useful and felt that they had not had enough learner support and feedback. Of these groups, 43.4 per cent (n = 72) felt that interaction on their module was not very useful for them and 47.3 per cent (n = 78) felt that there was not enough tutor feedback. The stage that these learners were at in their learning cycle would suggest that they expected less battery-intensive, i.e. information-heavy, discussion-light, on-line experiences. Students at different levels of study may need differential e-Learning contexts in order to feel enfranchised.

The connection between the achievement of the learning outcomes and the level of learning support and feedback also shows a highly significant association for students at Levels 1, 2 and 3 (x² (1) = .001, p<.01), and those students under 30 (x² (1) = .001, p<.01). From the data, students who felt that e-Learning was helping them to achieve their learning outcomes also felt that they were receiving enough learner support and feedback. However, analysis showed that this was not the case for postgraduate students (x² (1) = .599, p>.05), or those students who were older than 30 (x² (1) = .205, p>.05). In all, 40.0 per cent
(n = 379) of the students surveyed felt that there was not enough interaction and learning support.

In part, short-term demand for interaction can be achieved by maintaining the currency of the online experience. Of the student questionnaire respondents, 15.8 per cent (n = 222) valued the fact that announcements and the regular, structured upload of content during the module kept them up-to-date with developments. The interview analysis highlighted the value of appropriately timed, clearly identifiable materials (n = 28), feedback (n = 25), and consistency of types of resources between and within modules (n = 12). Despite this, academic teams need to engage with the process of development from short-term innovation into long-term demand-management, if their students are to be enfranchised.

3.5 Towards academic engagement?

In all, 23 staff that were interviewed focused upon the pioneering role of others, who are able to share good practice with the later settlers. This is crucial because so many were relatively naïve settlers. One member of staff ‘selected one module [for on-line use] and decided not to overcomplicate things… [Because] my awareness was a bit of a barrier’, and highlighted that ‘I also pinched other people’s ideas – I had a browse around and saw what they were up to. This allowed me to see how what I do fits in with other’s work – I could fill-in some gaps.’ Pioneers have the potential to empower others.

One senior manager who articulated that ‘threshold expectations are being demanded by students and need to be met by academic teams’ focused upon this pioneering-settling model. His faculty’s end-of-year report picked up this issue in its recommendation for enhanced ‘pedagogic development as programme teams discuss the potential of the system.’ This was pivotal for another academic who argued that ‘unless all staff in a team use it evenly then there is little point. There is some overlap across modules and it is useful for all staff to use the system.’ Again, empowerment is seen to stem from inclusive teamwork.

One member of staff in a different faculty noted that:

*The team’s modules are all on [the e-Learning system] – student pressure has increased this and this has put pressure on our workloads and staff IT ability. At the moment this is okay across the team as there is informal support and our IT skills are okay.*

Here negotiation between learners and teaching team changed the environmental boundaries of the learning context, and this local innovation was connected to the overall confidence and openness of the team. As learner expectations rise, the demand for, and foci of, professional development needs to be assessed in-line with a team’s overall vision, experience and improvement agenda, and the need to retain and recruit more learners. One staff interviewee noted that:

*[The e-Learning system] allows us to focus upon the links between modules in a programme. We can begin to make connections and give an overview of all of the modules… we can then show the links between learning outcomes and assessment, and students can be made aware of the other avenues that are open to them conceptually.*

Again the focus is on environmental change in order to increase student achievement, and the team recognised that a cohesive, planned approach would reap benefits.

4. Conclusions

These descriptive analyses indicate that even procedural, battery-intensive e-Learning engagements can have a positive impact on the learning experience where they are managed through organised co-operation. Developing this approach is more pressing for academic staff because when students were asked to nominate two factors that they disliked about the overall system, 401 (44.6 per cent) of the returns singled out learning and teaching elements. This illustrates the expectations of students for clarity of delivery across all levels of study. Amongst those students with greater experience of higher education there was an expectation that there would be more analytical and interactive work and less emphasis on battery-intensive e-Learning. Whilst some staff sees system reliability as a barrier to student usage, students see the improvements in their learning environment as more enfranchising.

The students identified two; quick wins for academic teams that are not only low cost in terms of time and resource overheads but also likely to increase participation. The first is the use of available communication tools to maintain currency and join-up various curriculum elements. Crucially, this factor would sharpen the students’ sense of on-line engagement and enfranchisement, and demonstrate a shared vision for use across a team. The second is for academic teams to plan and structure the e-Learning experience both in terms of what is presented on-line and by whom, and how that
maps onto other curriculum delivery mechanisms. This is crucial because students highlighted the disparity of experience where there was differential staff use. As staffs align their delivery of e-Learning activities with the time, locations and ways in which they interact with their learners, they are better able to pragmatically deliver what students say they want on-line.

This matters because where team approaches are articulated, students commented on:

- a more integrated and sophisticated use of e-learning;
- more feedback on progress;
- more task-based, student-controlled content; and
- a use of specific systems to reflect and enhance the learning and teaching architecture.

Where curriculum objectives are agreed and development is then centred on the sustainable integration of e-Learning by the team, academic participation will address the three implications for curriculum management that arise from Ip’s model of free-ranging (2004b): namely enabling students to change the boundaries of their learning environment; enhancing student achievement; and ensuring cohesion across a programme. A by-product for academic teams is that in the very process of engaging their students, there is more hope that they will in-turn become enfranchised within their own use of e-Learning.

References


Outline and Evaluation of a Joint European and Canadian Virtual Mobility: e-Learning Project.

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Abstract: The “virtual mobility” project was created as part of a joint Canadian and European Commission funded project to explore cross-cultural clinical curricular developments in the radiation sciences. The aim of the project was to facilitate student learning of the cross-cultural differences in the delivery of healthcare within the disciplines of diagnostic radiography and radiotherapy. The project was delivered as case study group work, on-line via the virtual learning environment (VLE) “Blackboard”. Upon completion of the project, participants and staff facilitators were encouraged to complete an on-line questionnaire, which was used to inform future improvements.

Keywords: Partnerships in e learning; cross-cultural education; on-line collaboration; group work.

1. Background

The “virtual Mobility” project was created as part of a three-year joint Canadian and European Commission funded project entitled “Cross-cultural Clinical Curricular Developments in the Radiation Sciences”. The funding period being 2002 – 2005. Joint approval and funding was granted by Human Resources Skills Development Canada and the European Commission’s Directorate General for Education and Culture, and involved the following institutions: The Michener Institute of Applied Health Sciences, Toronto, Ontario, Canada; QEII/Dalhousie School of Health Sciences, Halifax, Nova Scotia, Canada; Ottawa Hospital, Ottawa, Ontario, Canada; INHOLLAND University, Harlem, Netherlands; Institute Paul Lambin, Brussels, Belgium and University of Hertfordshire, Hatfield, UK.

In addition to physical student and faculty exchanges, an objective was set to develop a short on-line course, named the “Virtual Mobility Project”. This was to reflect the increasing interest in exploring flexible learning and e learning at traditional campus-based universities. Within the UK, the government has placed a greater emphasis on flexible leaning and e-learning, as outlined in the white paper “The future of higher education” (Department for education and skills, 2003). Increasing numbers of traditional campus-based universities have begun to provide distance education, and the traditional differences between distance-teaching universities and traditional universities are fading, due to a trend towards convergence, not only of technologies but also of pedagogies and institutional approaches (Collis and Moonen, 2001).

This “virtual mobility project” was developed to engage students to participate in on-line discussions and research related to a posted topic/case study via the virtual learning environment (VLE) “Blackboard”, which was hosted by the Michener Institute of Applied Sciences, Toronto, Canada. The structure of the project was developed during the first year of the project, with the intention to run it during the second and third years of the project.

2. The virtual mobility project

2.1 Aim

The aim of the project was to facilitate student learning of the cross-cultural differences in the delivery of healthcare within the disciplines of diagnostic radiography and radiotherapy. This was to be achieved by multi-cultural student groups collaborating on-line to discuss and submit a written report regarding a number of issues arising from a given case study. Fung (2004, p136) states that: “With advances in our understanding of learning, educators now place greater emphasis on collaborative learning and the development of participatory learning communities to promote the social construction of knowledge”.

The learning outcomes for the Virtual Mobility Project are outlined in table 1, below.

2.2 Method of delivery

The Virtual Mobility Project was delivered for the first time over a four-week period between January – February 2004.

31 students from 5 participating institutions took part in the project. Students were selected on a voluntary basis. All students undertaking the project were studying either diagnostic radiography or radiotherapy.

Discussion groups were formed by pairing European Institutions with Canadian Institutions.
The discussions could be conducted in either English or French, according to the comfort level of the students participating. Reports could be written in either language. To help students translate reports, a translation web site was posted in the external links section on “Blackboard”.

Table 1: The learning outcomes for the virtual mobility project (UH, IPL, InHolland, 2004)

<table>
<thead>
<tr>
<th>Upon successful completion of this course the learner will be able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Discuss professional behaviours in a global sense</td>
</tr>
<tr>
<td>2) Create an approach to dealing with cultural and translation issues among patients</td>
</tr>
<tr>
<td>3) Discuss strategies to address the issue of refusal of treatment</td>
</tr>
<tr>
<td>4) Compare professional practices in different countries</td>
</tr>
<tr>
<td>5) Communicate effectively in a cross-cultural environment</td>
</tr>
</tbody>
</table>

The project was delivered as case study group work, on-line via “Blackboard”. The case study is outlined in figure 1 below:

“You Are scheduled to treat a 15 year-old female patient with osteosarcoma. Although you suspect she can speak English, each day she is escorted by her father to treatment and all discussions that you need to have with her are conducted through the father as the translator. On this particular day, the father appears agitated and distraught. At the scheduled treatment time, the father presents to inform you that the patient will no longer be receiving treatment. Upon further enquiry, the father discloses that his wish to discontinue treatment is due to the perceived lack of respect afforded him by a technologist the day during an examination his daughter had at the CT Scanner. During this interaction with the patient’s father, you observe the patient arguing with her father (in a foreign language) and you sense that she is willing to receive treatment”.

Discussion Points:
1) Age of consent – refusal of treatment by father – does the father have the right to refuse treatment for the daughter?

2) Cultural/translation issues – accuracy of information being shared – how do you overcome this situation?

3) Professionalism - finding out about how the father was disrespected – how would you deal with this?

Figure 1: The case study for the virtual mobility project

The project consisted of two phases: phase 1 representing approximately 21 hours of work and phase 2 approximately 11 hours of work. For phase 1, groups were instructed to produce and post a single report comparing and contrasting their respective practices. For phase 2, the students were assigned to one of three separate discussion groups for the review of one (assigned) discussion point as in figure 1 above. Each of these discussion groups were directed to create and post a final synthesis of their assigned discussion point taking into account practice in all partner locations.

2.3 Challenges

There were a number of challenges to be faced in setting up the project.

Alignment and timing. The overall structure of the educational programmes and the way that students can register for practice differs in the participating countries. Programmes may be delivered over time periods varying between 2-4 years. In some participating countries, qualification entitles students to register immediately in order to practice, whereas currently in Canada, qualifying students are required to sit an additional external state examination in order to be allowed to practice. Differences also existed in the content and structure of individual courses or modules delivered at the individual participating institutions. It was important, therefore, for all participating institutions to examine their courses or modules, in order to decide where the “virtual mobility project” had most relevance to the overall structure and content. At some institutions, this was third year courses or modules; at others it was second year courses or modules. When each institution had identified a relevant course or module within which to run the project, participating students would be exempt from another element of coursework, so that the work...
undertaken for the project would contribute to the students overall mark for the course or module, and would not create an additional assessment burden. It was also felt to be preferable to run the project with groups of students who were currently undertaking academic blocks, as not all students would have access to computers at their clinical sites.

**Accessibility – choice of suitable virtual learning environment (VLE).** The project was delivered online via the VLE “Blackboard” hosted by the Michener Institute of Applied Sciences, Toronto. This institution had previous experience of using this VLE for structured group work, and was willing to create a project course site, register students and faculty members, and provide technical support if needed. Not all participating students were familiar with “Blackboard”, but guidance on how to use the site was made available. One of the benefits of using “Blackboard” was the on-line “chat” facility called “Virtual Classroom”. This gave students the opportunity to arrange real-time discussions, taking local time differences into account.

**Choice of common case study.** The students undertaking the project were studying either diagnostic radiography or radiotherapy. It was therefore important to select a case study, which was appropriate and relevant to both disciplines. One imaging modality, which has particular relevance to both disciplines, is CT scanning. In diagnostic radiography it could be used to help diagnose primary or metastatic spread of cancer for staging purposes. In radiotherapy, CT scanning can be used for treatment planning or simulation. It therefore seemed the ideal common area in which to locate the case study.

### 3. Evaluation

Upon completion of the Project, students and faculty facilitators were encouraged to complete an on-line evaluation form. Evaluation forms were completed by 23 (74%) of students and 5 (100%) facilitators. The evaluation questionnaire consisted of demographic information, multiple choice questions and open questions.

The following key areas will be considered here, both in terms of student and staff (faculty facilitator) evaluations:

- Quality of learning experience – did students learn about other cultures approaches to their discipline?
- Ease of use of “Blackboard” and technical support.
- Time spent working on the project and overall length of project.
- Key areas for improvement
- Things that worked well

#### 3.1 Quality of learning experience

Students were given the statement: “How would you describe your learning experience?” and were given the options of excellent, good, satisfactory or poor (See figure 2).

Staff were given the statement: “In my opinion this was a valuable learning experience for the students”, and were asked whether they strongly agreed, agreed, disagreed or strongly disagreed with the statement (See figure 3).

![Figure 2: “How would you describe your learning experience?”](image-url)
Both students and staff viewed the project’s value as a learning experience positively. In total, 70% of student respondents described the learning experience as “good” or “excellent” and 100% of staff respondents agreed or strongly agreed with the statement “In my opinion this was a valuable learning experience for the students”. This view was further supported by positive student comments. It was felt from this that the overall design of the project was good and that it provided a valuable learning experience.

Students were given the statement “I learned about other cultures’ approaches to my discipline”, and were asked whether they strongly agreed, agreed, disagreed or strongly disagreed with it.

Staff were given the statement: “In my opinion, my students learned about other cultures’ approaches to my discipline”, and were asked whether they strongly agreed, agreed, disagreed or strongly disagreed with the statement. Figure 4, below, combines student and staff responses.

In total, 92% of student respondents “agreed” or “strongly agreed” with the statement, and 80% of staff respondents “agreed” or “strongly agreed” with it. The very high response from students was further supported by comments on the strengths of the project. In addition to learning about cultural differences in healthcare, students also initiated discussion threads about the differences in radiography and radiotherapy education in their respective countries and discussed other social and cultural differences. The level of curiosity and interaction between the students increased as the project progressed, and the social interaction continued as students agreed times to “meet” online in “virtual classroom”, a “chat room” facility within “Blackboard”.

![Figure 3: “In my opinion this was a valuable learning experience for the students”](image1)

![Figure 4: “I learned about other cultures’ approaches to my discipline/ in my opinion, my students learned about other cultures’ approaches to my discipline”](image2)
3.2 Ease of use of “Blackboard” and technical support

Students and staff were given the statement: “I found Blackboard easy to use”, and were asked whether they strongly agreed, agreed, disagreed or strongly disagreed with the statement (see figure 5, below).

![Figure 5: “I found “Blackboard” easy to use”](image)

In total, all students and all staff agreed, or strongly agreed, with the statement “I found “Blackboard” easy to use”.

Students and staff were given the statement: “The technical support I received from the Michener met my needs”, and were asked whether they strongly agreed, agreed, disagreed or strongly disagreed with the statement (see figure 6, below).

All students and staff either agreed or strongly agreed that they found “Blackboard” easy to use, and that the support from the Michener Institute met their needs. These figures clearly indicate what is viewed by many to be one of the key components in the delivery of a successful on-line course. Salmon (2002) has stated that individual access and the induction of participants into on-line learning are essential prerequisites for the on-line learning process. Similarly, Kennedy and Duffy (2004) have described technical support as an essential feature of an on-line course. In an analysis of extensive field trial results carried out by the Canadian Virtual University, Harasim (1999, p48) reported that:

“The major problems students encountered were not related to their workload but rather to technical difficulties and slow networks.”

![Figure 6: “The technical support I received from the Michener met my needs”](image)

3.3 Time spent working on the project and overall length of project

Students were asked to indicate the approximate amount of time spent working on phases 1 and 2 (including research, postings, report writing etc.), from the following ranges:

- 1-5 hours
- 6-10 hours
- 11-15 hours
- 16-20 hours
- 21-25 hours
- Greater than 25 hours

Figure 7, below shows the student responses for phases 1 and 2 of the project.
The amount of time spent working on the project invoked a wide range of responses for both phase 1 and phase 2. Within the short timeframe for completion of the project students could be flexible in the amount of time they spent working on the project, and also when they chose to work on it. Students were not directed to keep a diary of their time spent working on the project and, as such, the responses are estimates. As can be seen in figure 7, above, the greatest percentage of student responses indicated that they spent between 6-10 hours working on both phases 1 and 2 of the project.

Staff were also asked to indicate the approximate amount of time they spent working on the project, from the following ranges:
- 1-5 hours
- 6-10 hours
- 11-15 hours
- 16-20 hours
- 21-25 hours
- Greater than 25 hours

See figure 8, below.

---

Figure 7: Amount of time (hours) students spent working on phases 1 and 2 of the project

Figure 8: Amount of time (hours) staff spent working on the project

Again, there was a spread of responses across the time ranges. Not all staff participants had experience in the area of online facilitation prior to running the project, and this may be one reason that contributed to the overall range of responses. Further evidence for this comes from the open question on key areas for improvement. Some staff requested clear guidelines on the role of the facilitator.

Students were asked to consider the length of time given to complete the case and to indicate whether it was “too short”, “just right” or “too long”. Figure 9, below, illustrates the student responses.
A significant proportion of students (39%) indicated that they felt the time given to complete the case was too short. Upon reflection, and further discussion at the end of the project, it was agreed to extend the period of the project from 4 to 6 weeks and to introduce an introductory phase to allow a degree of on-line socialisation before commencement of the project.

### 3.4 Key areas for improvement

In addition to multiple choice questions, students and staff facilitators were asked two open questions: “give two suggestions for improvement”, and “two things that worked well were:”

The student responses to the question asking for suggestions for improvement were varied and key responses were:
- Provide more information regarding expectations.
- Provide more specific details regarding the case itself.
- Review the timing of phases within the case study.
- Consider the use of a resource person.
- Consider the use of physical and/or on-line meeting prior to the start of the case study.
- Key staff responses to the question were:
  - More defined guidelines for the written reports.
  - Better communication with students at the start.
  - Good description for the students as to what is expected of them.
  - Review the timing and time set to run the project.
  - Guidelines for the facilitators.
- A small number of students expressed the desire for face-to-face meetings during the project. Allen and Lawless (2003) have identified that on-line collaboration can be a source of stress for some students, and Rosenberg (2001, in Schweizer et al, 2003) suggests that face-to-face classroom learning can be used to support e-learning in certain aspects.

### 3.5 Things that worked well

- In response to the open question asking for “things that worked well”, the following key responses were identified by students:
  - Good organisation.
  - Great way to learn about other countries and the way they practise.
  - Fantastic medium to present a lot of ideas.
  - Contact between students and teachers.
  - “Blackboard”, very easy to use and fun.

Staff responses identified that:
- Students were keen and self-directed.
- Good interaction occurred among most students.

### 3.6 Planning for future delivery

- From the experience of running the project for the first time, and taking into account student and staff evaluations, the following changes were agreed:
  - Instead of a 4-week period, the project would run over a period of 6 weeks.
  - It would include an introductory phase where the students could get to know each other.
  - The students would be provided with clearer guidelines.
  - “Milestones” rather than phases would be used to focus student effort and direction. The separation of phases was felt to disrupt the development of ideas and increase confusion amongst participants.
  - Guidelines would be produced on the role of the facilitator.
4. Conclusion

This project represents the first step in developing a cross-cultural on-line course, which enables students studying radiography or radiotherapy to collaborate internationally to gain a deeper insight into global and cultural differences within their chosen discipline of study.

The sustainability of the virtual mobility project beyond the period of funding has been agreed by all participating institutions. The Michener Institute is prepared to continue to host the project on “Blackboard”. Future developments might see the project being extended into a course or module, which could become more fully integrated into the programmes of study undertaken at the participating institutions.

Acknowledgements

I would like to acknowledge the encouragement and support provided by each participating institution and all staff and support staff directly and indirectly linked with the project. In particular, I would like to acknowledge the hard work undertaken by the following people:

Lori Boyd; Renate Bradley; Lynn Burgess; Collette De Muylder; Sarah Fearn; Ans Hegeman; Nicola Hopwood; John Hubert; Ginette Laroche; Joan Laurie; Cindy Murphy; Leslie Murray; Rosemarie Peikes; Regine Pirlot; Richard Price; Marij Urlings; Mario Van Olffen

References

Collaborative On-Line Teaching: The Inevitable Path to Deep Learning and Knowledge Sharing?

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Abstract: It is often stressed that the pedagogic models and approaches of Collaborative Online Learning support a learner’s shared knowledge building within collaborating groups of learners, the individual construction of knowledge and the formation of an ongoing learning Community of Practice. Based on a recent case study of a Danish Master’s programme, this paper will demonstrate that the emerging collaborative practice displays tendencies contrary to the generally accepted assumptions. The outcome is not only based on the models and their attributes, it is also affected by the emerging practice itself and the interaction among the participants during a course. From this perspective, it is relevant to look at which possibilities and obstacles teachers encounter when they try to detect slowly emerging tendencies that may lead to major misinterpretations of the subject matter and marginalize or even exclude students from participating in the learning Community of Practice. In conclusion, the case study will identify the slowly emerging tendencies that may be detected and observed at an early stage and thus indicate areas in on-line learning environments that require special attention.

Keywords: Collaborative on-line learning, Knowledge construction, Communities of practice, Emerging practice, Proaction, e-Learning

1. Introduction

In the literature of Collaborative Online Learning, it is often stressed that this pedagogic approach supports the learner’s shared knowledge building within collaborating groups of learners as well as the individual construction of knowledge. Collaborative Online Teaching also supports the formation of an ongoing learning Community of Practice (Benbunan-Fich and Hiltz 1999, Bullen 1998, Dirckinck-Holmfeld 2002, Garrison 1997, Harasim et al 1997, Koschmann 1996, Laurillard 2002, Stacey 1999). In recent years, the challenge of improving the outcome of Collaborative Online Learning has become an increasingly important issue (Cecez-Kecmanovic and Webb 2000). In this connection, the design of virtual learning environments and the implied roles of teachers and students are considered key factors (Ó Murchú and Sorensen 2004, Powers and Guan 2000) along with the support and coordination of the collaborative learning process (Carell et al 2005, Dillenbourg 2002, Weinberger et al. 2004), intervention in terms of feedback (Zumbach and Reimann, 2003) and mediation (Sorensen 2002, Salmon 2003).

The focus of improvement has been concentrated on how to design environments, how to model students’ and teachers’ activities and how to intervene in discussion fora (mediation, coaching, scaffolding etc.). To some extent, it might appear as if the processes of knowledge construction and the formation of Communities of Practice are considered to be the inevitable outcome of the collaborative educational models based on constructivist learning theory owing to these models’ inherent attributes and qualities.

A recent case study of the Danish Master’s programme in ICT and Learning (MIL) based on collaboration and constructivist pedagogy demonstrates that the emerging collaborative practice displays tendencies contrary to the generally accepted assumptions. The study identifies how the students slowly develop convergent, goal-oriented and cooperative (division of labour) strategies rather than divergent, explorative and collaborative (integrating) strategies. It also demonstrates how the changes in the students’ strategies may lead towards reproductive learning and a surface approach rather than reflective knowledge construction and deep learning.

The paper argues that the outcome of ongoing processes staged within the framework of collaborative e-Learning models is not only based on the models and their attributes. The outcome is also affected by the emerging practice itself and the interaction among the participants during a course. From this perspective, it becomes vital to look at the possibilities and obstacles encountered by teachers in their efforts to obtain the necessary knowledge to decide whether and how to support the learning process though intervention such as mediation, coordination, scaffolding, coaching, etc.
1.1 The missing link in improving collaborative on-line learning

To some degree, teachers may pay close attention to ongoing discussions (Salmon 2002, Sorensen 2002) to secure that learners participate, that contributions add value to discussions and that discussions do not develop in undesirable directions. It is much more demanding for teachers to detect slowly emerging tendencies, e.g. students’ gradual internalisation of misunderstandings, which eventually may lead to major misinterpretations of the subject matter (Laurillard 2002, p. 25) or social constructions in the emerging learning Community of Practice that may marginalize or even exclude students from participating in the community (Wenger 1998 p. 100 ff.). However, the problem of detecting slowly emerging tendencies in on-line learning environments is rarely touched upon in the literature.

In contrast to classroom teaching, slow tendencies cannot be observed directly in on-line environments at the early stages of their development (Hayles 1999, Orngreen and Leivinsen 2005). When they finally manifest themselves, the process has often been going on for so long that it takes more resources than normally required to solve the problems and coach the students (Leivinsen and Orngreen 2003). In other words, the invisibility of slowly emerging tendencies is a strain on the teachers’ ability to coach and facilitate collaborative learning. Neither the collaborative e-Learning models nor the Learning Management Systems available (Gerosa et al 2005, Leivinsen 2005, Reffay and Chanier 2003) provide teachers with a clue as to where they should focus their attention.

2. Research

A study was made to explore how individual students with their expectations and backgrounds influenced socialisation and learning in a class of 53 students – mature adults – during their first semester in 2002 on MIL. There were two data sources. The students completed two questionnaires, one at the very beginning of their studies and another after one year. The questionnaires were supplemented by eight qualitative interviews with students in the early summer 2003.

2.1 Presentation of the case - Master’s programme in ICT and learning

The Danish Master’s programme in ICT and Learning (MIL) is an “old” (4 years) on-line programme of 2 years duration. The form is blended mode – on-line and seminars - based on variations of constructivist pedagogy. The first semester begins with an on-line introduction to the LMS. During the semester, the class meets twice at weekend seminars. At the first seminar, the class is subdivided into 10 working groups. Each group has a private group space in the LMS. During the semester, the groups participate in two parallel courses, known as module M1 and M2.

The M1 subject area includes learning theory and collaborative on-line learning. The students discuss the curriculum and are organised by the teacher into various collaborative constellations concerning roles and tasks. The students are evaluated on their qualitative and quantitative participation in the discussions (Sorensen and Takle 2003), which take place in the M1 public discussion fora. M2 deals with human computer interaction and visual design of interactive learning applications. The M2 teachers expect the students to organize knowledge sharing in the public M2 discussion forum while working on their assessments in their private group spaces. The teachers offer fixed periods of guidance. The students are evaluated by means of written assignments at the end of each M2 sub-course. The final assignment is the design and user test of an e-Learning application interface.

3. Research methodology

3.1 MIL – A critical case study

MIL must be seen as a successful construction, well functioning and a general source of inspiration for other on-line master programmes. In the evaluation surveys, the students express an overall satisfaction, the percentage of accomplishment is relatively high and the admission of new students is stable. Therefore, the study of MIL falls within the definition of Flyvbjerg’s critical case study as a case that produces strategic understanding in relation to a general problem (2001). According to Flyvbjerg, critical cases may be more or less probable, and they are used to either confirm or disconfirm assumptions in relation to social processes in contextually dependent, floating environments. MIL is identified as a less probable critical case study, where interpretations are based on the assumption that if e-Learning aspects in practice turn out to be either (not) applied to MIL or problematic, we may expect the same to be relevant under analogue circumstances. Therefore, the reader must bear in mind that individual and collective adjustments to and negotiation of MIL’s ongoing social construction are not in any way inherently wrong and that MIL by no means is malfunctioning. MIL is a less probable critical case study, which in a specific
time and context has shown tendencies that may develop in unwanted directions under similar pedagogic designs and under more strained conditions, including e.g. less mature, experienced or competent students, pressure from the outside such as budget cuts, the EU Bologna-process harmonization, etc.

4. Questionnaires

In the first round, all 53 students received a questionnaire (Q1) on-line. In the second round, Table 1: Return frequency of questionnaires.

<table>
<thead>
<tr>
<th></th>
<th>Q1 Answers</th>
<th>Q2 Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students</td>
<td>43 out of 53</td>
<td>15 out of 33</td>
</tr>
<tr>
<td>Sum of answers</td>
<td></td>
<td>15 of 27</td>
</tr>
<tr>
<td>Response rate</td>
<td>81%</td>
<td>45.5 % of all</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55.6 % of potential</td>
</tr>
</tbody>
</table>

The two questionnaires covered 30 questions distributed between 6 themes, thus complementing each other. The first three themes in Q1 dealt with factual questions about the students’ previous knowledge of MIL and MIL’s LMS while Q2 asked about the students’ lived experience of being on-line students; the on-line collaboration; and MIL’s pedagogic design. The last three themes in Q1 focused on 1) the students’ impression of their own experience and level of competence in relation to on-line communication, collaboration and the subject matter; 2) the students’ expectations to MIL, their fellow students and the social context of the study (MIL, family, job); 3) “how would you act if”-questions about scenarios dealing with conflict and problem solving and decision-making. Q2 dealt with follow up questions. The questionnaires were made as tables in Microsoft Word, and therefore the input-slots for answers allowed the respondents to use freestyle text. The respondents could choose to elaborate their answers, which all of them did. The questionnaires were analysed using Grounded Theory in Atlas’s (software designed for Grounded Theory Analysis).

A series of questions in Q1 supplemented with information from the students’ personal presentation page in the LMS made it possible to divide the class into three subgroups, 21 novices, 18 experienced and 4 undetermined, according to their competencies as interacting agents in virtual learning environments based on on-line collaboration.

4.1 Interviews

Eight students among the 15 Q2 respondents agreed to participate in a qualitative, explorative interview (duration 1 hour) conducted as an open conversation framed by a question-guide. The interviews aimed at producing a more in depth narrative of the students’ own impressions and experiences during the first semester supplemented by questions about some of the themes from the questionnaires. As the interviewed students represented all the working-groups, but one, and they often referred to their group, some of the information from the interviews can be extended to all active students, thus compensating for the lower percentage of answers in Q2.

4.2 Findings

4.2.1 Time as an ultimate barrier

Students enrol in MIL with different views on what to expect. All students mention independency of time and space, which is also stressed on MIL’s homepage: “The net-based teaching allows you – from your own computer – to communicate independently of time and place with teachers, tutors, fellow students and administration. Teaching and collaboration are based on flexible, net-based communication ensuring that you will not feel isolated as an on-line student.” (Authors translation from http://www.hum.aau.dk/mil/ 2005, headline: New MIL student?).

Of course, space independency has a high priority for students living abroad, but in general, time-flexibility mattered more to students living in Denmark. Out of 43 students responding to Q1, 18 replied to several questions that they expected time-flexibility in on-line education to be a major advantage, which would ease their workload. For some students, time-flexibility was even crucial for completing an education at all. Although the rest
of the students (25) also saw time-flexibility as an advantage, they did not expect a decrease in workload compared to face-to-face courses. In their answers to other themes in the questionnaires, these 25 students displayed more knowledge about on-line education and experience in collaboration than the 18 time-dependent students. All the remaining 15 respondents in 2003 answered that the workload was much heavier than they originally had expected. They were also surprised to learn that on-line collaboration was not time-flexible at all. There were deadlines to assignments, fixed time-slots for specific activities, and they found that even within the group, time had to be carefully planned and coordinated.

Table 2: Dropout rate and leave-taking registered in the summer 2003.

<table>
<thead>
<tr>
<th></th>
<th>Dropout</th>
<th>On leave</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside case study</td>
<td>4 owing to private circumstances 7 because of time</td>
<td>5 because of time</td>
<td>16</td>
</tr>
<tr>
<td>Outside case study</td>
<td>3 because of time</td>
<td>1 (reason unknown)</td>
<td>4</td>
</tr>
<tr>
<td>Sum</td>
<td>14</td>
<td>6</td>
<td>20</td>
</tr>
</tbody>
</table>

Out of the 18 students relying heavily on time-flexibility, 10 dropped out owing to time pressure and another 5 took leave. These 15 students withdrew from MIL during the second semester. 3 students outside the case study also resigned because of time-pressure (according to the group), but as the students were outside the case study, it is not known whether they were dependent on time-flexibility from the beginning. Thus, only 3 time-dependent students out of 18 were able to adjust to the pedagogical design of collaborative on-line learning.

5. Alignment to time-pressure

Also the remaining students at MIL felt the time-pressure. In Q2, all respondents answered that MIL was more demanding than they expected and that the on-line collaborative form was time-consuming. However, they all agreed that the form also is challenging and enriching. This section gives examples of how time affected the remaining students and how they chose to deal with the time pressure both as individuals and in the emerging Community of Practice.

5.1 Adjustment of personal behaviour

The students pointed out that a coherent on-line dialogue implies formalisation and management: fixed meetings, an agenda and a chairperson. When these conditions were not met sufficiently, some students said they felt excluded from the learning process. Some had to control their inclination to comment on contributions because “The others seem to think it is annoying (read time-consuming, author’s comment), so I try to hold back” (Q2, author’s translation). They all agreed that on-line collaboration requires discipline, language adjustment and shared conventions. Otherwise it takes too long to unravel misunderstandings or conflicts. As it is difficult to prioritize one’s efforts, most students explained that they had adopted a strict and ordered approach to control their own time. These individual adjustments became part of the individual negotiation about the social conventions and the ongoing mutual constitution of the Community of Practice.

5.2 Adjustment of collaboration and the community of practice

The students found it easy to get used to the technical side of the LMS, and soon even inexperienced students were using alternative on-line communication tools. However, they found it demanding to adjust to the collaborative form. All students stressed that course M1 aiming at training on-line collaboration was successful. They also stressed that experienced fellow students had to support novices in moving from peripheral to full participation (Wenger 1998) in the virtual learning environment and the emerging Community of Practice. Some experienced students showed signs of fatigue towards the collaborative form and what they considered irrelevant contributions in the discussion fora. They called some fellow students chatty or brawlers. Even though mutual responsibility and support were evident among the remaining students at MIL in 2003, this may indicate signs of strain on the mutual solidarity.

In Q2 and the interviews, most of the respondents answered that they preferred a flexible and negotiating form of collaboration. Such a form fitted the preliminary stages in each learning process where the students had to explore and negotiate the basic understanding of the subject matter. However, the time-pressure demanded a rational and controlled approach leaving little space for wondering and reflection. One respondent wrote that: “... this stuff (read: assignment, authors comment) has to be done as effectively as possible. Therefore, we have to be strictly goal-oriented” (Q2, author’s translation). Others argued that the balance between
collaboration and the time spent on immersion into the subject matter should be adjusted in favour of the latter to improve learning rather than rote learning. In the interview, one respondent said that: “It’s all about reflection, but I haven’t had time to reflect on anything” (Interview, author’s translation). One consequence of dealing with the time-pressure by acting in a goal-oriented manner and getting things done was that too many contributions were weak structured and took time to read and comment on. In Q2 and the interviews, the students indicated that the drawbacks were: A time-consuming process, misunderstandings and conflicts.

The goal-oriented tendency can also be seen in the way students coped with the large amount of contributions in the discussion fora and the curriculum (See also Orngreen and Levinsen 2005). Both Q2 and the interviews included the question How do you cope with the contributions and the discussion fora. All the students replied that their strategies of choice were based on rejection rather than additional interests. The overriding criteria was time, which can be subdivide into sub-criteria such as:

Cost benefit choice: Available time and minimum requirements in relation to assignments and course evaluations. Mutual solidarity within the working groups.

Rejection of fellow students by choice: Chatty, brawling or boring students. Contributions from other groups (Self communication, see Orngreen and Levinsen 2004).

Rejection of content by choice: Contributions that are not strictly in the student’s own interest. Theory that is not already known unless it is required.

In Innovation - and Learning Organisation Theory, it is well documented that groups and individuals who experience a situation and context as chaotic or coming out of control strive to make order and often establish an inflexible and goal-oriented alternative (Darsø 2001). The students at MIL did not create what is called destructive order. However, if the strain on the participants in collaborative on-line learning becomes too hard, tendencies as observed at MIL might turn into a self-increasing process leading to more time-pressure, which in turn has a negative effect on the ongoing constitution of the Community of Practice. This situation may lead to lower tolerance towards novice or insecure fellow students, less time to immersion in and reflection on the subject matter, and an increasingly selective and surface approach (Entwistle 2000) to the curriculum. In other words, instead of supporting deep learning, collaborative on-line learning may lead to a surface approach to learning.

5.3 Periods of absence

One assumption about on-line collaboration in written conferences is that: “... if somebody is absent from the learning environment in periods, it is relatively easy to stay updated on the main activities. Of course it is expected that the participants actually do exploit this option.” (Dirckinck-Holmfeld 2002b. Author’s translation). Due to the evident signs of strain on the students, I asked in the interviews how they would cope with absence e.g. due to illness: “Then I’d be in deep trouble!” (Interview, Author’s translation): “...that is really hard...you can’t stay away for 4-5 days - so being independent of time is disingenuous (Interview, author’s translation). The students argued that it was impossible to stay updated though the LMS. The only way to cope with absence was to make arrangements with the working group, e.g. ensure that they produced overviews and summaries. This is an area in which MIL has displayed a strong development of mutual responsibility in the Communities of Practice as long as the remaining students have had the energy to support the absent fellow student.

If we consider the inexperienced students’ need for support and the view on absence, it becomes clear that under strained conditions, time-pressure and the tendency towards goal-oriented behaviour may lead to cost-benefit considerations marginalizing or excluding students from the programme (see also Lawless and Allen 2003).

5.4 Towards individualisation

Based on the tendency towards goal-oriented strategies and their possible negative influence on social processes and the learning approach, it was interesting to see whether the combination of the students’ initial competencies and their choice on how to organize the second semester’s project and examination paper showed any patterns.
Table 3: Competence and second semester projects. The information includes basic units from MIL and the table includes all students in the class.

<table>
<thead>
<tr>
<th></th>
<th>Summer 2003</th>
<th>Novice</th>
<th>Undetermined</th>
<th>Experienced</th>
<th>Sum in case</th>
<th>+ outside the case</th>
<th>Sum, all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solo projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Summer 2003</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Group projects</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>16</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Sum active</td>
<td>16</td>
<td>3</td>
<td>8</td>
<td>27</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Resigned</td>
<td></td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>On leave</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Sum not-active</td>
<td>5</td>
<td>1</td>
<td>10</td>
<td>16</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>In total::</td>
<td></td>
<td>21</td>
<td>4</td>
<td>18</td>
<td>43</td>
<td>10</td>
<td>53</td>
</tr>
</tbody>
</table>

Apart from a high frequency of solo projects (11), table 2 shows that it is not a distinct trait for novices to prefer solo projects, just as experienced students do not prefer to take leave. On the contrary, it is a distinct pattern that experienced students prefer group projects, while novices do not take leave, they resign.

Without explaining the tendency Salmon mentions that working alone is a characteristic of level 5 in her five-step model (Salmon 2002 and 2003). Perhaps, students just drop collaboration at a certain stage, or maybe the reason for the high frequency should be found outside MIL. However, it may also be interpreted as a sign of strain from time-pressure affecting the constitution of Communities of Practice over a longer period than one semester. Maybe some experienced students got hit by “virtual fatigue” (as one respondent called it), and maybe some novices never gained enough experience to counterbalance the disadvantages of on-line collaboration with the advantages of learning in a social context.

This means that teachers will benefit when coaching and facilitating collaborative learning if they are able to detect tendencies towards individualisation, virtual fatigue and marginalisation of students in the Community of Practice.

6. Conclusions

There seems to be a dilemma inherent in the design of MIL and collaborative on-line teaching in general. At the outset, MIL is flexible and in accordance with the constructivist understanding of learning and context as a basically floating and unpredictable process. At the same time, the curriculum is large and demanding, and the activities are time-consuming. As a consequence, students must work hard, and no unexpected interference must occur if they want to complete the programme and pass the evaluations. It is a paradox that the students’ individual goal-oriented compensations and negotiations in the Community of Practice increase the time-pressure. Another paradox is that the interfering events forcing the adjustment of norms (incoherence in discussion, weak structured contributions, etc.) are likely to occur in any floating environment such as the socially constructed practice of an on-line collaborative programme. These events can neither be controlled nor planned, and the best way to cope with unpredictable, but likely to occur events, is to gain an overview providing the participants – including the teacher – with the necessary information to proact accordingly.

The analysis of MIL demonstrates that constructivist pedagogic design models for collaborative on-line education do not - as an inherent quality - support knowledge sharing and deep learning. The constructivist approach frames and supports a learning process as opposed to an Instructional design. But whether an on-line course or education tips one way or the other still depends on how you deal with the context and the slowly emerging social processes. The pedagogic design tends to promote the opposite of its intention, i.e. a rational goal-oriented approach. Moreover, if the participants are under stress, the process becomes self-increasing and enforces choices of rejection and a surface learning approach rather than an explorative, reflective and deep learning approach.

The case study has identified slowly emerging tendencies that might be vital to detect in their early stages monitoring their development. They may point to areas that require the teacher’s awareness. In his book *Communities of Practice* (1998, p. 228) Wenger formulates this as follows:

“Learning cannot be designed: it can only be designed for – that is, facilitated or frustrated.”

Once, on-line learning environments have been equipped with adequate proactive teacher tools (Orngreen and Levinsen 2005), such awareness areas may enhance teachers’ awareness of potential critical manifestations during an ongoing
course and support the process of facilitating learning.

Acknowledgements

The author gratefully acknowledges the support from the HCI research group at the Department of Informatics at Copenhagen Business School and the goodwill of the students and teachers at MIL, who invited me into their world.

References


Implementing Courseware to Support Learning Through Real-World Erroneous Examples: Students’ Perceptions of Tertiary Courseware and Obstacles to Implementing Effective Delivery Through VLE

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Abstract: This paper presents a study in a UK university that investigated how first-year (freshman) Information Systems undergraduates perceive learning through courseware containing real-world erroneous examples derived from their peers and what obstacles had to be overcome to implement effective e-Learning support for using and creating such courseware. The study finds that students find the courseware very effective in dealing with their personal misconceptions while also providing other secondary pedagogic benefits for both students and lecturers.

Keywords: courseware, vicarious learning, and personalisation

1. Introduction

Erroneous examples have often been used in many subjects to prevent students making common mistakes in a particular domain; for example, calculus in mathematics and systems design in computer science. However, such examples are often only loosely related to the actual difficulties and causes of misconceptions that the students may actually have with the domain. Consequently, often to the surprise of the lecturer or tutor, students still make errors that are related to erroneous examples already given to them. A possible solution for this is, to use as examples, errors that actually came from the student population themselves or another student population that has similar characteristics to the target student population. Such examples, compared with those from other sources, would be more grounded in the experience of the students. e-Learning courseware (online learning material) that delivers teaching through real-world erroneous examples, if effectively implemented, may have a distinct advantage over traditional learning material in that it enables the students to vicariously experience through rich media how the errors were made and how they can be effectively corrected. However, some outstanding questions remain concerning effective implementation of such courseware; in particular, how would students react to learning from courseware that uses errors instead of the usual ‘perfect answers’ and whether their reactions can help to improve future courseware design?

2. Current use of erroneous examples in mathematics

The behaviourist view of learning that informs much of traditional schooling is not likely to invite students and teachers to see errors in a positive light. Behaviourism assumes that learning is enhanced when correct responses are rewarded (positive reinforcement) and incorrect ones are either punished or extinguished through lack of attention (withholding of positive reinforcement) (Miller 1983).

As opposed to learning and teaching of language and programming, most of today’s mathematics teaching still follows the traditional approach and tries to exclude error-making at all costs even at the cost of reducing learning opportunities.

Within the traditional framework, paying explicit attention to (mathematical) errors in class is even considered by many as dangerous since it could interfere with fixing the correct result in the student's mind. However, our approaches use errors as learning opportunities and they may help to overcome the traditional transmission view of mathematics (and computer science) teaching and learning.

Indeed, the effectiveness of different ways to use errors as a springboard for learning is a question that has to be investigated empirically. Additionally, whether the effect can be different for different types of learners is an open issue and may depend on the specific individual learner characteristics.
Previous research have indicated that including erroneous learning objects into a learning experience can serve several purposes:

1. Improvement of learner's motivation (Strecker 1999) and influence on students' attitudes towards failure and success.
2. Proper understanding of concepts, which includes conceptual change in case of a misconception and understanding concept's boundaries. For concept learning, previous research indicates that people tend to use positive instances and ignore negative instances, even though this is often an inefficient strategy. One measure to push students to look at negative instances is to require an explicit work on erroneous examples.
3. Improve reasoning capabilities, e.g., the correct application of rules and the application of correct rules as well as hierarchical/structured problem solving.
4. Train meta-reasoning, including critical thinking, self-monitoring, and enforce self-explanation to judge solution steps as correct or faulty. Meta-cognitive skills are required to overcome the barriers imposed by the student’s prior knowledge and conceptions, and finding and correcting errors in an example can stimulate and prompt meta-cognitive activities. Critical thinking is sometimes neglected for mathematics and its applications. However, in real life people have to be able to judge whether a mathematical result is acceptable or to discover the conditions under which it is correct. In other words, they have to be able to find out the reason for an error. Learning should also therefore, target this capability.
5. Encourage exploration. Borasi (1994) reports striking experiences on how even below-average students start questioning and exploring mathematics, when confronted with an error and encouraged to dwell on it.
6. Change attitudes. In the traditional classroom culture, there is not much room for being wrong, not even temporarily. Schoenfeld (1989) reports that most students believe that if you can't solve a problem in a few minutes, you can't solve it at all. A mistake is interpreted as an ultimate failure and there is little room for experimentation (and debugging). When guessing, experimenting and playing with partially correct conjectures are discouraged, the only remaining alternative for many students is getting 'stuck'. Schoenfeld (ibid.) concludes that this attitude is an important factor in students' inability to cope with non-routine problems.

3. Real-world erroneous examples and vicarious learning

As mentioned earlier, the advantage that real-world erroneous examples may have over a collection of "commonly made mistakes" is that it can provide the context for the errors as well as what process was actually involved in correcting the misconceptions. This is crucially important as only showing the errors and a corrected version may not address the misconceptions that the students may have – only the symptoms of the misconceptions are dealt with. By walking the students through the context of the error and the correction process, the students can in effect learn ‘vicariously’ from the experience of other students.

Vicarious learning is learning that takes place while observing learning dialogues between a student and a lecturer/tutor (Stenning et al., 1999). The most common instances of this type of learning occurring are during lectures and group tutorials. When a student and lecturer have a discussion in front of the class, the rest of the class learns something from that discussion by observing the dialogue that goes on. The concept of vicarious learning is not new. Chronicles of dialogues (as opposed to continuous prose) have been used for conveying ideas or concepts in a wide range of disciplines for centuries – for example, religion (Poole, 1685), law (Hobbes, 1971) and neurolinguistic programming (Bandler, 1985). On a larger scale, television broadcasts have allowed the public to observe debates and discussions on topics ranging from current affairs to personal issues.

3.1 Vicarious learning as courseware

So where is vicarious learning relative to other courseware (online learning material) that currently exist? As a broad classification, online learning materials can be categorised into three categories of courseware (Mayes, 1995); primary, secondary and tertiary.

The most common of these is primary courseware, which is used for introducing concepts to students. This can be in the form of electronic books, online lectures or electronic sources of encyclopaedic form. Secondary courseware allows the student to explore concepts learnt from primary courseware in further depth and complexity through performing related tasks. Examples of secondary courseware include simulation programs and modelling tools. Tertiary courseware uses as a learning resource the dialogues that take place within the context of the use of secondary courseware or offline learning material. These
 dialogues can be in the form of a one-to-one dialogue between a student and a tutor or a classroom discussion on a certain topic. Consequently, the main aim of tertiary courseware is not to present new ideas, but to clarify and facilitate exploration of concepts and assist students when they have misconceptions on a topic. Examples of such tertiary courseware include dialogues captured in the form of Frequently Answered Questions (FAQs) and online discussions in computer-mediated communication (CMC) environments. With respect to this classification, materials that can effectively support vicarious learning can be classified as tertiary courseware.

It is apparent from the classification given above that, while tertiary courseware does not have to be based solely on dialogues surrounding erroneous examples, such dialogues will be rich in content that other students observing the dialogue would find useful for correcting similar misconceptions that they may have. Therefore, in order to implement effective tertiary courseware, it is crucial to be able to capture the learning dialogues that take place during discussions of erroneous examples.

4. Existing systems for capturing learning dialogues

There are many VLEs (Virtual Learning Environment) that allow recorded classroom and tutorial activities to be accessed online. However, few are suited to supporting effective vicarious learning through erroneous examples.

The Dissemination tutoring system (http://www.hcrc.ed.ac.uk/Vicar/TT/), as used at Heriot-Watt University and University of Edinburgh, is a simple video-based vicarious learning system consisting of video recordings of the interactions in one window, which is accompanied by notes on the topic under discussion and perhaps the page of the lecture note on the topic in another window. This system makes use of one static camera angle in each video clip and provides minimal support for navigating within the video clip and the props (lecture note) that are provided. The system is used for teaching Human Computer Interaction courses.

On the other end of the spectrum, the eClass Project (formerly Classroom2000) at Georgia Institute of Technology (http://www.cc.gatech.edu/fce/eclass/index.html) shows what state-of-the-art lecture recording and dissemination technology consists of. The eClass system is the result of a study initiated in 1995 into automated capture of teaching and learning experience via an ubiquitous computing environment (Abowd, 1999). By combining video/audio recording with time-stamped slides and annotation, the system has managed to develop and utilise technologies to effectively put lectures online. To date, 24 ‘instructors’ have used eClass in more than 100 classes. However, this emphasis of putting lectures (i.e. what the lecturer is doing) online means that eClass does not focus on student actions (or interaction) and feedback, which is essential for facilitating vicarious learning. The materials that have been captured consist of recordings of lecturers giving a lecture and interacting with an electronic whiteboard with very little or no dialogue with the students in the lecture. Additionally, eClass requires expensive equipment such as electronic whiteboards and backup equipment all of which contribute to a significant price tag, making it not cost-effective to implement in an individual lecturer’s office or small tutorial rooms, where dialogues between tutor and students (or between only students) around errors made by students would often take place.

Of the two systems presented, neither seems to have the right balance between having the adequate technology to support production of effective vicarious learning material and using the technology already implemented in an appropriate way to support vicarious learning. For example, many video clips in the Dissemination tutoring system showed a tutor and a student interacting around some props (either a whiteboard or a piece of paper on the table). Despite both participants frequently referring to these props, the system did not effectively capture what was being pointed to or written on these props. On the other hand, eClass use a sufficient number of camera angles to capture lectures for online presentations. However, the overall setup of both systems does not support effective capture of dialogues between the teacher and the students during lectures or tutorials.

5. Study setup

From previous research into the use of erroneous examples and lecture capturing systems, it is clear that the following questions need to be answered in order to create effective vicarious learning material based on real-world erroneous examples:

1. How, when and where to capture learning dialogues based on real-world erroneous examples?
2. How to create effective courseware from those dialogues?
3. How will the students use the courseware?
4. Will the students, who usually prefer learning with ‘perfect answers’, accept courseware that contains real-world erroneous example?

A three-phase study was setup to investigate the above issues concerning the use of real-world erroneous examples in VLEs for teaching systems diagram construction (in Computer Science):

- Phase 1: Capturing of real-world erroneous examples and using them in learning material
- Phase 2: Use of learning material real-world erroneous examples
- Phase 3: Students’ attitude to learning using erroneous examples

The studies were conducted with student volunteers on first-year undergraduates (freshman) Information Systems course at University College London (UCL). The implications for VLE design deriving from results of the first two phases of the study have already been reported in two previous publications (Monthienvichienchai & Sasse 2002; 2003). In this paper, the results of the final phase (phase 3) of the study are reported. The main intention is to complement the quantitative data that was collected during the first two phases with the rich qualitative data of this phase. This should allow VLE and content designers to create effective learning material containing erroneous examples.

5.1 Capturing real-world erroneous examples

This phase uses contents created during the first two phases of the study as the test material to probe the attitude of students towards using real-world erroneous examples. One particularly suitable tutorial session that was captured was chosen for the study, as it contained many key issues in systems design in one session. The result is a QuickTime™ video clip containing the conceptual knowledge level of interaction of a tutorial, during which the following topics were covered:

- Data Flow Diagram (DFDs) decomposition
- Physical vs. Logical DFDs
- Linking different levels of DFDs
- Dealing with error conditions in DFDs
- Deriving a pseudocode for a process
- Dealing with missing functionality in the design
- Differentiating system state and system process

These topics are explicitly shown in the video clip by the implementation of QuickTime™ chapters. Additionally, the video clip also implements the following form of navigation features: play, pause, rewind, forward, move to beginning of clip and move to end of clip through ‘button’ interface; and rewind and forward through a direct-manipulation interface. The video clip is also synchronised with changes that were made to the student’s work during the tutorial. This allows the courseware to show what changes are made to the work as soon as it happens in the video clip. The screenshots (Figure 1) below show a close up of the video interface and how the video windows was placed and synchronised with a view of the student’s work. The courseware is accessible through a web browser and only requires QuickTime™ to be installed.

Figure 1: Screenshots showing the video window and how it is synchronised with the view of the student’s work

5.2 Subjects

12 students volunteered to take part in the study and were given access to the material developed above. They were given the task of doing a questionnaire-based assignment (see Figure 2 for an excerpt) that corresponds to the concepts that were covered in the material. Each student had unlimited amount of time to complete the assignment under observation. Once the assignment has been completed, each student
was interviewed about their experience of using erroneous examples during the session. They were also informed that the interviewer was not involved with the process of creating the material and their comments will be anonymised.

Figure 2: Scanned image of the student's work while interacting with the courseware (1 question out of 7)

6. Students’ perceptions of erroneous examples and vicarious learning

Every student who was asked what they thought about being able to see another student's tutorial commented that the ability to see another student’s tutorial is very useful. The following sub-sections discuss different categories of students’ comments in detail (for accuracy, the transcripts of the students’ comments are presented “word for word”, i.e. with no grammatical correction).

6.1 Learning from erroneous examples

A common perception among students was that the material allowed them to learn from other student’s mistakes and this was perceived to be useful for the students.

“I think the ideal [version] will be good as well, but with this, I think you learn from the mistakes, what not to do. The good thing about this is it tells you what not to do and then tells us how to do it. Whereas if you just tell us how to do it, then we’ll just copy that and not learning issues in other things.” Student 10

“Because you can look at what mistakes they've made and maybe it’s something that I didn’t really think about. So, it’s another chance for me to learn about other people’s mistakes so that I don’t really make the same mistakes again.” Student 9

“Say if you have this common problem with that <student> you may not actually realise it or something but then realise just then that oh I’ve actually done the same thing as her or him.” Student 11

6.2 Perceived relevance of erroneous examples

Some students commented, more specifically, that the particular material they interacted with would have been very useful for them had they had access to it before they had submitted their most recent System Design coursework (for ethical reason, students who volunteered for this study was given access to the material only after submitting their related coursework). This is despite the fact that the material only raised a limited number of relevant issues for the coursework.

“... it’s not so much about seeing another person’s tutorial, it's being able to see the mistakes that other people make from their work ... and how it gets corrected and what the corrections are... Cause, having handed in my coursework, I know I’ve made some of those mistakes ...” Student 7

“Yeah, I think I would have [used it if it was made available during the coursework week] because it would have helped us with like our DFDs and stuff... Because you know we have to do the coursework. Yeah, it might have come in handy for that to see where they make their mistakes so that we don’t make the same ones.” Student 8

“Because like when I was just looking at that now, because I’m doing a coursework with DFDs I think that is like that’s helped me see what could might be wrong with mine, you know, because I have never done DFDs before so it’s like. I know it now that you have to think of everything from, not like I didn’t know this before the tutorial, but it’s sort of given me an example to see how like you can’t have sort of “input details” you have to have ... you don’t even
need that because it’s not a system process, so you know, things like that. So I think even though I’m not doing exactly the same thing as that, it’s still helpful to see the sort of comments that you can make on her project. You know you can sort of apply them to your own, which is quite helpful I think.” Student 5

6.3 Benefits of real-world erroneous examples

Some students also commented on the social value of the material. More specifically, they commented on how the material helped to boost their confidence by allowing them to see what goes on in another student’s tutorial.

“It gives you ideas of what like how you want to prepare yourself when going into a tutorial session because in the beginning she was flipping around and didn’t know where to start. So it makes you realize you should be prepared for it and know what you’re talking about … because you’re going into these assignments not knowing, or expecting, like how much effort and how your work is going to turn out. So, it’ll boost your confidence and kind of help you out while going through the process I would say.” Student 6

“I think it’s helpful in a way because then you can just sort of see the sort of things that will be said in a tutorial. But in a sense it might not be very nice for the student if they don’t want their tutorial shown to everyone else.” Student 5

This observation is consistent with those made previously by Lee et al. (1999) that one of the benefits of vicarious learning is social which results from “exposure to peer discussion [that] creates positive feelings of being part of a learning community”. Also, these comments indicate how interaction with vicarious learning material developed for this study can be considered as Legitimate Peripheral Participation (Wenger 1998) in the community of practice of students. In this case, the material can affect the self-identity and the practice of the student interacting with it.

6.4 Willingness to share own errors with other students

The student above (Student 5) raised an issue that is not uncommon among students in this study. While every student thought that the material was useful, not all of them were enthusiastic about having their own tutorial sessions recorded. Ironically, the feature of the material that the students find most useful – the ability to see and learn from another student’s mistakes – was the main area of concern when considering whether they would allow their tutorial session to be shown to other students.

“It would probably be quite embarrassing because I’ll say dumb things and people would laugh or whatever. But I mean, for example, say if it was … I don’t know. It’ll probably be a bit embarrassing but I mean if it was like come in and look at that where you just don’t know who it is then I think it’ll probably be fine. Well, you don’t actually have to see the girl’s face in this and it would still be the same thing… It probably would but I mean to you it would but to them they would just see, o they make like … Say if you make a really silly mistake like if you completely miss you miss a process out, an obvious process out, I mean sure you correct it at the end, but it’s just silly for missing the obvious process out in the first place. Which would be…I don’t know.” Student 11

Another concern when considering whether to share their own errors or not is the fear of plagiarism. Students were concerned that people viewing the material would have an unfair advantage over the person being filmed. However, this was only the case if the student being filmed had the same assignment as those viewing the material.

“I mean if they’re doing, if the coursework topic’s different to the topic that I’m doing, I wouldn’t mind [being recorded] at all because I mean if they can learn something out of the tutorial that we have that will be quite good, because I would like to like see their tutorials as well. But if they’re doing the same topic and if they had the chance to look at my tutorial, I don’t think I would … no… But I mean if it’s a different topic, a different coursework title I wouldn’t mind at all.” Student 9

One student (Student 8) did not want to be recorded at all, citing a combination of not wanting other people to see her mistakes and the general dislike of being recorded on film. However, the same student said that she would consent if the material can be anonymised so that people would not be able to recognise her.

7. Further analysis

7.1 Causes vs. symptoms of misconceptions

While studying the capture and production of vicarious learning materials (phase 1 of this study), whether as an experiment or a case study, there was one process that consistently took
place when materials were created, which may not have taken place if the tutorial sessions were not being captured to create vicarious learning materials. This process was the tutor’s discovery of the cause of the misconceptions in the students’ misunderstandings. It is important to highlight the fact that this process actually took place, as it was a fundamental process in creating effective real-world erroneous example based material during this research. When conducting tutorials for students on this course (Information Systems), in order for students to effectively learn vicariously to avoid the mistake made by the student in the material, they needed not only to be able to see the other student’s actions (corrections and amendments), but also to understand why those misconceptions happened in the first place. Probing deeper into and identifying the source of the student’s misunderstanding, when conducting tutorials for creating vicarious learning material achieved this. Many students on this course (more than a quarter), through their misconceptions, arrived at conclusions (in this case, DFDs) that they knew to be wrong, or at least not totally correct. However, since they did not know how else they could externalise their design, they did not revise their flawed conclusions. However, when students were shown how such misconceptions came about in the first place, they were able to identify misconceptions in their own designs, enabling them to amend their conclusions accordingly.

For this reason, while creating courseware for this case study, it was necessary for the tutor to probe deeper than usual into why the student made the mistakes that he/she did. If the misconceptions are not explained from the student’s point of view, the resulting courseware is just an extension of primary courseware, i.e. the material will contain “how not to do it” and will then be followed by “how to do it”.

7.2 Erroneous examples and phenomenography

The concept of exploring a student’s misconception may not only serve the purpose of creating tertiary courseware. The processes of exploring and categorising how students experience learning are fundamental to the phenomenographic research methodology (Marton, 1981), whose focus is on the variations in ways students experience a certain phenomenon in a certain context. It is possible for the tutor, after conducting individual tutorials with a number of students from the course, to recognise a pattern in the different ways in which students have understood or misunderstood key concepts. Additionally, as a phenomenographic study categorises events in terms of the students’ variations on how they experience a phenomenon (Marton and Booth, 1997), it may be feasible to suggest that such categories can also be used to categorise real-world erroneous examples based courseware (as opposed to categorising them using the curriculum structure which may or may not reflect how the students have experienced the course). As a result of exploring the misconceptions of various students on the same topic during the course of this study, it was possible to discover many reasons for students’ misconceptions and erroneous actions in their coursework – often the reason behind the misconceptions, while logical, was completely unpredictable.

8. Conclusions

This study has demonstrated the significant potential of courseware that are derived directly from real-world learning experience of students who were dealing with and benefiting from real-world erroneous examples. It highlights the gap that currently exists in the supporting the individual learning needs of students by the current crop of personalised eLearning solutions (e.g. adaptive hypermedia). Such solutions place emphasis on tailoring a vast array of external content to suits certain needs to individual students. However, there is great potential in meeting the individual needs of the students by deriving fewer but better targeted ‘home-made’ courseware from students’ particular cohort, such that he/she can learn from the experience of his/her peers (note that a cohort can also mean a community of students, so the potential for reuse outside a single institution or geographic location is still preserved). VLEs that provide support for collaborative learning go some way in support this need. However, there are many learning dialogues that students would benefit from having access to that are not captured by such VLEs. Professional content developers can also increase the effectiveness of their material by building their content not just on expert domain ontology of the subject, but also on phenomenographic data of how students approach learning that subject. Only by supporting the use and creation of the full spectrum of courseware could a VLE be able to truly support all the learning needs of the student.

Acknowledgements

This publication is partly a result of work in the context of the iClass project, funded under the 6th Framework Programme of the European Community (IST 507922). The authors are solely responsible for its content. The European Community is not responsible for any use that might be made of information appearing therein.
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Topic Maps e-Learning Portal Development

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Abstract: Topic Maps, ISO/IEC 13250 standard, are designed to facilitate the organization and navigation of large collections of information objects by creating meta-level perspectives of their underlying concepts and relationships. The underlying structure of concepts and relations is expressed by domain ontologies. The Topics Maps technology can become the core of an e-learning portal that will integrate different kinds of information and knowledge resources, available in the educational institution – this idea was explored in the Ph.D. dissertation of the author. The offered portal solution promises to bring advantages both for content consumers (students) and content providers (teachers, administrative staff), but numerous problems hinder the practical implementation of this portal and therefore it requires certain changes in the functioning of the educational institution and asks teachers, teaching assistants and e-courses designers to change their routines and to develop new skills. In the paper we offer a new methodology for development and maintenance of the Topic Maps e-learning portal and we briefly present a pilot application.

Keywords: e-Learning portal, Ontology engineering, Knowledge methodology, Topic Maps, Omnigator

1. Introduction

In the last three decades numerous approaches have appeared which have tried to adopt information and communication technologies for the purpose of learning and education. The term “e-learning” was accepted for expressing the effort to transform educational processes through application of different up-to-date electronic media and to customize learning to student’s needs in terms of study style, time and space. The dramatic growth of local and wide area computer networks accelerated the evolution of the phenomenon of online education (also Internet-based education, web-based education, education via computer-mediated communication, virtual education).

Online education is realized in virtual study environments (also online education systems), e.g. WebCT, Blackboard or LearningSpace. Virtual study environments can be used within the context of the traditional education system, in part-time education, or to facilitate distance-education and therefore they are interesting for different kinds of educational institutions. Through virtual study environments, e-courses are managed and provided to students. The general shift of emphasis towards the Semantic web idea has to be reflected by the developers of particular web-based applications. In the educational context, it means thinking about the next generation of virtual study environments that would overcome insufficiencies of current systems such as information overflow, lack of customization, necessity of manual management and updating of stored instructional e-content, high set-up costs etc.

The term e-learning implies a shift in emphasis in education: we talk about “computer assisted learning”, not about “computer assisted teaching”.

This implies an effort to stimulate the student’s own activity, and de-emphasises the role of the teacher. The objectivist approach where the educational process was conducted by teachers, and students demonstrated their knowledge level in tests, where they reproduced facts and information, is replaced by a constructivist theory, based on the opinion that students have to develop their own approaches to understand and organize knowledge. Accentuation of knowledge structures, their internalization by students and the environments that must enable this internalization – it all makes us think about adaptation of knowledge management (KM) principles into the educational area and to understand e-learning solutions as pure KM solutions.

The paper is focused on the need for an innovative virtual study environment, developed in accordance with the Semantic web idea and reflecting the theories of student’s internal processes of knowledge organization. We describe a novel solution, an ontology-driven Topic Maps portal that mainly addresses tasks of content management of e-courses and which integrates different information and knowledge resources of the educational institution.

2. Topic maps technology

Topic maps (TM), the ISO/IEC 13250 standard, are designed to facilitate the organization and navigation of large collections of information objects by creating meta-level perspectives of their underlying concepts and relationships. The underlying structure of concepts and relations are
expressed by domain ontologies, or by other modeling formalisms, e.g. subject categorizations, classifications or schemas, relational or object-oriented schemas, indices and thesauruses.

Topic maps promise to solve the following tasks:
- The problem of metadata – the TM application operates with metadata records on available information resources. These records are not a part of resources, but are stored and managed independently.
- The network structure of links – interconnection of topics (and so, also resources) minimizes the risk of being lost in the information space, although the search possibilities are maximized.
- The structure of knowledge in the domain – the TM standard was developed for explicit modeling of knowledge and simple navigation in knowledge resources, therefore it visualizes the terminology of the domain and allows each user to view the terminology in scopes which reflect the needs and abilities of the user.

The Topic Maps model defines three basic building blocks: topic, association and occurrence which together form "TAO of Topic Maps", as Pepper, 2000 humorously says. Other concepts which extend the expressive power of TM are the core of TM applications and whose applicability in the following way. Each e-course is focused on certain discipline which has its own terminology. This terminology is conceptualized by the discipline (domain) ontology. The TM application of study resources can be built above this ontology. Such TM application visualizes the discipline terminology, which helps students to understand the structures of studied disciplines. Together with the discipline ontologies, used for subject categorization of resources, it is possible to apply a kind of course ontology for arranging units and elements that together form the course content. Therefore through the TM-based portal, teachers can define the recommended order of resources (presentations, documents, exercises etc.) to be studied as well as in the e-course's study content module in current virtual study environments. Also, all other parts of the e-course (students' agenda, evaluation tools, communication tools) can be integrated into the

3. e-Learning portal

Our basic idea is to use a TM application (more precisely, a web portal based on the TM standard) as a gate to all information, and if possible, to all knowledge resources of the educational institution. This idea has two main advantages.
- Integration of currently separated resources of information and knowledge at the university, such as scheduling applications, students' agenda information systems, digital and classic libraries, shared directories etc.
- More user friendly, more intuitive navigation of the info-space, enabled by ontologies which are the core of TM applications and whose application is innovative in contrast with websites organized using predefined categories and sections.

In virtual study environments, TM technology is applicable in the following way. Each e-course is focused on certain discipline which has its own terminology. This terminology is conceptualized by the discipline (domain) ontology. The TM application of study resources can be built above this ontology. Such TM application visualizes the discipline terminology, which helps students to understand the structures of studied disciplines. Together with the discipline ontologies, used for subject categorization of resources, it is possible to apply a kind of course ontology for arranging units and elements that together form the course content. Therefore through the TM-based portal, teachers can define the recommended order of resources (presentations, documents, exercises etc.) to be studied as well as in the e-course's study content module in current virtual study environments. Also, all other parts of the e-course (students' agenda, evaluation tools, communication tools) can be integrated into the
TM portal using the occurrence elements. All these integrations are motivated by the effort to unify access mechanisms to information. E.g. while using WebCT 4.1 Campus Edition, students have to uncomfortably click through individual e-courses and check e-mail boxes or assignments evaluation records in each of the e-courses separately. The TM solution enables unified access to all information of the same type, e.g. to all e-mails, all assignment scores etc.

4. Development of the portal

No methodology of TM applications creation is presented in the basic ISO/IEC Topic Maps standard, so the consecution totally depends on authors of particular TM applications and on software used for the implementation of the TM application. General TM developers’ guides suggest starting either top-down (i.e. by defining the application area (Rath, 2003), or bottom-up, i.e. by summarizing the available information and knowledge resources to be covered by the TM application (Vatant, 2001). The first approach helps to reduce the space of documents and resources to be considered with respect to the application domain, while the opposite approach promises not to omit any currently available resources and to enable the TM application to access these resources and repositories.

In both approaches, the next TM application development contains the following steps:

- definition of functional requirements and the purpose of the future TM,
- definition of schema of the TM portal - the ontology,
- selection of the tool for implementation of the TM solution,
- population of instances, including evaluation of fulfilling all restrictions and constraints,
- optional revision of the schema of the TM.

The fundamental task is the selection of reference vocabularies and ontologies of types, categories, relationships etc. which help to coordinate the effort of the team of TM portal developers, especially to avoid misunderstandings and misinterpretations of the skeleton of the TM portal and to ensure further extension and sharability of the portal.

4.1 Reusable ontologies

For our purpose, that is using ontologies in the description of educational resources and processes in the context of virtual study environments, three types of reusable ontologies are of interest:

Linguistic ontologies (also lexical databases) which conceptualize natural languages and help to understand terms, which seem to be common, but in practice can become sources of misunderstanding. The most prominent ontology of this type is Word Net (WordNet, 2005), a large lexical database in English based on psycholinguistic theories. WordNet attempts to organize lexical information in terms of word meanings rather than word forms, though inflectional morphology is also a criterion. WordNet 2.0 contains words organized in sets of synonyms (synsets), each representing one underlying lexical concept, with a brief explanation of the intuitive sense in English. Synsets are interlinked via relations such as synonymy, antonymy, meronymy (part-of relation), holonymy (has-a relation) hyponymy (subclass-of relation), hypernymy (super class-of relation). The lexicon is divided into five categories: nouns, verbs, adverbs, adjectives and function words. WordNet database is under continuous development.

Domain ontologies which model concepts and relations in particular areas, so we can use them to describe disciplines which are studied in courses. It means that domain concepts are applicable as subject descriptors of resources; the relations between concepts make relations between resources visible. If we consider using ontology as an integrative element that would allow us to interconnect educational resources related to the course or the whole study programme, optionally prepared by various authors from different institutions, it is clear that such an ontology must not only to cover the relevant domain (area, discipline), but must be of a good quality and must be accepted by all authors of resources, especially authors of applications that make these resources available to users (i.e. to students, teachers, other staff of the faculty). Unfortunately, at the moment there are not suitable ontologies available for all domains, but only for those areas, where the critical necessity to manage large repositories of documents has already prompted the development of ontologies. Such areas are e.g. medicine, chemistry or law. In disciplines, where ontological engineering is not so advanced, it is possible to think about adopting some of developed taxonomies or categorizations and reusing them for the development of a new ontology. E.g. in the area of computer science education, we propose to use the ACM Computer Classification System, which is recommended to be used for description of content of all ACM publications (ACM CCS, 2005). Reusable domain ontologies are available in web libraries of ontologies.
Knowledge management ontologies which are included among the knowledge-based techniques for building organizational memory systems. For our broader objective, i.e. description of information and knowledge resources at the university, such an approach is of interest. (Abecker et al., 1998) distinguishes three types of knowledge management ontologies that may partly overlap in certain concepts and relations:

- Domain ontologies which model the content of the information sources (as previously discussed),
- Information ontologies which describe the different kinds of information resources, their structure, access rights, format properties,
- Enterprise ontologies which model the context of an organization, business processes, organization of the enterprise etc.

4.2 Creation of the ontology

The process of ontology construction is critical, mainly in complex domains. There are two main approaches that aid a large-scale ontology construction from scratch:

- The first one facilitates the manual process of ontological engineering by providing editors, consistency checkers, natural language processing tools, etc. Protégé-2000 is an example of this category (Protégé, 2005).
- The second approach relies on machine learning and automated language processing techniques to extract concepts and ontological relations from given databases and texts. This approach, usually called ontology learning, is explained in great detail in (Maedche, 2002). One example of such system is OntoLearn, presented in (Navigli et al., 2003).

Our proposed ontologies for the description of educational reality are expected to be created manually. The development methodology would partly depend on the chosen ontology editor. If we use Protégé-2000, the following steps (formulated in Protégé-2000 terminology) are recommended (Noy and McGuiness, 2001; Noy et al., 2001; Gómez-Pérez et al., 2004):

- Determine the domain and scope of the ontology, i.e. answer basic questions “What is the domain that the ontology will cover?”, “For what types of questions should the information in the ontology provide answers?”,”Who will use and maintain the ontology?” A good way to define the scope is to start with so-called competency questions; this means a set of queries that will be used above the knowledge base, based on the ontology. The list of competency questions can help to check if the ontology contains enough information.
- Consider reusing existing ontologies. The process of ontology creation can be accelerated by refining and extending existing ontologies from public libraries, web repositories etc.
- Enumerate important terms in the ontology, without worrying about any overlap between concepts they represent, distinguishing properties and relations.
- Define the classes and the class hierarchy either using the top-down or bottom-up approach, or a combination of both approaches. One question is whether to start with the most general class and then generate more specialized concepts or vice versa. Class hierarchy automatically assumes inheritance, which means that if a class A is a super class of class B, then every instance of B is also instance of A.
- Define the properties of classes – slots. Properties of classes can be intrinsic, extrinsic, parts (if concept is structured), relationships with other individuals. All subclasses of a class inherit slots of the class. A slot should be attached to the most general class that can have that property.
- Define the facets of the slots. A slot can have different facets describing the value type, allowed values, cardinality and other features.
- Create instances. Deciding whether a particular concept is a class or an individual instance depends on what the potential applications of the ontology are and takes into consideration the lowest level of granularity in the representation. If concepts form a natural hierarchy, then we should represent them as classes.

4.3 Ontology of educational environment

For the description of a university environment and its information and knowledge resources, three kinds of ontologies are needed:

- a general ontology describing the reality of the educational institution,
- a course ontology that defines the structure of the course,
- Domain ontologies that conceptualize individual disciplines.

The general ontology of the educational institution contains concepts and relations referring to information and knowledge resources and processes at the university, but without direct relation to particular courses. It contains:
• concepts such as address, article, bachelor program, bachelor thesis, conference, consultation, course, credit, database, department, email, entrance test, enrolment, examination, faculty etc.,
• And relations such as (course)-is-previous-to-(course), (course)-is-recommended-to-(study programme/semester), (person)-is-supervisor-of-(course), etc.
• Course ontology defines concepts that describe parts of individual courses, kinds of involved learning objects, instructional strategies, learning styles, student profiles, educational goals, etc. There are:
  • concepts such as active material, answer, assignment, difficulty, discussion, evaluation, exam, exercise, feedback, glossary, grade, homework, image, interactivity, item, learning style etc.,
  • And relations such as (lecture/exercise etc.)–Is-previous-to–(lecture/exercise etc.), (prerequisite)–is requested–in (course), (presentation/assignment/question)–assigned-to–(lecture/exercise) etc.

Domain ontologies describe terms and their relations which are valid in a certain discipline, taught in courses. For each field, a different ontology is demanded. If possible, existing domain ontology can be adopted. The usefulness of these ontologies lies in the fact that they can help to structure courses’ contents logically according to structures of disciplines. For students, it is highly important to gain an insight into the terminology of the studied area. If concepts of ontologies are used for defining keywords or subject descriptors of educational resources, while searching repository of resources, students internalize the discipline terminology in a natural way.

These three kinds of ontologies (general, course and domain) can be merged together. Therefore, we get a large collection of concepts and relations, describing the university with all its information and knowledge resources and its study programmes on a very detailed level. Above such a large ontology (or above its semantic slices), it is possible to implement an application which serves as a universal gate to all resources. Practical realization of this application may reuse TM technology.

The presented extracts of general, course and domain ontologies are illustrative only. Real applications would be based on ontologies, which should result from a detailed analysis and broad understanding of all involved concepts and their relations among users of particular ontology application. We expect that these ontologies for the description of an educational reality, courses and particular disciplines would be reusable for the purpose of different educational institutions, so the efforts of educational experts and university management to develop the ontologies would be very fruitful. Knowledge engineers and ontology engineers, skilful in the construction of knowledge bases, will have to participate on the development of the proposed TM e-learning portal.

5. Pilot application

For better explanation of our proposed TM solution, we developed a pilot application using Omnigator, a free version of TM software provided by (Ontopia, 2005). Our application integrates information and knowledge resources related to several courses on Artificial intelligence (AI), sub areas which are taught in the Faculty of Informatics and Management at the University of Hradec Kralove. These resources are traditionally separated in different information systems and repositories, e.g. website of the faculty, student's agenda information system of the faculty, digital library of the faculty, university library, private and shared folders on university computer network etc. The underlying ontology of our application reuses parts of ACM CCS and the WordNet lexical database. The following snapshots illustrate what the application looks like and how it can be used. (Our version of TM software was limited in graphic functions; therefore the design of the application is not as attractive and user-friendly as the full solution would be.)

The first snapshot (Fig. 1) shows how the TM application presents information related to particular AI course (here it is Logic programming 1.). The page contains:
  • Name of the course,
  • Relevant study programs (with hyperlinks to their topic pages),
  • Name of the supervisor of the course and of teaching assistants (with hyperlinks to their topics pages),
  • String information about prerequisites and recommended semester,
  • List of resources (different kinds of online resources – e-courses, scheduling application and student agenda system – again with hyperlinks),
  • Hyperlinks to 4 of 94 scoped occurrences, i.e. particular resources that are associated with the scope of the topic “LP1”: 
The second snapshot (Fig. 2) presents a particular lecture in the Logic programming course. Different information and resources are available on this page, e.g.:
- Brief syllabus of the lecture,
- Note about a PowerPoint presentation file stored in shared folders,
- Hyperlinks to html-pages stored in the WebCT virtual study environment, where traditional e-courses are still provided,
- Hyperlinks to topic pages of previous and following lectures and exercises where the content of the current lecture is reused.

The last snapshot (Fig. 3) shows the page of the topic "Agent", i.e. particular important concept in AI.
- Associations "ACM CSS category", "Has subcategory" and "Is element of" explain the position of the topic in the ACM CCS and relation to other close topics.
- The course association "Studied in" shows what courses (lectures) are related to Agent topic.
- Internal and external occurrences refer to topic resources: e.g. information about books available in the university library, hyperlinks to online web resources, string value information – here, quotations of definitions from the WordNet lexical database. The scopes assigned to occurrences inform about the level of prerequisite knowledge, i.e. that a particular book is aimed mostly at experts, or about language of resources etc.
6. Conclusion

In this paper we have proposed understanding virtual study environments as a kind of knowledge management system and integrating them with other information and knowledge resources, both digital and non-digital, which are available at the educational institution. We see the Topic Maps technology as a suitable tool for this proposed integration and we offer a general framework for the development of the Topic Maps-driven e-learning portal. The main idea is to interconnect different information systems, used by students and staff of the faculty and to reuse domain ontologies for the subject classification of the content. See (Olsevicova, 2005), where the presented idea is explained in detail. See also (Dicheva et al. 2004; Dichev and Dicheva, 2005) for other TM applications in the educational context, mainly a novel architecture improving the effectiveness of searches in concept-based digital course libraries. (Schwotzer, 2004) explains how Topic Maps can be used for knowledge representation in distributed knowledge management systems and understands the exchange of Topic Maps to be the exchange of explicit knowledge. In this perspective, we can consider the interlinking of our proposed Topic Maps portal of a particular educational institution with similar portals of other educational institutions.

Acknowledgements

This contribution was partially supported by the Czech Science Foundation Project No. 406/04/2140 KNOMEDIAS

References

Encouraging Student Participation in an On-line Course Using ‘Pull’ Initiatives

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Abstract: This paper presents an empirical study involving initiatives that encouraged students to log onto online courses in entrepreneurship delivered by the University of Glamorgan. The aim of the research was to explore items of interest to the online students that may increase participation in the forums and hence potentially enhanced engagement with the course module. The online tutor created additional forums within the discussion board of the virtual learning environment (VLE) that included a variety of online games and quizzes that were relative to the module topic. The rationale that underpinned this initiative was to reduce the possible blandness of the VLE as perceived by some students. The games and quizzes were carefully designed to enhance knowledge in the subject and thereby provided additional learning opportunities. The initiative was also thought to assist in the formation of an online learning community. The study involved experimentation by the online tutor with subsequent observation of the behavioural patterns of the students. In one module, the dedicated social and games forums attracted 54% of the total postings for the module. The findings suggest that including online quizzes and games that are relevant to the taught subject can increase the participation levels of the students and possibly enhance the learning process. The findings of this study may inform the design, development and delivery of online learning programmes. The findings also inform strategies of good practice in online moderation and may help to reduce withdrawal rates, which are typically high in the field of e-learning (Potashnik and Capper, 1998).

Keywords: Virtual learning environment, Fun, Discussion forum, Participation, Games

1. Introduction

Increasing numbers of educational institutions are embracing the idea of delivering courses that are partly or extensively delivered online (Palloff and Pratt, 2001). Despite initial enthusiasm, e-learning has been subject to adverse attention in recent years due to some large projects that have borne the publicised stigma as ‘costly failures’. The British Government’s e-University is a prime example (Guardian Unlimited, 23 May, 2005). Various criticisms and concerns in e-learning have been forwarded by a number of scholars. Peters (1993) fears that distance education often adopts a mass production philosophy and benefits that may be derived from the face-to-face classroom are consequently lost. In a similar vein, Noble (2002) warns that distance education is becoming a commodity. These arguments infer that the transactional distance between the tutor and the learner is increasing. However, Valenta and Therriault (2001) refer to evaluative studies whereby students involved in distance education spoke of having experienced increased individual attention from their tutors. The perception of a widening gap between the students and tutor could be morally damaging to these typically non-traditional students that find themselves immersed in a means of study that may be totally unfamiliar to them and hence generate ‘virtual anxiety’, especially in the case of technophobes. Rheingold (1995) discusses the negative impact of this anxiety and includes the participants’ fear of how their postings might be perceived by other users. Indeed, a study by Peachey (2004) found that 57% of [non-traditional] students that had completed an online course experienced significant levels of initial trepidation in posting their first messages to the discussion forums. All of these students said that they were anxious as to how their messages would be perceived by their [unknown] peers. This is exacerbated in fully online courses as face-to-face contact plays a significant part in the process of socialisation (Jones and Peachey, 2005). Students might also experience a sense of isolation that may erode their personal motivation levels ultimately leading to possible withdrawal from the course. For example, Purcell-Robertson and Purcell (2000) believe that a medium that involves the student sitting alone at a computer can invite feelings of disconnectedness from the learning. In a research study of 427 students who enrolled on online courses between 2001 and 2003 delivered by the University of Glamorgan and its partner colleges throughout Wales, 20% of the students spoke of having experienced a sense of isolation and regarded this as the main negative issue in their online study. A further 14% of the online students regarded the lack of face-to-face interaction as the main shortfall (ECW, 2003). These findings are consistent with the experiences of online students in a study highlighted by Neal (2005) who found that students did perceive collaborative interaction as ‘fun’ but not isolation or online anxiety. Neal also revealed that online teachers themselves
also experience similar online trepidation and that the teaching becomes less enjoyable when there is some discomfort. Finally, Neal argues that formalisation can undermine the sense of fun and consequently impact negatively on the perceptions of the online students.

Hence, it is clear that formal learning in an online course carries unique problems and there is scope for lateral thinking and innovative actions as inspirational drivers. This paper presents an empirical study that involves a paradigmatic shift from ‘push’ to ‘push and pull’ strategies in encouraging student participation in the online environment. It was hoped that the online students will feel that they want to log on and not feel that they have to. The aim of this study was therefore to explore items of interest to the online students that might encourage them to participate in the online forums of the VLE, i.e. to apply a push and pull as opposed to a push strategy.

1.1 The background and context
As part of the Entrepreneurial Action Plan (EAP) initiative delivered by the National Assembly for Wales (UK) and partially funded through the European Union’s Objective One strategy, the University of Glamorgan formed ‘E-College Wales’ (ECW). The main aim of this innovative initiative was to contribute to the regeneration of businesses in Wales by way of an accredited training programme in entrepreneurship that was accessible to candidates throughout the Objective One areas of Wales. This initiative involved a major investment in e-learning and led to the development of a number of undergraduate and postgraduate business enterprise courses at the University of Glamorgan. ECW claims to be one of Europe’s largest online learning projects and over 1000 students throughout Wales have already embarked on these courses since 2001. The courses were delivered almost entirely online by the University of Glamorgan and partner colleges across Wales and were as follows:

Undergraduate:
- Higher National Certificate (HNC) in Business Enterprise
- Foundation Degree (FD) in Business Enterprise
- Bachelor of Arts (BA) in Business Enterprise

Postgraduate:
- Master of Arts in Professional Development (MAPD)

This study focuses on three undergraduate modules, namely the Level 2 modules:
- Small Business Planning (EB2S03)
- Developing Small Business Marketing Communications (EB2S08)

And the Level 3 module:
- The Entrepreneur and Society (EB3S09)

These courses were modular in structure with each module being 9 weeks in duration. Three modules could be delivered in one academic season for part-time students and 6 modules for full time students who would study 2 modules concurrently. The online courses offered 24/7 flexibility and the mean age of these non-traditional students was 37 years. The typical student retention rate of these online courses was around 50%. The virtual learning environment (VLE) platform that was to support the programme was Blackboard®. Course materials were accessible online and students had links to electronic database journals and library catalogues. Students were also able to interact with their peers and moderator via the VLE communications facilities primarily by means of the discussion boards within the forums (refer to Figure 1).

Figure 1: Example of the multiple forums set up by the on-line moderator
The assessment was centred round two coursework assignments that were electronically submitted by means of the Blackboard© VLE communication facilities. In order to persuade the students to engage with the course material, a series of tasks were posted within separate forums of the discussion board of the VLE (as shown in Figure 1) where each task is set within its dedicated forum. The students were encouraged to participate and complete each of these tasks that were entirely relevant to the learning objectives of the course module. However, completion of these tasks was not an obligation and there was no penalty applied for non-participation. Indeed, it was commonly found throughout the ECW programme that some students failed to address any of the set tasks preferring only to submit the coursework.

Both instructivism and constructivism were adopted as viable pedagogical concepts to underpin these courses. The Blackboard© forums would address the socio-constructivist element by affording interaction among the group. These forums were entirely text-based in nature. The instructivist component involved the development of web-pages that housed the course material.

Figure 2: Typical opening task messages as posted by the on-line moderator

Figure 2 represents a typical task found in the level 2 'Developing Small Business Marketing Communications' (DSBMC) module. The students were required to respond to the initial task message posted by the on-line moderator. The moderator would then endeavour to facilitate a discussion around the topic. A common complaint forwarded by the online students was that the text-based environment was inherently bland. The web pages that housed the course content were also text-based but did include some animation as shown in Figure 3.

Figure 3: An example of an animated sequence within the course materials pages
Students who appeared to be absent from the discussion boards of the VLE forums for a predefined period were contacted via email or telephone and encouraged to participate. A common pattern that emerged was that the online students responded by immediately posting just one or two messages, but the status quo soon prevailed and the cycle continued. This ‘push’ tactic is problematic in that the student might feel pressured to participate potentially leading to uncomfortable negative experiences such as stress, anger, frustration or guilt. These emotions could discourage the student in continuing the course and the strategy offers no guarantee that the student will further engage with the course material.

2. A review of the literature

In the literature, there is a distinct paucity of research into push / pull factors that encourage student participation in the online environment. In the context of an online course, there are few references to gaming, quizzes and similar online learning activities although these are frequently found in the face-to-face classroom. A course centred round ‘electronic page-turning’ harbours particular weaknesses as Cohen and Ellis (2001) notes:

> Online teaching and learning classes with extensive reading / discussion formats without synchronous meetings, the use of videos, or interactive experiences (group activities) online learning quickly became boring (p.142).

Kear (2004) discerned that many Open University students studying the T305 course failed to participate online having been put off by having to read so many messages and Race (1994) discusses the goals that feature in a ‘complete’ learning environment:

> The primary goal of creating a complete learning environment is to create a situation where the instructional objectives can be met. A secondary goal is to create an environment that is fun and exciting to use, (p.140).

Race’s dichotomous perspective of the goals misses the point that some students may withdraw from the course if they fail to be motivated and the primary goal consequently cannot be realised. Parker (1999) argues that interaction not only increases students’ motivation but also introduces a positive perception of the course. Stefanov, Stoyanov and Nikolov (1998, p.85) posit that the “development of effective interactive learning environments will motivate and engage the learner” although it is argued that the use of the term ‘will’ in their statement is underpinned by a very bold assumption. Interaction levels between the online moderator and the students, and among the students themselves requires a mediating tool: “Just expecting students to start debating online is like putting students into an empty room, closing the door and telling them to get on with it” (Fox, 2001, p.58). Canning (2002) outlined some of the difficulties in initiating and maintaining learner-learner interaction in a study of an online course. Canning found that the tutorial staff made many valid attempts to initiate interaction among the student group but this failed to materialise essentially due to student indifference. Canning does not elaborate on the tactics used by the tutorial staff and hence it remains unclear whether push or pull initiatives were used in this instance.

Items of interest to the online students coupled with additional learning opportunities and the prospect of vibrant interpersonal interactivity (for students who desire social interaction) is an ideal that could address many of the mentioned problems. According to Blanchette (2001), questioning techniques can afford opportunities for interaction and learning. The *modus operandi* may manifest online as a strategy consisting of activities involving crosswords and quizzes. This approach soundly embedded in a non-threatening online atmosphere, is a possible step in the right direction.

3. Research methods

This research involved an ethnographical study of the behaviour of the online students in their response to ‘experimental’ forums that were included in the Blackboard® discussion board. Blackboard® has facilities for capturing the number of logons (hits) and these data were analysed accordingly. The number of postings made by each student was also manually counted and recorded.

Of the 3 online modules that were subject to this research, the experimental forums were added to 2 of these modules with the third module acting as a control. All of these 3 modules formed part of the BA Enterprise online course. Both the ‘Developing Small Business Marketing Communications’ (DSBMC) and ‘Small Business Planning’ (SBP) were level 2 modules and ‘The Entrepreneur and Society’ (ES) module was a final year (level 3) module. The level 2 students studied both the DSBMC and SBP modules concurrently. The experimental forums were added to the DSBMC and ES modules and the SBP module was used as the control reference.
Three hypotheses were tested in this study:

H1 - The students would participate more willingly if a series of light-hearted online games and quizzes relevant to the learning objectives for the module were integrated into the programme.

H2 - The students would participate more willingly if the online moderator made concrete efforts to create a social and informal environment.

H3 – The students’ participation levels would be generally lower in the control module than the experimental modules.

The level 2 students were informed beforehand that the moderating styles would differ between the two modules of which they were studying with additional items applied to the DSBMC and ES modules to augment the learning process.

3.1 The strategies

The online moderator applied a ‘push and pull’ initiative to the ES and DSBMC modules in order to create extra interest for the online students. The push and pull strategy comprised the following elements:

- The development of an informal and ‘comfortable’ environment for the students to reduce possible anxiety
- The building of an online ‘community’
- The reduction of possible blandness by introducing a series of games and quizzes to the modules that were relevant to the learning objectives
- The bestowment of high levels of praise and encouragement to the students
- The application of a social element to the module
- The use of coloured font and photographs within the prose

The online moderator de-formalised the experimental forums by posting socially oriented messages and discussed personal issues such as his family, his hobbies, etc. Light humour was also included in these forums as a de-formalisation tactic (Lewis and Allen 2005).

A typical ‘push’ strategy was applied to the SBP control module. This push strategy involved adherence to the doctrine of ‘good practice’ in online moderation as recommended by a set of directives published at the University of Glamorgan as part of its Quality Assurance policy. This QA doctrine included guidelines such as logging on regularly, offering prompt feedback, contacting students and advising accordingly when their participation levels fall, and so forth. These guidelines were stringently followed in all of the modules. It was imperative in ethical terms that this research study was not detrimental to the students and the accomplishment of the learning objectives for all modules remained of paramount importance.

The two special forums added to the DSBMC and the ES modules are shown in Figure 4.

Figure 4: The forums of the ES module
In both the DSBMC and the ES modules, a forum was specifically set up to satisfy the social aspirations of some students. This forum was a general asynchronous ‘chat’ forum whereby the students could discuss anything of interest to them provided the ground rules regarding online etiquette were followed. Although the intention was that the students would take ownership for this forum, it was decided that the online moderator would be allowed access in order to facilitate the discussions and keep the forum ‘alive’. A forum was also added whereby students could access the online quiz.

In both the experimental DSBMC and ES modules, the additional socially oriented forum was titled the ‘Cybercafe’ and the games forum was titled ‘Fun and Games’ (as shown in Figure 4).

The opening message posted for the SBP control module was informative, relatively formalised and entirely text-based. However, the DSBMC and ES modules adopted a more informally tone and made use of coloured font. There was no obligation for the students to participate in these additional forums. A photograph of the online moderator was added to convey a personal touch (refer to Figure 5).

![Image of the opening statement for the ES module](image)

Figure 5: The opening statement for the ES module

Activities such as a content-related crossword and a content-related bingo quiz were accessible to the students. The objective of this action was to increase the student engagement with the course module by offering items of possible interest. A couple of small prizes were added to instil a sense of authenticity and to add to the fun. The quiz was entitled ‘Quiz Bingo’ whereby each student was randomly allocated 6 letters of the alphabet on an ‘electronic bingo card’. Twice weekly the online moderator posted a question within the Fun and Games forum. Once a student responded with a correct answer to the question, a randomly drawn letter of the alphabet was released to all of the online students. Once a student had acquired all of the letters on his/her ‘electronic bingo card’, he/she would then post a claim and win the prize. Many of these questions required the student to revert to the course material to seek the solution. Once the correct solution was posted, the online moderator would initiate a discussion on the topic that was relative to the question (refer to Figure 6). In addition to the quiz bingo game, a crossword was also designed to address the same participation and learning objectives as the quiz bingo and was successfully completed by a student in a surprisingly short time despite the relatively high difficulty level of the crossword clues.
4. Findings

In the ES module, 7 students were active online (3 male, 4 female). The task forums attracted a total of 544 posted messages with an additional 148 posted messages directed at the special ‘Fun and Games’ and ‘Cybercafe’ forums. Ignoring all postings made by the online moderator, the students posted 270 messages to the task forums and 92 messages to the special forums. Hence, the special forums attracted 27% of the total student postings for the module. In the DSBMC module, 12 students were active online (3 male, 9 female). The task forums attracted a total of 251 posted messages with an additional 136 posted messages directed at the special ‘Fun and Games’ and ‘Cybercafe’ forums. Ignoring all postings made by the online moderator, the students posted 46 messages to the task forums and 64 messages to the special forums. Hence, the special forums attracted 54% of the total student postings for the module. Refer to Table 1.

Table 1: Details of number of postings made to online forums for each module

<table>
<thead>
<tr>
<th>Forum</th>
<th>Tasks</th>
<th>Fun and Games / Cybercafe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>Students</td>
<td>Moderator</td>
</tr>
<tr>
<td>ES</td>
<td>270</td>
<td>56</td>
</tr>
<tr>
<td>DSBMC</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td>SBP (Control)</td>
<td>41</td>
<td>26</td>
</tr>
</tbody>
</table>

Other forums were also included, namely ‘Announcements’ and ‘Revision’. These forums were purely informative and non-interactive and hence these forums were not subject to this study. The responses to the quiz questions were relatively swift. A response by a student to the question posted in Figure 6 was received later that same day (Figure 7).

Figure 6: Typical question for the ‘Quiz Bingo’ game

Figure 7: A student’s response to the question in Figure 4

The online moderator then sparked a discussion regarding the work of Schumpeter. It was found that some students were considerably more active in the Fun and Games forum than the task...
forums. For example, one student posted 27 messages within the Fun and Games forum but only 6 messages in the task forums. Furthermore, the quality of the response to a quiz question as seen in Figure 8 suggests that some students appeared to be engaging significantly with the course materials.

Figure 8: A student’s ‘articulate’ response to a quiz question in the DSBMC module

The statistical data regarding the number of webpage accesses (hits) made by the students during the 9-week duration of each module was drawn from the Blackboard© VLE and graphically presented in figures 9, 10 and 11.

Figure 9: Activity levels (hits) of the DSBMC module
What is noticeable about the graphs in Figures 9 and 10 are their relatively horizontal profiles. Both of these modules were core modules and had the same student population albeit at different levels.

The graphical representation of the students’ participation on the SBP control module is shown in Figure 11.

There is a stark difference in the graphical profiles between the DSBMC and SBP modules although the level 2 cohort studied both modules concurrently. After a period of relatively high levels of activity, the initiative appeared to be lost and failed to pick up again afterwards. This was not the case in the ES and DSBMC modules where participation levels of the students were relatively consistent throughout the module. No evidence emerged in the students’ assignment scores that suggested a difference in the learning acquired from the DSBMC and SBP courses.

4.1 Student comments
The online moderator endeavoured to apply an informal approach, encourage and motivate the students, and instil a sense of excitement and fun in the experimental modules. At the end of these modules, some of the students posted messages spontaneously within the forums directed at the online moderator. These student responses were positive (and flattering):

‘And a big thank you Paul I’m sure we all wouldn’t have engaged in the topic with such fervour if it hadn’t been for your enthusiasm in leading the module topic…….(ES student, posted 15/05/05)
‘I agree. I’ve really enjoyed working with you Paul!’(ES student, posted 25/05/05)
‘Well I don’t know about anyone else but I think Paul is a fantastic leader who motivates from the start and makes it more..."
interesting

Thanks for all of your support during this year. Hope to see you next year for more encouragement. (DSBMC student, posted 12/05/05)

It was noticeable that no such comments were posted to the forums of the SBP control module.

4.2 Limitations

It needs to be acknowledged that there are a number of variables that might influence the findings. For example, the apparent success of the DSBMC module as opposed to the SBP module might be attributed simply to the students’ preference for the subject of marketing over the subject of business strategy. In addition, there were a number of unique benefits for Objective One students that are thought to influence the enrolment and persistence of the students. These benefits included no fees for the course or the online activity and the loan of a free laptop for some students. Generalisation of the findings is perilous considering the relatively small population numbers in each module.

5. Conclusions

The findings of this study were remarkably consistent with all three hypotheses. To recap:

H1 - The students would participate more willingly if a series of light-hearted online games and quizzes relevant to the learning objectives for the module were integrated into the programme.

H2 - The students would participate more willingly if the online moderator made concrete efforts to create a social and informal environment.

H3 – The students’ participation levels would be generally lower in the control module than the experimental modules.

The findings also agree with the findings of Neal (2005) (refer to page 2 of this paper) and suggest that the inclusion of quizzes and games that are wholly relevant to the objectives of the course modules may potentially increase participation of the online students to the discussion forums. Commonly used push factors have proved to be quick fixes to a fundamental underlying problem. In terms of the ECW programme, it is recommended that the typical push strategies should be substituted by a push and pull ideology. The objective is accomplished when the online students feel that they want to log on and not that they have to. The findings of this study are believed to be of benefit to personnel involved in the design, development and delivery of online courses. Finally, there is a clear need for further evaluative research into the impact on students’ satisfaction, learning potential and retention in introducing such ‘fun’ activities in online courses.

References


Providing ‘Quality Care’ to International Students Through On-line Communication

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Abstract: This paper evaluates an approach to dissertation supervision, designed to assist international students with their academic writing. It argues that a blended approach to supervision within a Virtual Learning Environment can provide high quality individualised care not otherwise available. This leads to deeper, critical learning and more meaningful participation in Higher Education.

Keywords: Computer mediated communication, academic writing, internationalisation, critical thinking

1. Introduction

This paper evaluates the on-line dissertation supervision of 20 postgraduate international students of Information Systems. It builds on earlier studies (Perry 2004, 2005) prompted by the evident difficulty international students experience in succeeding on their courses, a difficulty made apparent by the high incidence of alleged plagiarism (Perry 2005). A defining feature of the intervention described in this paper is the part played by on-line communication.

The 2004 study considered 3 students’ progress and suggested that cautious generalizations could be made. Firstly, a blended, flexible approach to supervision is likely to be beneficial. Secondly the increased reliance on written communication in a Virtual Learning Environment (VLE) encourages an explicitness that is critical to success. This paper assesses the extent to which the conclusions drawn from the previous study still hold true, taking account of the progress of the whole cohort and of longer-term evidence. It further explores three key questions:

- To what extent can on-line communication provide students with individualised ‘quality care’ sometimes thought to be lacking in mass higher education;
- Can on-line communication facilitate the acculturation of international students into a UK university and
- Is on-line communication distinctive in the way it develops critical thinking skills?

1.1 Background

The concerns of this paper reflect the continued internationalisation of education, the growing number of students for whom the medium of instruction is a language other than their own, the disproportionate number of international students accused of plagiarism and the increased provision of virtual and distance learning in Higher Education. As McNamara and Harris (1997) and

Elsey (1990) suggest, if financial concerns continue to motivate UK universities to seduce students from abroad, then there is a moral obligation to provide them with a learning context in which they can thrive.

While this study takes a non-essentialist view of international students, some generalisations may be relevant to gaining an understanding, if not always of the students themselves, then of prevailing attitudes towards them. Contrasting views of knowledge in western and non-western countries are well documented (Ballard and Clanchy 1988; Leask 2004, Perry 2005). The fact that learning styles, too, may be culturally determined (Richardson 2000) may make acculturation into the UK academy difficult for some students. It is, however, very likely that difficulties more obviously experienced by international students highlight general failings in the care provided, for example, with respect to the quality of feedback given to students (UWESU 2004; Nink 2005).

1.2 General approach

This study adopts a qualitative and reflexive case study approach. The stance taken is explicitly feminist in its concern for a vulnerable group (Griffiths 1998) and also in the prominence given to the need to provide a nurturing, inclusive learning environment.

As a female academic in a male dominated department I know from my own ‘lived experience’ what it means to belong to a vulnerable minority group, and empathise readily with the students in my care (Perry 2001). In terms of the conduct of this research I am very much on the inside: as supervisor, the provider of feedback and the person responding to emails, I play a key part. This central position is both a strength and weakness of the research.
1.3 Operational concepts

This section explains the use of concepts that take on specific meaning in the study: ‘adequacy’ of writing and ‘critical’ thinking.

1.3.1 Adequacy of writing

Two sources of data are used to evaluate the effectiveness of this intervention. One is the way students and staffs feel and think about the approach. The arguably more objective source is the writing itself: in defining the term ‘adequate’ as a descriptor of students’ writing, I deal with the ‘evaluative content of factual statements’ (Griffiths 1998, p 50), attempting to provide a definition that is fixed within the context of this study and not subject to (too much) individual interpretation.

This study adopts the notion of threshold achievement (Moon 2004), as making explicit what students have to do in order to write a dissertation of an adequate standard. Citation is treated as an indicative skill: if a student is able to cite to an adequate standard, the student’s academic writing is likely to be adequate more generally. It shows the degree to which the student is able to reflect on his/her own and others’ knowledge, using this knowledge to develop an argument and moving to deeper styles of learning, including metacognition.

‘Adequate’ writing should have the following characteristics with respect to citation:
- It should display an appreciation of recognised conventions for citation and referencing, and the writer should be able to use these conventions accurately in final submissions of work;
- It should display an awareness of when words or ideas need to be attributed;
- The reader should be able to distinguish words or ideas that are the writer’s own from those of another author;
- Words or ideas of another author should be included because they are part of an argument developed by the writer;
- The way in which a writer includes these words or ideas should communicate to the reader her/his own position: the extent to which s/he views the author as an authority with whom s/he is in agreement.

1.3.2 Critical thinking.

Western models of learning, including an emphasis on critical thinking, rest on particular views of knowledge. Baxter Magolda’s ‘model of epistemological reflection’ (Baxter Magolda 1999, p 42) and Perry’s ‘scheme of intellectual development’ (in Richardson 2000 p 46) suggest that learners move from surface to deeper learning, as their view of knowledge develops. Citation is where academic writers make explicit how they view the knowledge of others.

Critical thinking is associated with critical language awareness (Fairclough 2001; Gee 1996), when the student gains awareness of him/herself as a writer, of the choices that are available to him/her and of the wider social and cultural implications of the choice of particular discourses. These become issues of power and of individual identity that have particular relevance for international students.

Critical language awareness may form part of a ‘critical pedagogy’, challenging ‘the societal power structure…and reversing social inequities’ (Cummins and Sayers 1990). In Gee’s (1996) words, mastery of a discourse empowers the individual as a whole person, involving the ‘integration of identity.’

1.4 Structure of paper and presentation and analysis of data

Section 2 presents the case study on which this paper is based. A difficulty in presenting qualitative research is in ensuring unbiased selection of data for detailed consideration (Yin 1988). I selected that which surprised or informed, rather than that which confirmed a particular bias. Firstly a brief account is given of the distinctive characteristics of the support given to students. Secondly a sample of the staff and students’ views on on-line supervision is presented without interpretation. Thirdly a vignette represents the supervision of one student.

The students are disguised in such a way that both meaning and anonymity are preserved.

Section 3 evaluates the data collected and the paper concludes by considering the extent to which the intervention could be implemented more widely.

2. The case study

2.1 Overview of on-line support provided

Successful supervision appeared to be dependent on a mix of modes of communication, including some face-to-face contact to establish initial rapport, usually followed by frequent and detailed written communication. The distinctive aspects of the support were, however, computer-mediated and delivered to the students within a VLE. It comprised:
• Handbooks and guidelines
• Discussion forums set up to provide access to peer support, as well to deal with ‘frequently asked questions’
• Planned feedback on students’ work; email exchanges and the sending of ‘marked’ word processed documents, were used extensively. Feedback was carefully planned to complement guidelines given to the students on the use of different citation styles. Students were encouraged to reflect on the way citation style (direct or indirect, integral or non-integral) communicated to the reader the extent of agreement with the cited text. This level of critical language awareness is seen as indicative of critical thinking as discussed above.

2.2 Evaluation of students’ writing

2.2.1 The process

At the start of the study the writing of all students was deemed to be inadequate (as defined in 1.3.1). They submitted a minimum of a further 3 pieces of work, and feedback was given as follows:

• Standard guidance along the lines of, ‘you need to include more secondary literature, and to reference your work thoroughly and accurately – see your dissertation handbook’ was given in response to the first draft. The adequacy of writing was measured and recorded to reflect achievement after this initial standard feedback.

• Feedback on intermediate drafts focused in greater detail on academic writing. Students were given explicit guidance in the use of different citation styles. All drafts were archived for subsequent analysis.

• Adequacy of writing in the final submission provides evidence of the effectiveness of the intervention.

While acknowledging that determining whether a student’s writing has really improved is inevitably subjective, the study aims to make measurement of improvement transparent through the use of clearly defined descriptors. Furthermore each student’s work was assessed by a minimum of two academic staff.

2.2.2 The outcome

The evaluation of students’ writing outlined above provides strong evidence of the effectiveness of the blended support provided. The standard support raises the level of the students’ writing to at best barely adequate. In most cases the writing continues to be inadequate. Following the intervention two students make minimal progress, but all show some improvement. There are no cases of plagiarism. 17 students show substantial improvement, moving up at least two ‘grades’.

The majority of students (13 out of 20) achieve ‘more than adequate’ or above in their writing. The writing of two students is ‘excellent’ following the intervention.

2.3 Views of supervisors and students

The following includes some of the more striking views on on-line supervision as experienced by the participants in this study, drawn from a range of sources: informal interviews, both email and face-to-face and informal discussions with colleagues. Here only a small sample can be included, but all views wholly or partly critical of on-line supervision are represented.

<table>
<thead>
<tr>
<th>Students’ views</th>
<th>Supervisors’ views</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s nice when a tutor gives you proper feedback.</td>
<td>Email can become a sort of pseudo contact where nothing much happens – for example you can spend weeks trying to set up a meeting</td>
</tr>
<tr>
<td>I know that I am understood when I write</td>
<td>Email is depersonalising, and therefore more professional - the personal becomes less in email. But the supervisor may be less likely to pick up on emotional blocks in emails</td>
</tr>
<tr>
<td>The student doesn’t have to worry that it might be the wrong time for an appointment or the right time to make a phone call</td>
<td>The asynchronous nature of email communication gives time to get over barriers and it allows the student to ‘hide anxiety’ but that is not always useful.</td>
</tr>
<tr>
<td>I worry sometime when I email my supervisor because it’s easy to get someone upset with the wrong words</td>
<td>The use of email results in a better conversation. They have time to read what you’ve said and think about it. It is a more equal exchange.</td>
</tr>
<tr>
<td></td>
<td>It is incredibly time-consuming.</td>
</tr>
<tr>
<td></td>
<td>It is inclusive and helpful.</td>
</tr>
<tr>
<td></td>
<td>Email communication is safe</td>
</tr>
</tbody>
</table>
2.4 Nadia

Nadia impresses as an extremely dedicated student: studying abroad with her husband and two small children. I initially form an impression of her as very reserved, but she emerges as warm, responsive and grateful for help given.

In spite of her demanding domestic situation Nadia has passed all her assessment at the first attempt. The majority of students and nearly all international students have to redo at least one element of their assessed work. I meet Nadia for several brief conversations before she starts work on her dissertation.

My involvement with Nadia’s dissertation is relatively brief as I take over the supervision from a colleague, when she goes on leave. Also Nadia submits her dissertation early, as she has to return to her home country and wants to have completed the degree before doing so. My colleague comments on Nadia’s first version in a face-to-face meeting, giving generalised reminders about the use of secondary literature and referencing. I join them for this meeting.

Nadia sends me further chapters to read quite promptly. She is working fast. Her English is generally understandable: she makes minor mistakes, for example in verb tense and number agreement, but her choice of vocabulary is accurate and she writes in the appropriate register. Her use of secondary literature is limited and referencing is incomplete. She restricts herself almost entirely to non-integral indirect citations and uses a numeric (rather than ‘Author-date’) referencing system.

One of Nadia’s main themes in her study is the extent to which specific theories can be used for evaluating websites. Here (when the context more obviously demands it) her use of secondary sources is relatively clear, and helpful to the reader. For example, she writes,

*It is believed that … website that incorporates a managed additional set of facilities is most likely to achieve the best balance and it is more realistic.* [6]

The guidance given is mainly by email in a relatively intense period during the month prior to its submission, and we have one face-to-face meeting. Our email exchanges feel extremely efficient. We are working to tight timescales and getting the job done. However, any real human warmth is reserved for face-to-face contact, when I learn that on top of her domestic chores and work on her dissertation she also works half time as a sales assistant. I learn just how exhausted Nadia is… Her quiet manner now seems to be a form of reserving her energy.

I am aware that she is determined to submit her work early and am anxious to be encouraging – and do not wish to imply that my approach is in any way different from that of my colleague. I email advice to her as follows:

*Generally this is fine – I don’t think any of the comments I have made on your work are critical.*

This may not be strictly true – and I go on to give generalised advice about substantiating every statement that she makes with evidence, ‘covering’ myself at the same time:

*I haven’t had time to reread all the chapters you have sent me, but when you proofread your final draft make sure that where possible you have:*

- Provided evidence for statements that you make
- Referred back to specific sections in earlier chapters (to make the reader appreciate how an argument is being developed)

Next comes some more explicit advice:

*You could also improve (and vary) your use of secondary literature.*

The model you use most consistently is the non-integral direct quotation – where you make a statement and add the reference in brackets afterwards, for example on page 43 you write:

‘As every society has different needs and priorities, there is no single universal standard model for e-government plan [5]’ this is often appropriate but it is limited because:

- Sometimes it is difficult for the reader to tell when your views start and the quoted author’s stop
- It suggests total agreement with the source

You could use formulations like:

X suggests this… but Y points out that…
Z describes e-government as… however my observations suggest that…

But I still feel the need to reassure her:

As I said, I am generally pleased with what you’ve done – so don’t worry unduly about my comments

This is rather confusing advice, I think in retrospect. Am I giving Nadia permission to
ignore my comments? However she does respond, supplying several specific references. For example, when she writes that ‘cultural factors and society capabilities of different countries need to be considered’, I ask for examples and evidence. She adds the following:

’. Organization culture is important because normally people resist changes and different ways of encouraging the employees have to be considered (Pacific Council, 2002)...Finally the structure of government has to be considered. Some services may be private in a country while it is governmental in other country. For example, Telecommunication industry is private in the UK but it is governmental elsewhere.’

Nadia has been coaxed into providing a reference, giving more detail. Also she has responded to my more general advice: the piece is now dense with references; she is linking her sections effectively and now integrates direct quotations into her own sentences, for example:

The term ‘digital divide’ is usually defined as ‘access or lack of access to the Internet’ (Loges and Jong).

She makes a clearer distinction between her views and those of other authors: her efforts to interpret others’ views become transparent to the reader. Several times she makes a statement supported by a citation, and then interprets the significance of this with a sentence beginning, ‘this means that….’. She is not resorting to mimicry, using the formulations that I have suggested; rather she is creating her own formulation, and using this formulation repeatedly. This results in writing that is adequate, but the level of sophistication and subtlety of meaning that she achieves is limited by her command of English.

When we later meet face-to-face Nadia glows when she speaks of the UK education system. She is particularly impressed by access to on-line material prepared by staff. At home the method of delivery was solely the lecture, where students desperately tried to take notes – which they later shared. Readings were recommended, but these were hard to get hold of and guidance was in any case vague and unhelpful. She seems to come to life as she speaks and it is as if the experience at a UK university has been that of a feast for the starving. Her ambition is to return to do a PhD.

Nevertheless, her experience of study in the UK has not been without difficulty and she describes how her attitude to academic writing has been transformed:

No, she is not confident in English. Reading was very difficult at the beginning. ‘The Indian students, they speak so fast’. But she does not translate ‘whole sentences’. She looks up ‘only words’ in the dictionary. Yes, she enjoys writing ...

Her husband reads and corrects her written English. (He has been studying in the UK for two years longer than she has.)

‘I learnt a lot that I didn’t know before. What was very helpful was to be told to think about the reader: ‘I thought before, reader know everything’. She says that it is even new to her husband (who has just submitted a PhD on a highly technical subject.) He didn’t know ‘about the reader and about references’.

3. Discussion

This section returns to the issues identified in the introduction; it assesses the evidence that a blended approach to supervision, with increased reliance on written communication, improves the quality of care of international students.

3.1 Evidence of the benefits of a blended approach to supervision

Online supervision has clear benefits. Apart from the convenience associated with asynchronous communication, access to a supervisor via email is viewed as less intimidating than approaching a closed office door. However, this study supports Jackson’s (2003) view that for international students it may be particularly important to include face-to-face support. Nadia may be the exception that proves the rule: her dedication to her studies was such that the email support may have been sufficient without the face-to-face contact. However, her ability to understand the nuances of occasionally ambiguous emails may have been dependent on familiarity established face-to-face. Also, unlike all other students in the study, Nadia was not isolated from family and friends; indeed, her husband was able to support her directly with her studies.

3.2 Evidence of the benefits of written communication

The use of written guidelines and written feedback on work offers explicitness and a level of detail that is of demonstrable benefit to the majority of students in the study. It gives the opportunity to:

• Repeat guidance (for international students it is helpful to say the same thing in the same way several times);
• Adopt the apprenticeship model of learning (Lave and Wenger, 2002), where the supervisor ‘shows’ the student how to write in the academic style;
• Improve writing skills through the email communication itself, where the use of specialist vocabulary can be rehearsed.

The use of on-line written communication also means that wider benefits of using ICT in composition can be exploited (Perry 2004). Ease of editing text in electronic form gives it a ‘provisionality’ (Goodwyn 2000) that is helpful to the novice writer, encouraging the type of reworking that characterises proficient writing (Shaughnessy 1977).

Support offered to the students in this study was designed to be focused and explicit as already discussed. Conversations in writing between student and supervisor, the ‘critical friend’ (Goodwyn 2000, p 14) fostered such precision. Some students learned to imitate phrases and constructions used in feedback. Some appeared to learn a new language through use; others, such as Nadia learned to use limited vocabulary to develop and communicate their own independent, critical thinking. The frequency and quantity of the communication that allowed this development would not have been possible without email.

### 3.3 Evidence that on-line communication facilitates acculturation into a UK university and in developing critical thinking skills

Given that writing in the academic style is viewed as emblematic of western academic culture, on-line exchanges with supervisors and peers permit the student to participate – as an apprentice – in that culture, to ‘practise’ academic writing under the scrutiny of an expert.

Online exchanges such as that described in 2.4 suggest that the very explicitness of the advice given may lead to an overly prescriptive approach. While intending to help students to become democratic in their thinking, the tenor of my interactions (defined by this very explicitness) may, ironically, have reinforced their dependency on authority. It is crucial that the supervisor does not ‘think the thoughts’ for the student; rather s/he indicates the type of thoughts that are expected. These thoughts may involve subtle evaluation of others’ ideas in relation to a line of argument being developed. When a supervisor points out that it is not clear whether a student agrees or disagrees with a quotation from another author (or indeed where the cited text stops and the student’s interpretation or critique starts) this student may be confronting characteristics of a hitherto unfamiliar academic culture. It is evident that Nadia took pleasure in this process of acculturation.

For none of the students in the study did critical thinking and writing skills come naturally; all required guidance of some kind. A consistent feature of this guidance was close engagement with written text and a form of ‘interactive composing’ evident in the account of Nadia’s supervision. Again, it is difficult to imagine how this could have been achieved in the context of mass higher education without collaborative writing tools and email.

In Hunt’s (2004) view authenticity is lacking in most communication experienced by students in the course of academic study. Students are reading and writing in a manner that is ‘disconnected from any real social occasion or motive.’ Effective communication with a supervisor – and potentially with a group of peers studying related areas – provides a meaningful social context for writing. This study confirms Henri’s (1992) view that successful communication via email exhibits social, interactive, cognitive and metacognitive dimensions. Not surprisingly those email exchanges that tended to be productive, leading to improved writing, were also characterised by their interactivity and by the genuine dialogue that emerged. The exchange with Nadia provides clear evidence of the cognitive dimension in the way she exhibits deeper learning. If the metacognitive dimension is only revealed in face-to-face discussion, this does not in any way diminish her progress as a critical thinker.

### 3.4 Evidence of provision of ‘quality care’ that may be lacking in mass higher education

Goldhaber (1997 in Lankshear and Knobel 2003) reflects on computer-mediated communication as a source of much valued attention to individuals. It can provide a means of reducing the anonymity of mass higher education.

The use of the VLE for information storage and for dealing with frequently asked questions via a discussion forum, frees the supervisor to deal with the needs of individuals to a degree that would be impossible in face-to-face meetings. There is scope for responses to be more considered – of a better quality – in written communication: difficult issues or areas of confusion are relentlessly pursued until understanding is reached.

Claims are made for the democratic and egalitarian nature of electronic learning and the
way it can shift the balance of power both within a cohort and between student and teacher (Kaye 1991). Flexibility means increased equity and fairness – as different students tend to thrive in a VLE (Jackson 2003). It also means that different demands are made of the teacher who becomes coach rather than transmitter of information (Edwards et al. 2002). This is a new relationship to which some staff, as well as students, have difficulty in adapting (Saunders and Klemming 2003), as is shown by the ambivalence articulated in 2.3 towards the ‘impersonal’ nature of email.

Online supervision encourages greater rigour, and individualised care is inevitably time-consuming, regardless of the mode of delivery. This study argues, nevertheless, that the convenience of online communication, and the explicitness that results when feedback is written, contribute to a more efficient use of supervisor’s time.

4. Conclusion

A blended approach to supervision within a VLE can use resources efficiently to provide high quality care. In addition to improvements in students’ writing – and helping them to avoid plagiarism – there are wider benefits to be gained in terms of deeper, critical learning and meaningful participation in Higher Education.

There may, however, be difficulty in gaining full staff engagement in such an approach, as is discussed elsewhere (Perry 2005). The reflexive stance adopted in this paper draws attention to the importance of further attributes that are critical to effective supervision: commitment to, and empathy with, students as individuals. This empathetic approach is one that does not always find favour in a male dominated workplace; this may prove to be a barrier to the intervention’s wider successful implementation.

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Using Software Testing Techniques for Efficient Handling of Programming Exercises in an e-Learning Platform

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Abstract: e-Learning has become a major field of interest in recent years, and multiple approaches and solutions have been developed. A typical form of e-learning application comprises exercise submission and assessment systems that allow students to work on assignments whenever and where they want (i.e., dislocated, asynchronous work). In basic computer science courses, programming exercises are widely used and courses usually have a very large number of participants. However, there is still no efficient way for supporting tutors to correct these exercises, as experience has shown that correction (and, beyond that, automatic grading) are difficult and time consuming.

In this paper we present an enhancement of the xLx platform developed at the University of Muenster to efficiently support tutors in handling Java programming exercises electronically. The new component is based on concepts of automatic static and dynamic testing approaches, well known from software engineering, and provides an automatic pre-correction of submitted solutions. In addition, a tutor is able to annotate solutions manually, by adding comments that are associated with the source code of the solution in an intelligent way. Static tests are based on a compilation of the sources to find syntactical errors, while dynamic tests use test cases defined by tutors during the creation of the exercises and have to be executed correctly on the solutions in order to receive credits for the exercises.

Keywords: Programming exercises, Automatic pre-correction, e-Learning, Blended learning

1. Introduction

e-Learning has become a major field of interest in recent years, and multiple approaches and solutions have been developed so far. A typical form of e-learning applications are exercise submission and assessment systems that allow students to work on their assignments whenever and where they want (i.e., dislocated, asynchronous work). Since the demand for new types of exercises arises based on the teaching environment, it is important that e-learning systems provide a flexible way to add new types of exercises and that they are scalable concerning the demands of different courses and lectures. This paper describes an enhancement of an e-learning platform by an automatic program testing facility.

In undergraduate and basic computer science courses, programming exercises and assessments are widely used. These courses usually have a very large number of participants which leads to several problems when the submitted exercises have to be corrected and graded by tutors. The main reason for this is that programming exercises, no matter which programming language is used, tend to have a large degree of freedom for learners. Thus, simply comparing the provided solutions with a sample solution does not produce a reasonable result that can be used for grading, since different, yet still correct solutions to one and the same exercise exist. It is possible that the submitted solution still fulfils the required aspects of the exercise, but follows a completely different way to solve the problem than the given sample solution. Only a manual correction by an experienced tutor and a semantic comparison with a sample solution can lead to an acceptable form of correction. The tutor must be aware that there are a lot of ways to solve one specific programming problem. Some programming languages offer a larger degree of freedom than others, but generally this characteristic is typical for a high-level programming language.

As a consequence, correcting and grading of programming exercises is commonly done completely manually. Only centralized submission systems are sometimes used to standardize the submission process, but this does not solve the actual problem that arises with this special exercise type. Thus, tutors have to install a submitted solution on a test system to execute and run tests. Running tests on a submitted source code is essential, since it has a high complexity and even an experienced tutor might overlook faults by only reviewing the source code without executing it. In case of several hundred submitted exercises, which is a regular figure in courses at large universities, this can be an exhausting task for a tutor. Annotating source code is also not very comfortable since the student will have to browse through the full source code in order to find the annotations made by a
tutor. This is why annotations are often made manually on printouts of the source code.

A couple of approaches for automatically correcting and grading programming exercises exist in the literature, but recent solutions mostly offer an automated testing by interacting via the command line with provided solutions. These approaches are of course very limited since there are a lot of applications or software components that do not have a command line interface such as most Java classes, GUI based applications or stand-alone algorithms that are not embedded in a specific program. The most sophisticated system so far is “Praktomat” (Zeller 2000) which has been developed at the University of Passau to support programming learning classes. Other approaches such as BOSS (Joy and Luck 1995), TRY (Reek 1989), Online Programming Assessment Tool (Roberts and Verbyla 2003) or ELP (Truong et. al. 2003) mostly focus either on offering a solution to submit exercises using a Web interface or offer concrete testing functionalities but not both.

In this paper we provide a closer look at the integration of programming exercises in the xLx e-learning platform that has been developed at the University of Muenster (Hüsemann et al. 2002). The new component is Web based and builds on foundations well known from software engineering. The exercises are a typical part of undergraduate and basic computer science lectures and normally several hundreds of students assign to those courses. The paper starts with an explanation of the existing platform in Section 2, and then explains the enhanced architecture of the xLx system that now integrates JUnit and Apache ANT to automatically compile sources and execute test cases on a submitted solution in Section 3. In particular, we explain in detail how tutors can define exercises and assign (Java) test cases to them. We also show the learner’s view and indicate how annotations are provided for learners to learn from mistakes. In Section 4 we provide a short explanation of security reflections that had to be done since submitted code is executed on the xLx server that might be maleficient, and we conclude with a short outlook.

2. xLx – a scalable e-learning platform

xLx is the abbreviation for “eXtreme e-Learning eXperience” (Hüsemann et. al. 2002, Vossen and Westerkamp 2004). It is a Web based online learning platform developed at the University of Muenster that can either be used in university or commercial contexts. The main objective of xLx is to support the exercise portion of technically oriented university courses (e.g., database systems, database implementation, computer networks, workflow management). xLx is part of a “blended learning strategy” that combines classroom teaching with electronic exercise work. This strategy is based on the observation that classroom teaching in the courses mentioned is necessary and leads to better learning results than a complete shift of teaching solely to Web courses. The original motivation for the development of xLx was based on the following observations: Current university classes (and embedded exercises) typically take place in strictly periodic meetings, are bound to certain teaching environments, mostly ignoring the progress, needs, and time constraints of individual learners. Students spend less and less time and effort to work on courses and exercises continuously. Reasons for this trend are manifold and shall not be discussed here. The target courses of our system, in particular database and information systems courses, offer lots of potentials for computer-based, interactive, often visualized or animated training and testing. Learners need to practice and train their skills with full-scale software systems (e.g., database management systems) that are reasonably administered at the university only.

xLx addresses these observations as follows. Students can work on assigned exercises anytime and anywhere if Internet access and a standard Web browser are available. Students may determine their own pace when solving exercises; however, a didactically meaningful sequencing of exercises is still enforced by the system (as is a time limit per assignment). Moreover, students may ask for additional exercises either if they have difficulties with the presented material or if they would like to work on more challenging problems. Finally, learning modules based on realistic problems and transparent access to underlying commercial systems raise hopes in more fun and better learning success while solving the exercises accompanying a course. Correcting and grading assessments can be quite time consuming (depending on the exercise types used in the assessment). The use of xLx to make the grading process more efficient, particularly for complex exercise types such as programming exercises is also one of its primary goals.

xLx embodies a personalized learning platform that offers hands-on experience in terms of practical exercises, covering a wide range of conceptual, language specific or algorithmic aspects of a particular field. xLx gives transparent access to underlying (commercial) systems (e.g., database or workflow management systems), which are centrally administrated. The xLx platform organizes exercise solving in terms of
closed user groups, where every member has his or her own password-protected account. Each account provides access to a course portal that offers traditional material such as slides, lecture notes, learning objects (Downes 2001), and further links as well as an email list, a discussion forum, and a personalized training section. This training section is divided into two parts: Test section: In this section students are able to train their skills concerning course relevant techniques (e.g., SQL queries, object-relational features of SQL: 1999, transformation of XML documents with XSLT or XQuery), and they can deepen their understanding of covered algorithmic techniques (e.g., database system algorithms such as algebraic query optimization, the two-phase-locking protocol for transaction synchronization, or the redo-winners protocols for restarts after system crashes, see Weikum and Vossen 2002).

Submit section: This section contains the exercises that have to be solved during the term and according to predefined deadlines. New exercises show up in this section as the necessary background has been covered in class. Solutions can be prepared and tested in the test section mentioned above. Once submitted, solutions cannot be changed any more, and they appear on a work list of a teaching assistant by whom they are corrected and annotated.

So far, xLx knows five types of exercises: free-text, multiple choice, SQL queries, XSLT and XQuery transformations. While the first two of these exercise types are standard ingredients of an e-learning system, the latter are unique to our system, as they are coupled with transparently integrated underlying systems, in our case a relational database for SQL (IBM DB2 Universal Database) and XSLT and XQuery processors. The integration of different systems avoids technological and administrative barriers, as students do not have to install these systems at home; instead, they are accessed via standard Web browsers. Finally, exercises for the last four of the above types are stored along with solutions inside the xLx platform, which allows for an automatic pre-checking of solutions and makes life of teaching assistants easier.

Technically speaking, xLx is a Web based application and implemented in typical three-tier client-server architecture. To access xLx only a standard Web browser is needed; special plug-ins or additional client-side applications such as Java Runtime Environment (JRE) or Flash™ are not required. The xLx platform is implemented on top of an Apache Web server and a mySQL database running on a Linux platform, i.e., the entire xLx system is based on open source software. The mySQL database contains student data, exercises and solutions. Communication between clients and the xLx platform is secured by SSL (HTTPS), which provides basic security of confidential student data (passwords, solutions, and student's grades). All Web pages are generated dynamically by PHP4 scripts (ordinary pages) and Java Servlets (database connections via JDBC). The database server IBM DB2 Universal Database is used for database related exercises (SQL: 1999, object-relational features, DB2 extenders). Thanks to the IBM DB2 scholar's program, there are no costs involved in using DB2 at universities. Finally, PHP is used for calls to the XQuery and XSLT command-line processors.

3. Programming exercises and assessments in xLx

Since xLx is mainly used in technically oriented computer science courses at university, one very specific type of exercise was so far missing to support the all base courses in an efficient way: xLx was not able to handle programming exercises; we will now explain how we have remedied this situation.

An analysis of this very specific type of exercise has come to the conclusion that only certain aspects of the solutions are relevant for grading. This is on the one hand the question whether the submitted solution fulfills the specifications stated in the exercise and on the other hand the way how certain problems have been solved (e.g., implementation of a specific sorting algorithm that is required in the exercise). Other aspects such as naming of internal variables, methods or classes are (usually) not relevant for grading, but prevent an automated code review based on a comparative approach. Our approach to the verification of programming exercise solutions is based on methods and techniques well known from the field of software testing. Software testing has become quite a large field of knowledge in recent years and many different techniques and methods exist. Owing to the fact that (automated) software testing represents an important aspect in the quality assurance process of commercial software development, our approach adopts these techniques and methods to the context of e-learning.

Two main types of software tests can be distinguished (apart from many other possible classifications that exist). On the one hand, static tests analyse or probe a test object (in the e-learning case this is the submitted solution) without executing it. A syntax-check of source code is an example for a static testing technique. In addition, all kinds of reviews such as technical
walkthroughs or even informal reviews can be classified as static tests. On the other hand, tests of functionality are known as dynamic tests. The first step in a dynamic test is to specify test cases that invoke a certain reaction or output on the test object. In addition, the expected outcome of the tests needs to be defined in advance. Comparing the expected behaviour with the actual behaviour builds the foundation to classify a test as failed or passed.

![Integrative approach of the xLx-java-testing-module.](image)

The new exercise type currently only supports Java programming exercises. This decision was made since Java is widely used both in educational and business contexts. In addition, sophisticated build tools such as Apache ANT and test tools such as JUnit (Massol 2003, Hatcher 2002) are available for Java. As Apache ANT and JUnit have already proved to work well in the testing framework on which xLx relies, they have been integrated into the platform. The enhanced architecture of the xLx system is shown in Figure 1. The basic xLx system uses a HTTP based upload mechanism to store the solutions of the learners in the file system of the server. The calls of the underlying test mechanisms are done by the PHP command-line functionality and are described next.

For pre-correction of programming exercises xLx uses both static and dynamic tests. Like for each exercise type supported by xLx the platform provides a framework to create, solve, grade, annotate and view the results of exercises. For the programming exercise type the user interface is quite simple, as the solution is developed on the student’s machine by using an IDE (Integrated Development Environment) or editor program of his or her choice. xLx only has to provide a simple browser-based upload functionality in order to submit the file(s) of a learner’s solution to the xLx server. After a learner has submitted a solution, the first step of the automatic correction facility is a static test by compiling the source code of the learner. This is done by xLx on the server. The compilation results are stored as an XML file that is later parsed by PHP to get the results back into the xLx system. It represents the static test results since only a syntactically correct Java file can be compiled. If the compilation fails (e.g., due to syntax errors or due to irresolvable dependencies to other java classes) the dynamic testing step is not executed and an error message is presented to the learner who has tried to submit the exercise. If the compilation was successful, the dynamic test cases are applied next.

JUnit is used as testing framework that executes the test cases and collects the results. Special JUnit test cases are defined in Java (see Listing 1) for every exercise. To better handle the compilation and test process, Apache ANT is used to both compile the submitted solutions, i.e., the Java files, and execute the JUnit test cases on these solutions. JUnit and Apache ANT can be integrated quite simple because of a so-called ANT Task (a plug-in for ANT) for JUnit that is already available. This enables a high flexibility that comparable approaches, which focus on a simple, command line-oriented, text-based input/output concept, cannot offer. In contrast to the new xLx module these command line-oriented systems cannot use, for example, the Java Reflection API in test cases to allow a very detailed way of analysing the submitted solutions. Other testing frameworks such as DejaGNU do not offer a wide range of functionalities that can be used so easily because typically those frameworks use a very restricted and proprietary scripting language to specify test cases. Since Java is a full-fledged programming language there are actually no limits for the creativity of test case designers.

The test case shown in Listing 1 sketches the basic design of a JUnit test class. One or more methods beginning with the keyword “test” indicate the test methods that will be executed by the framework. After setting up the required

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objects for the actual test (this setup is called fixture in the JUnit terminology), the specific tests are defined by using so-called assertions that are fully maintained by JUnit. An assertion compares a specified result value with its expected outcome. A textual description of the assertion can be added optionally. JUnit monitors the results of the executed assertions automatically. Finally, a test protocol is being created as a result.

```java
import junit.framework.*;
public class TestMyTest extends TestCase {
    // Constructor to provide the class name
    public TestMyTest(String name) {
        super(name);
    }
    // actual test case
    public void testSampleTestmethod() {
        // Test fixture
        MyDate aMyDate = new MyDate();
        aMyDate.setJahr(2010);
        // Assertions
        Assert.assertEquals("Testing getter and setter methods for year", 2010, aMyDate.getJahr());
        // ...
    }
}
```

Listing 1: A basic test case.

The information that a test case has passed or has failed is, in contrast to the compilation results, not necessarily presented to the learner. This decision depends on whether the test case has been declared as public or hidden by the tutor. For a public test case, the result of the test is presented to the student. These test cases are not used for grading and therefore no credits can be achieved for public test cases. So the basic idea of public test cases is to define a certain level of quality and/or functionality that the submitted solutions will have to fulfill in order to be accepted by the system. Hidden test cases, on the other hand, are used for grading the submissions of learners. When designing a programming exercise in xLx, the tutor can define for every hidden test case the credit points that can be achieved if a particular test case is executed successfully. Figure 2 shows the xLx front-end to define programming exercises. In the upper portion of the screen a tutor can assign an exercise to an already existing section that comprises several exercises to be solved by learners. The level classifies the difficulty of the exercise, for which in this case a maximum of 10 points can be achieved. The type of the exercise is “Java” which points to a (Java language) programming exercise. The text of the exercise to be solved is defined in the middle portion of the screen and will be displayed to the learner. The lower portion of the screen (with screen texts still in German) defines the test cases (here: Test1MyDate.java, Test2MyDate.java, and MyDateTestHilfsmethoden.java) that will be executed on the solutions of the learners. The first test case is marked as essential for this exercise and is defined as a public one without any credits. The second one is a hidden test case for which the learners can earn up to 10 points. In the lower right part of the screen tutors can upload sample solutions that will also be displayed for a corrector of the exercise.

Figure 2: xLx GUI for a tutor to configure new exercises.
As mentioned before, test cases are specified using the JUnit test case class. All test cases that are stored in a separate class can be used for grading. If more than one test case is provided in a single class (a so-called test suite) the assigned credits for this suite can only be achieved if all tests inside the suite passed. This also gives the tutor a lot of flexibility when designing test cases and the associated grading scheme.

Clearly, test cases may fail for different reasons. One is that the expected outcome does not match the actual outcome of the submitted solution. This is the most typical reason why a test case fails and is just called “failure”. Another reason might be an unhandled exception during the execution of a test case. This could be the case when the test case calls a test object with values that are not allowed and that are not correctly rejected by the test object. To this end, xLx can also track exceptions. If a test case fails due to an exception this is called “error”. The test protocol does not only show the exact figure of passed and failed test cases; in case of an exception, detailed information is given about the latter and thus learners get a clue of what went wrong and tutors can get a better view inside the provided solution.

It should be obvious that an automated test can only provide limited feedback information to a student. To give learners more information on their solution, xLx also offers a possibility to review and annotate the source code of the provided solutions in a very comfortable way by a human tutor in addition to the automated features that do not require any interaction with the tutor. As shown in Figure 3, xLx displays all source files within the browser window and applies a special Java syntax-highlighting scheme to make the reading of the source code more comfortable. To annotate a certain line of code, the tutor simply writes notes into a special input box and xLx associates the comment with the source file and the specified line of code without changing it.

When a student takes a look on the corrected and graded solution, all initially submitted source files can be viewed within the browser window. Figure 3 pictures this screen that is comparable to the screen of the tutor. Every line that contains an annotation made by the tutor is marked with a special glyph that indicates the presence of a comment (see source code lines 9 and 10 in Figure 3). By clicking on the glyph the annotation made by the tutor is shown in the lower part of the window. The mixture of automated testing and grading in combination with a source code review done by a tutor provides a maximum learning experience for the student.

When developing the Java testing module for xLx, a major aspect has been security. Since unknown code provided by students is compiled and executed on the same server on which xLx itself is running on, there must be a guarantee that malicious code cannot affect the system. Since Java applications are not executed directly on the physical machine but inside a virtual machine (VM), there are some integrated security mechanisms in the Java VM that can be used to secure the system. The Java interpreter can be configured using so-called Java policies. Policies are simple text files that specify detailed rules describing which classes of learners’ solutions are
allowed to execute which functionalities on the system. This also includes a precise way to control IO access to the hard disk and to the network. Using a very restricted policy for the programming exercise module of xLx, we can ensure that even malicious code cannot harm the system if it gets executed.

4. Summary and conclusions

xLx has been used successfully for several years in different courses and in different universities (VAWi 2002). The spectrum of these courses covered databases, XML and computer networks. Each student had to solve an average of 40 exercises throughout a term. One of the main intentions of the xLx platform is the natural integration of third-party modules to allow hands on experience with real-world enterprise application systems. The newly integrated Java exercise type has so far been tested in small courses only. A “real world” course scenario with a many participants will be introduced soon, in order to verify its design goals such as reduction of work and time effort on correcting and grading programming exercises.

It will be interesting to observe server performance since it has to handle a load of hundreds of users executing Java applications on it in huge courses. The Java compiler has not been designed to be used in a multi-user environment, and it will be interesting to see how performance will scale. If problems concerning system performance and stability should arise, a modification will have to be applied to the existing architecture: by implementing a ticket-based scheduler-driven compilation and testing process it will be possible to better balance the high load that is created by hundreds of submissions at the same time. Though students won’t get an instant feedback any more after submitting their exercises since they will have to wait for the compilation/testing job to be completed, this should not be such a big problem because the time between submitting a solution and getting a feedback from the system should only take same seconds.

For courses done in the last couple of years we have recognized a high acceptance of the system and particularly of the test section. There has been a frequent usage of the attached third-party systems; for example, more than 100 students of a database course generated a total of 50,000 SQL statements against the underlying DB2 database. Students have also accessed the xLx platform from all over the world and all around the clock. Some of them, who stayed abroad, for example in Finland and Australia, have used the system to work on the exercises to manage their examination after their return.

xLx can be found on the Web at https://dbms.uni-muenster.de/xLx. Its front end is entirely designed in English so that even foreign learners can use it. A demo access can also be obtained over the Web.

References

ICT and Schools: Identification of Factors Influencing the use of new Media in Vocational Training Schools

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Abstract: In this paper, we analysed teachers’ characteristics described in the literature on classroom media use to identify those factors, which can explain teachers’ use of new media in classrooms with some degree of validity. Using this literature as a basis, in this paper we develop a theoretical model which describes both positive and negative factors, which influence teachers’ use of new media in classrooms. These factors include: “constructivist teaching style”, “willingness to cooperate”, “openness to change”, “lack of ICT-competence”, “lack of time” and “lack of ICT confidence”. We assessed the validity of the model by testing it using data collected from a survey of fifty-two Swiss and Austrian teachers. We carried out Pearson correlations to evaluate whether the factors in the model had a positive or a negative influence on teachers’ classroom media use. The hypothesized correlations between our variables were all statistically significant. Specifically, all six variables were significantly correlated with the dependent variable “use of new media in classrooms”. This result supported our hypothesis concerning positive and negative relationships between variables. In a second, exploratory investigation, we performed OLS regression analysis to investigate, which of the factors in our model are of predictive value with respect to the dependent variable “use of new media in classrooms”. Our findings show that the variable “constructivist teaching style” was of particular explanatory value. This suggests that only teachers who adopt a pupil-oriented, constructivist teaching style are likely to make use of new technology in classrooms. The variable “lack of available time” was identified as a second important factor influencing the “use of new media in classrooms”. This suggests that teachers are not able to make full use of new media when they lack the time needed to prepare teaching material using the new media, since time is also needed for teachers to learn new hardware and software computer skills. The results of this study have a series of important, practical implications.

Keywords: Media use, Classroom, and teachers’ characteristics, Predicting factors

1. Introduction

Over the last couple of years, researchers have made great efforts to analyse the use of new media in schools. As part of this line of research, several aspects of classroom media use have been investigated, including, for instance: the identification of obstacles to the integration of information and communication technology (ICT) in education, the use of laptops and internet in classrooms, the impact of ICT on the teachers, etc. (Ehmke et al., 2004, Schaumburg, 2002, Smeets et al., 1999). Another focus of attention has been the identification of factors that determine the successful and sustainable use of new media in schools, as well as the derivation and implementation of long-term measures. Thus far, three types of relevant factors have been identified: the technical equipment available in schools, the general conditions of the school organization, and the characteristics of teachers.

Regarding technical equipment, obstacles for the integration of new technologies in the classroom can occur, because of schools’ insufficient availability of said equipment (Pelgrum, 2001), the location of devices (Becker, 2000), and insufficient access to computer laboratories (Schaumburg, 2002).

Conditions related to school organization comprise aspects such as the cooperative culture of the school (i.e., formal and informal exchange of information between teachers and sections), and the compatibility of innovation with current curricula. Further, the school principal acting as a promoter for the use on new media plays an important role, as do offers for vocational teachers’ training (Schaumburg, 2002, Scholl and Prasse, 2000).

Finally, the teachers’ characteristics play an important role. According to a Becta study (Becta, 2004) study, which reviewed the research literature on barriers to the uptake of ICT by teachers, a number of teacher-level barriers have been identified:

- lack of time — for both formal training and self-directed exploration (Fabry & Higgs 1997), and for preparing ICT resources for lessons (Preston et al. 2000);
- lack of self-confidence in using ICT (Pelgrum 2001);
- negative experiences with ICT in the past (Snoeyink & Ertmer 2001);
- fear of embarrassment in front of pupils and colleagues, loss of status and an effective degrading of professional skills (Russell and Bradley, 1997);

Reference this paper as:
classroom management difficulties when using ICT, especially where pupil-to-computer ratios are poor (Cox et al. 1999);
- lack of the knowledge necessary to enable teachers to resolve technical problems when they occur (Vanfossen, 1999);
- lack of personal change management skills (Cox et al. 1999);
- perception that technology does not enhance learning (Preston et al., 2000, Yuen and Ma, 2002);
- lack of motivation to change long-standing pedagogical practices (Snoeyink & Ertmer 2001); perception of computers as complicated and difficult to use (Cox et al. 1999).

Additional factors not mentioned in the BECTA study, and reported elsewhere in the literature as well, are: teaching style (constructivist vs. traditional teaching); teacher roles, willingness to cooperate with others (Schaumburg, 2002, Smeets et al., 1999, Ehmke et al., 2004).

In this paper we report on the findings of a study, which was carried out as part of the Lab@Future project funded by the European commission. The study analysed a number of teachers' characteristics (derived from the literature on classroom media use) with the aim to identify factors those factors, which can explain the use of new media in classrooms with some degree of validity. Using the literature as a basis, we constructed an explanatory model of factors influencing classroom media use. We assessed its validity by testing it using data collected from a survey of fifty-two Swiss and Austrian teachers.

As already mentioned earlier, prior research pinpointing key factors influencing classroom media use can be summarized by categorizing these factors into three domains: technological factors, teacher characteristics and school characteristics. As part or the literature review, we selected empirical studies for further analysis as illustrated in Table 1. For each study we specified the focus, identifying the core questions it addresses. The goal has been to facilitate differentiating between studies analysing implementation processes, and studies investigating the usage of ICT or other aspects. In parallel, the technology under investigation was identified – some studies used a somewhat narrow understanding of ICT, for example they exclusively analysed laptop- or internet-use in schools.

Table 1: Overview of literature review

<table>
<thead>
<tr>
<th>Authors</th>
<th>Focus of study</th>
<th>Technology under investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implementation of new media in schools</td>
<td>Use of new media in classrooms</td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td>Teachers</td>
</tr>
<tr>
<td>Becker (2000)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Chen &amp; Looi (1999)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ehmke et al. (2004)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pelgrum (2001)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Schaumburg (2002)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Scholl &amp; Prasse (2001)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Smeets et al. (1999)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Veen (1993)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Venezky &amp; Davis (2000)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
2. Teachers’ characteristics

Several authors (Ehmke et al., 2004, Cuban et al., 2001) have pointed out that cooperation and communication between teachers, such as the exchange of ICT experience and mutual encouragement to use new media, has a positive effect on the willingness to utilize new media in the classroom.

Another variable, which influences classroom use of new media positively is teaching style (Veen, 1993, Schaumburg, 2002). For instance, Becker (2000) found that “Computer-using teachers (...) are distinctively more constructivists than non-computer-using teachers (p. 12)”. Constructivism claims that skills and knowledge cannot be directly transmitted from teacher to students. The theory suggests getting students to articulate their understanding, and defending them against contrary points of view, claiming that understanding comes from individuals expending effort to integrate newly communicated claims and ideas with their own prior beliefs and understanding. Veen (1993) further states that using computers should fit into existing skills of teachers and should not demand for too much effort to change. The literature on factors which impact the use of new media in classrooms positively has identified the teachers’ openness to change as a key issue (Mumtaz, 2000, Fabry and Higgs, 1997, Snoeyink and Ertmer, 2001, Dawes, 1999).

In addition to variables which have a positive influence on classroom media use, a number of variables have been identified, which have a negative influence.

<table>
<thead>
<tr>
<th>Positive influencing factors</th>
<th>Negative influencing factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openness to change</td>
<td>Lack of time</td>
</tr>
<tr>
<td>Willingness to cooperate</td>
<td>Lack of ICT-confidence</td>
</tr>
<tr>
<td>Constructivist teaching style</td>
<td>Lack of ICT-competence</td>
</tr>
</tbody>
</table>
In order to test this model we hypothesize:

- Hypothesis 1: “Openess to change”, “Willingness to cooperate” and “Constructivist teaching style” will correlate significantly and positively with “Use of new media in classrooms”.
- Hypothesis 2: “Lack of time”, “Lack of ICT-confidence” and “Lack of ICT-competence” will have a negative impact on the degree of “Use of new media in classrooms”.

Furthermore we performed an exploratory investigation:
- Which variables appropriately explain the dependent variable “Use of new media in classrooms”?

3. Method

3.1 Design and participants

We contacted and informed principals from vocational training schools in Switzerland and Austria about this study and asked them to motivate teachers to participate. Although school principals were cooperative, it turned out to be very difficult to motivate teachers to participate. An online questionnaire was available between March and May 2005. Fifty-two teachers (5 women and 47 men) from four schools in Austria and seven vocational training schools in Switzerland responded to the questionnaire. The average age of the teachers was 48 years (SD=7.01) ranging from 36 years to 62 years. They taught in their current schools for about 14 years (SD=8.79). Teachers used the computers privately as well as in their vocational setting on average for more than 16 years (SD=5.59). Teachers rated their computer experience on a scale ranging from 1=no experience to 100=very good experience. Teachers’ computer experience was estimated slightly above average, with M=64.53 (minimum experience=10, maximum experience=90, SD=21.17).

3.2 Instrument

We developed an online questionnaire which comprised 31 closed and open-ended questions. Besides the demographic data, seven variables were operationalised for the current study, based on the model of teachers’ characteristics described earlier. Teachers rated each of these questionnaire items on a four-point Likert-scale. The other variables of the questionnaire were used to collect data for a descriptive analysis of the current use of new media in classrooms. In the following section, the variables are described in more detail. Wherever possible we used already existing items from previous studies examining classroom media use.

Dependent scale - “Use of new media in classrooms”: This scale determined the actual use of different new media teaching in classrooms, such as simulations, computer games, office and Internet programs etc. This scale was adapted from Stein (2002) (12 items, for each scale we calculated Cronbach’s α; (.81), values ranged from 0=never used to 3=very often used).

The independent, scale “Constructivist teaching style” analysed the extent to which teachers used a pupil-oriented, constructivist teaching style. According to the findings in the literature (Becker, 2000, Veen, 1993), teachers following a more constructivist teaching style were more likely to use ICT in the classroom. Teachers indicated to which extend they used different teaching and learning techniques in their classroom, such as ex-cathedra teaching, pupil-oriented teaching, group work, problem-oriented teaching, etc. (11 items adapted from interim report of Mandl et al., (2003), Cronbach’s α=.81, values ranged from 1=no pupil-oriented, constructivist teaching style to 4=pupil-oriented, constructivist teaching style).

The scale “Willingness to cooperate” measured cooperative behaviour that teachers exhibited in everyday school life, such as exchanging teaching material and discussing teaching goals and problems (3 items adapted from Ehmke et al., 2004, Cronbach’s α=.72, values ranged from 1=no willingness to cooperate to 4=high willingness to cooperate).

The scale “Openness to change” addressed the willingness of teachers to change their teaching practices. Items of this scale included statements like “My role as a teacher makes it necessary to support the use of new media in classrooms” (5 items adapted from Ehmke et al., 2004, Cronbach’s α=.83, values ranged from 1=no openness to change to 4=high openness to change).

Rating the scale “Lack of time” teachers indicated how much time they had available to prepare and research (multimedia) materials for lessons to make full use of ICT. Items included statements like time spent after the lessons for preparation and wrapping up teaching material, etc. (7 items adapted from Ehmke et al., 2004, Cronbach’s α=.71, values ranged from 1=time available to 4=lack of time).
The scale “Lack of ICT-confidence” measured the extent to which teachers considered themselves well skilled in using ICT. Statements like “When problems occur while using ICT, I am confident to solve these problems” were included into this scale (9 items adapted from Ehmke et al., 2004, Cronbach’s $\alpha=.83$, values ranged from 1=ICT-confidence to 4=lack of ICT-confidence).

To attain a high level of competence in ICT teachers need to be provided with effective training. Items of the scale “Lack of ICT-competence” addressed aspects like keeping pedagogical and didactical standards of knowledge up to date, regularly participating in trainings, etc. (13 items adapted from Ehmke et al., 2004, Cronbach’s $\alpha=.71$, values ranged from 1=ICT-competence to 4=lack of ICT-competence).

In addition to the scales based on the teacher characteristics’ model described above, we collected information on the kind of media teachers actually used in the classroom. Therefore, we also asked teachers to indicate how often they used traditional media like chalkboard, schoolbooks, worksheets, slides, etc. (7 items, Cronbach’s $\alpha=.60$, values ranged from 0=never used to 3=very often used).

4. Results

4.1 Use of media in the classroom

The results of our study concerning the use of traditional as well as new media in the classroom showed that vocational training teachers mainly used traditional media in the classroom. They mostly used worksheets ($M=2.55$, $SD=.58$) and slides ($M=2.08$, $SD=.79$) and often chalkboards and schoolbooks. Use of workbooks and videos was seldom. The teachers did not use audiotapes during their lessons (see Figure 2).

**Figure 2**: Average use of traditional media in classrooms (0=never, 3=very often)

Compared to the use of traditional media, teachers appeared to make rather restricted use of new media (see Figure 3). No use was made of: chat, web logs and audio- / video-conferencing tools. Computer games, training programmes, programming tools and newsgroups were seldom used (all means<1). Sometimes teachers used simulations ($M=0.90$, $SD=.84$), referencing tools ($M=1.09$, $SD=.74$) and email ($M=0.82$, $SD=.85$) during their lessons. Office software ($M=1.23$, $SD=.92$) and internet browsers ($M=1.25$, $SD=.90$) were used more often.

**Figure 3**: Average use of new media in classrooms (0=never, 3=very often)
When comparing these usage patterns with the teachers’ private use of computers, it turned out that they used particular computer programmes far more often on a private basis. Specifically, they used office software (M=2.54, SD=.70), internet browsers (M=2.58, SD=.83) and email (M=2.50, SD=.83) on a daily base (0=no use, 3=daily use).

### 4.2 Variables influencing the use of new media in classrooms

Pearson’s correlations were calculated to analyse relationships between variables. The results presented in Table 2 confirmed our hypothesis. All independent variables show statistically significant correlations with the dependent variable “Use of new media in classroom”. Further, our assumptions about positive and negative influence of the independent variables on the variable “Use of new media in classrooms” were also been confirmed. The variables, “Constructivist teaching style”, “Willingness to cooperate” and “Openness to change” all have positive correlation coefficients, whereas the variables “Lack of ICT-Competence”, “Lack of time”, and “Lack of ICT confidence” show negative correlation coefficients.

#### Table 2: Correlation between variables (** Correlation is significant at the 0.01 level, 2-tailed; * Correlation is significant at the 0.05 level, 2-tailed)

<table>
<thead>
<tr>
<th></th>
<th>Use of new media</th>
<th>Constr.</th>
<th>Will. to coop.</th>
<th>Open. to change</th>
<th>Lack of ICT-comp.</th>
<th>Lack of time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of new media in classrooms</td>
<td>Pears. Cor.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructivist teaching style</td>
<td>Pears. Cor.</td>
<td>.522(**)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>52</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to cooperate</td>
<td>Pears. Cor.</td>
<td>.362(**)</td>
<td>.146</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness to change</td>
<td>Pears. Cor.</td>
<td>.620(**)</td>
<td>.256</td>
<td>.281(*)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Lack of ICT-competence</td>
<td>Pears. Cor.</td>
<td>-.588(**)</td>
<td>-.345(*)</td>
<td>-.190</td>
<td>-.634(**)</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>51</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Lack of time</td>
<td>Pears. Cor.</td>
<td>-.575(**)</td>
<td>-.234</td>
<td>-.342(*)</td>
<td>.588(**)</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Lack of ICT-confidence</td>
<td>Pears. Cor.</td>
<td>-.513(**)</td>
<td>-.196</td>
<td>-.342(*)</td>
<td>-.670(**)</td>
<td>.417(**)</td>
</tr>
<tr>
<td>N</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>51</td>
<td>.085</td>
</tr>
</tbody>
</table>

Second, we performed an exploratory investigation to identify variables explaining best the dependent variable “Use of new media in classrooms” using standard multiple regression test. Along with the dependent variable, the independent variables “Constructivist teaching style”, “Willingness to cooperate”, “Openness to change”, “Lack of ICT-competence”, “Lack of time”, and “Lack of ICT-confidence” were included into the analysis.

The coefficient of determination (adjusted $R^2$) for the model regression is .58, indicating that 58% of the variance in the dependent variable “Use of new media in classrooms” was explained by the independent variables. The multiple regression coefficient R for regression was significantly different from zero (R(a)=.79, $R^2$=.63), F(6, 43)=12.27, p<.001.

The variables “Constructivist teaching style” (p<.05) and “Lack of time” (p<.05) showed the best explanatory value. The variables “Openness to change” (p=.06) and “Lack of ICT-confidence” (p=.07) came very close to the 0.05 statistical significance level (see Table 3).
Table 3: Results of the standard multiple regression analysis ((a) DV: Use of new media in classrooms)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised coefficients</th>
<th>Standardised coefficients</th>
<th>T</th>
<th>One-tailed Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-1.90</td>
<td>.32</td>
<td>-5.86</td>
<td>.00</td>
</tr>
<tr>
<td>Constructivist teaching style</td>
<td>.20</td>
<td>.10</td>
<td>.22</td>
<td>2.00</td>
</tr>
<tr>
<td>Willingness to cooperate</td>
<td>.10</td>
<td>.08</td>
<td>.13</td>
<td>1.30</td>
</tr>
<tr>
<td>Openness to change</td>
<td>.15</td>
<td>.09</td>
<td>.23</td>
<td>1.57</td>
</tr>
<tr>
<td>Lack of ICT-Competence</td>
<td>-.09</td>
<td>.13</td>
<td>-.10</td>
<td>-1.72</td>
</tr>
<tr>
<td>Lack of time</td>
<td>-.17</td>
<td>.09</td>
<td>-.27</td>
<td>-1.99</td>
</tr>
<tr>
<td>Lack of ICT confidence</td>
<td>-.15</td>
<td>.09</td>
<td>-.20</td>
<td>-1.50</td>
</tr>
</tbody>
</table>

Conclusions

In this study we performed an online survey of teachers in Austria and Switzerland, collecting data about the use of traditional as well as new media in classrooms and in private settings. We developed and empirically tested a model, identifying teachers’ characteristics that have either positive or negative effects on the use of new media in the classroom.

Compared to traditional media, teachers appeared to make restricted use of new media in the classroom. Office software and internet browsers were the only applications used to some extent. Different usage behaviour was found for private use of new media. Teachers used office software, internet browsers and email on a daily base. These results lead to a reinterpretation of previous research findings (cf. (Becta, 2004) which highlighted the importance of teachers access to ICT at home. This access was assumed to allow them to utilize the technology in their work. In our study, teachers had personal access to ICT and used it, but were reluctant to use it in their work.

We carried out Pearson correlations to evaluate whether the factors in the model had a positive or a negative influence on teachers’ classroom media use. The hypothesized correlations between our variables were all statistically significant. Specifically, all six variables were significantly correlated with the dependent variable “use of new media in classrooms”. This result supported our hypothesis concerning positive and negative relationships between variables. Additionally to descriptive statistics (Smeets et al., 1999, Pelgrum, 2001) our study provided information concerning the strengths of interrelation between subjective attitudinal measures and behaviour – the actual use of new media. Further, our data confirmed relationships between the independent variables, which are in line with the findings of Ertmer (1999, cited from Becta, 2004).

In a second, exploratory investigation, we performed OLS regression analysis to investigate, which of the factors in our model are of predictive value with respect to the dependent variable “Use of new media in classrooms”. Our findings showed that the variable “constructivist teaching style” was of particular explanatory value. This suggests that teachers who adopt a pupil-oriented, constructivist teaching style are more likely to make use of new technology in classrooms. In his study Becker (2000) also concluded that: “Computer-using teachers […] are distinctly more constructivist than non-using teachers” (p. 12). On the basis of our finding, we suggest that it is not enough to train teachers in ICT-skills but combine this with pedagogical trainings, providing information about the use of new media in a constructivist way.

The variable “Lack of available time” was identified as a second important factor influencing the “Use of new media in classrooms”. According to Manternach-Wigans (1999) “Teachers are very concerned about the lack of time for technology. They say they need more time to learn computer basics, time to attend technology training sessions, time to figure out how to integrate technology in the classroom, and time in the classroom to use technology” (p.28). Similar results have been found in other studies (Fabry and Higgs, 1997, Preston et al., 2000). Snoeynik and Ertmer (2001, cited from Becta, 2004) suggest that non-contact time for teachers to undertake ICT training during school hours should be provided. Other measures might include: support for teachers to prepare and search (multimedia) materials for lessons, as well as to learn new hardware and software skills, for example providing access to and sharing of online resources. Further, novel employment and teaching policies, with time explicitly allocated to the preparation of materials in “new media form” in the teachers’ schedule could be provided. Dissemination of targeted software tools that...
facilitate the authoring / assembly process are necessary.

In synthesis, this study has shown that teachers actually use ICT to a large extent in private settings, but many are still reluctant to use technology in school. Appropriate support (technical as well as pedagogical) in schools should be provided to decrease this fear.

Acknowledgements

The work presented in this paper was carried out as part of the EC-funded project lab@future “School LABoratory anticipating FUTURE needs of European Youth”, IST-2001-34204, 7th IST CALL, 1.5.2002-30.4.2005. The participating organizations are: Systema Informatics S.A, Greece; Parallel Graphics, Ireland; University of Bremen, Germany; Centre National de la Recherche Scientifique, Laboratoire d'Analyse et d'Architecture des Systemes, France; Thales Communications; France; Vienna University of Technology - Institute of Software Technology and Interactive Systems, Austria; Center for Scientific Visualization, Slovenia; Center for Activity Theory and Developmental Work Research, University of Helsinki, Finland; Eidgenoessische Technische Hochschule Zuerich, Switzerland.

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Using an Online Games-Based Learning Approach to Teach Database Design Concepts

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Abstract: The study of database systems is typically core in undergraduate and postgraduate programmes related to computer science and information systems. However, one component of this curriculum that many learners have difficulty with is database analysis and design, an area that is critical to the development of modern information systems. This paper proposes a set of principles for the design of a games-based learning environment to help the learner develop the skills necessary to understand and perform database analysis and design effectively. The paper also presents some preliminary results on the use of this environment.

Keywords: Collaborative e-learning; innovative teaching and learning technologies for web-based education; e-pedagogy; design and development of online courseware.

1. Introduction

The database is now the underlying framework of the information system and has fundamentally changed the way many organizations and individuals work. This is reflected within tertiary education where databases form a core area of study in undergraduate and postgraduate programmes related to computer science and information systems, and typically at least an elective on other data-intensive programmes (ACM/IEEE, 2001; EUCIP, 2003). The core studies are commonly based on the relational data model, SQL (the de facto language for relational DBMSs), data modelling and relational database design. This curriculum supports industry needs where the relational DBMS is the dominant data-processing software currently in use, with estimated new licence sales of between US$6 billion and US$10 billion per year (Connolly and Begg, 2004).

With more than 30 years since Codd proposed the relational data model in his seminal paper, the core relational theory is a mature and established area in relation to other parts of the computing curriculum. However, one component of this curriculum that many learners have difficulty with is database analysis and design. For the purposes of this paper we use the term ‘database analysis and design’ to encompass requirements analysis, conceptual database design (including ER modelling), logical database design (including mapping to the relational model and validating the model using normalization) and physical database design (Connolly and Begg, 2004).

In this paper, we explore a range of teaching techniques that supplement traditional teaching methods with more non-traditional methods based on interactive visualization and computer games to help overcome these difficulties and help the learner develop the skills necessary to understand and perform database analysis and design effectively.

1.1 Problems with teaching database analysis and design

Mohtashami and Scher (2000) note that pedagogical strategies for teaching database analysis and design traditionally follow a similar modality to that of other technical programmes in computing science or information systems. A significant amount of technical knowledge must be imparted with the lecturer becoming a ‘sage on stage’ and the students passive listeners. While students tend to cope well with basic concepts and practical components of the curriculum, one area that many students find difficult is the abstract and complex domain of database analysis and design. A comparable problem has been identified with object-oriented analysis and design, which is also highly abstract (e.g. Yazici et al., 2001). This is borne out by a recent European survey that found that the primary skill that organizations considered to be lacking in both new IT graduate recruits and current IT staff was database design (database tuning and database administration were second and third, respectively) (Connolly and Laiho, 2004).

To undertake database analysis and design effectively for an even moderately complex system, a student requires (among others) the skills to:
- work in a project team and apply appropriate fact-finding techniques to elicit requirements from the client (both ‘soft’, people-oriented skills);
- conceptualise a design from a set of requirements (‘soft’, analytical skills);
- map a conceptual design to a logical/physical design (‘hard’, technical skills);
• reflect and review intermediate designs, particularly where information complexity is present (a combination of ‘soft’ and ‘hard’ skills).

Students often have considerable difficulty comprehending implementation-independent issues and analysing problems where there is no single, simple, well-known or correct solution. They have difficulty handling the ambiguity and vagueness that can arise during database analysis. Students can also display an inability to translate classroom examples to other domains with analogous scenarios, betraying a lack of analytical problem-solving skills. For the students these problems can lead to confusion, a lack of self-confidence and a lack of motivation to continue.

In this paper we explore the use of interactive visualization and computer games to provide a web-based collaborative learning environment to supplement traditional methods of teaching database analysis and design. We have chosen to examine such an environment for several reasons:

• The younger generation have grown up in a technologically sophisticated environment populated by home computers, the Internet, graphic-rich movies, multi-player Internet gaming, Nintendo GameBoys™, XBoxes™, DVD players, mobile phones, interactive television and iPods™, which has led to changes in their experiences, attitudes and expectations (e.g. Prensky, 2001; Kolb et al., 2001). This suggests that we should investigate and exploit those aspects of the technologies the modern learner has been exposed to, such as computer games, with a view to identifying those aspects that might be transferable in pedagogical terms, into teaching (Connolly et al., 2004).

• There is empirical evidence that games can be an effective tool for enhancing learning and understanding of complex subject matter (Ricci et al., 1996; Cordova and Lepper, 1996).

• Educationalists are interested in the intensity of involvement between instructional strategies, motivational processes and learning outcomes. It would be highly desirable to harness the appropriate properties of computer games that enhance learning and improve student performance.

This paper is structured into four further sections. The next section discusses the pedagogical basis for developing a problem-based learning environment based on visualization and computer games to teach database analysis and design, leading in the section thereafter to a set of principles for the design of the proposed learning environment. The penultimate section discusses the on-going design of this environment. The final section provides some concluding remarks and directions for future research.

2. Previous Research

In this section we examine previous research related to the use of computer games in education, covering motivation and flow; constructivism as a pedagogical approach to learning and the appropriateness of problem-based learning for our purposes.

2.1 Motivation

Motivation is a key concept in many theories of learning. Katzef (2000) stresses motivation is a critical factor for instructional design and for learning to occur the learner must be motivated to learn. Malone and Lepper (1987) present a theoretical framework of intrinsic motivation in the design of educational computer games. They postulate that intrinsic motivation is created by four individual factors: challenge, fantasy, curiosity and control and three interpersonal factors: cooperation, competition and recognition. Interestingly many of these factors also describe what makes a good game, irrespective of its educational qualities.

Prensky (2001) defines the key characteristics of (simulation) games as: rules, goals and objectives, outcomes and feedback, conflict (and/or competition, challenge, opposition), interaction, and representation of story. While intrinsic motivation is highly desirable, many of the activities in which learners engage in is directly influenced by extrinsic rather than intrinsic motivation (Csikszentmihalyi and Nakamura (1989). Unfortunately evidence suggests that extrinsic motivators may lead to merely short-range activity while actually reducing long-range interest in a topic while with intrinsic motivators learners tend to persist longer, work harder, actively apply strategies and retain key information more consistently. Thus, extrinsic motivators must be supported by intrinsic motivators, otherwise the result is likely to be a reduction in the very behaviour we want to promote. One of the most serious problems that research has pointed out during the past two decades is that extrinsic motivation when used alone is likely to have precisely the opposite impact that we want it to have on learner achievement (Lepper amd Hodell, 1989).

In determining what makes a particular situation or activity intrinsically motivating to an individual, the Csikszentmihalyi’s (1990) concept of flow is often mentioned. The conditions likely to induce the state of flow are challenge, control, performance criteria and feedback (Connolly et al., 2004).
2.2 Constructivism and learning environments

2.2.1 Constructivist and sociocultural theory

While traditional education was guided by the paradigm of didactic instruction there is now an emphasis on constructivism as a philosophical, epistemological and pedagogical approach. Constructivism focuses on knowledge construction, not knowledge reproduction (Collins, 1991). Vygotsky’s sociocultural theory of learning emphasises that human intelligence originates in our culture. Individual cognitive gain occurs first in interaction with other people and in the next phase within the individual (Forman and McPhail, 1993).

According to Gance (2002) the main pedagogical components commonly associated with these models are:
- A cognitively engaged learner who actively seeks to explore her environment for new information.
- A pedagogy that often includes a hands-on, dialogic interaction with the learning environment. For example, actually designing a database is preferred to simply being told how to design a database.
- A pedagogy that often requires a learning context that creates a problem-solving situation that is realistic.
- An environment that typically includes a social component often interpreted as interaction with other learners and with mentors in the context of learning.

2.2.2 Problem-based learning

Many researchers have expressed their hope that constructivism will lead to better educational software and better learning (e.g. Brown et al., 1989; Jonassen, 1994). They emphasise the need for open-ended exploratory authentic learning environments in which learners can develop personally meaningful and transferable knowledge and understanding. The problem-based learning (PBL) model encompasses the principles of constructivism. With PBL the teacher (facilitator) is available for consultation and plays a significant role in modelling the metacognitive thinking associated with the problem-solving process. This reflects a cognitive apprenticeship environment (Collins et al., 1990) with coaching and scaffolding (e.g. offering hints, reminders and feedback) provided to support the learner in developing metacognitive skills. As these skills develop, the scaffolding is gradually removed. The intention is to force learners to assume as much of the task on their own, as soon as possible. The cognitive apprenticeship model also advocates:
- **modelling**, which involves an expert (the teacher) performing a task so that the learner can observe and build a conceptual model of the processes required to accomplish it;
- **articulation** (either verbal as mentioned above or written);
- **reflection**, to enable learners “to compare their own problem-solving processes with those of an expert, another learner, and ultimately, an internal cognitive model of expertise” (Collins et al., 1990);
- **exploration**, to push learners into a mode of problem-solving on their own.

Savery and Duffy (1995) comment that PBL should stimulate, and therefore engage the learner in, the problem-solving behaviour that the practicing professional would employ. The PBL approach is now used across a range of subject disciplines.

A similar concept to articulation that has been cited as an important element of simulation games is **debriefing** (Lederman and Kato, 1995). Games and simulations differ in that simulations include elements of the real world whereas games are “separate from the real world”. Debriefing is an essential element of any simulation game because it links what has been experienced during the simulation with learning. Debriefing provides the opportunity for learners to consolidate their experience and assess the value of the knowledge they have obtained in terms of its theoretical and practical application to situations that exist in reality.

3. Guiding Principles For The Online Games-Based Learning Environment

We illustrate the influences for the online games-based collaborative learning environment that we are developing to teach database analysis and design based on the above research in Figure 1, depicting the relationships between the game, the teacher, learners and the environment. In addition, we put forward our own principles for the learning environment as follows:
1. Start with an authentic problem grounded in professional practice. This problem should be both realistic and sufficiently complex to develop analytical and problem-solving skills.
2. Encourage learners to take responsibility (ownership) for learning and to be aware of the knowledge construction process.
3. Allow learners to develop their own process to reach a solution.
4. Provide learners with the opportunity to experience and appreciate other perspectives (this may come about as part of the next principle).

5. Provide opportunities for interaction and collaboration, either learner-learner, learner-teacher or learner-system.

6. Ensure that the learning environment motivates, engages and challenges the learner.

7. Provide feedback mechanisms to enable learners to be fully aware of their progress.

8. Provide support mechanisms for learners using coaching and scaffolding.

9. Be flexible to support different learning styles.


11. Provide an integrated assessment.

While many examples of collaborative learning are in the more traditional face-to-face mode, there is evidence that supports the view that collaboration that is many-to-many, time and place independent, and distributed can have its advantages (e.g. Warschauer, 1997). As we discuss shortly, early results from a prototype of the learning environment that we have developed are encouraging and show enhanced performance across the student cohorts.

4. Designing the learning environment

Video case studies have been used for several years within computing-related undergraduate and postgraduate modules in the School of Computing at the University of Paisley. The videos were developed by the School to provide students with real-world organizational problem scenarios such as organizational change within a library, a marina and a veterinary practice through which they could develop and apply a range of different skills and concepts. Although the use of the videos was found to be engaging, their main drawback was that students could not interact with the characters and scenarios presented to them, they could only view them in a sequential, linear and passive fashion. In addition, for several years the School has been developing online learning materials for various undergraduate and postgraduate modules/programmes as well as interactive visualizations that enhance these materials. In particular, material has been developed for the undergraduate ‘Introduction to Database Systems’ and the postgraduate ‘Fundamentals of Database Systems’ modules.

To develop the students’ learning experience further in these two modules, it was decided to develop an educational simulation game around the video case studies and use the interactive visualizations and online learning materials as a form of digital scaffolding in an attempt to increase student interactivity and engagement with the problem scenarios being presented. For example, students would be able to interact with the characters by asking different types of preset questions, which would influence the outcome of the problem situation. The simulation game provides the opportunity for students to learn and apply a range of relevant skills and techniques relating to data-
base analysis and design within a more interactive, engaging and stimulating environment more akin to the real-world setting that students may find themselves in industry.

The simulation game is part of a wider learning environment as shown in Figure 2. The following three main components form the learning environment:

- The online learning units/topics (entry level 1) introduce the concepts to be explored; these units are structured in a hierarchical manner allowing students to ‘drill down’ to obtain further details. Topics are hyperlinked to allow non-sequential browsing.
- The visualizations (entry level 2) enhance learning by providing animated walkthroughs of specific examples (e.g. construction of an ER diagram or the process of normalization).
- The simulation game (entry level 3) provides a real-world simulated environment within which to apply skills and techniques.

The simulation game is part of a natural evolution of the learning environment in which all three elements work together. This means that students working through the simulation game can pause at appropriate points and ‘drill down’ via the Digital Assistant to the interactive visualizations or to individual topics.

5. Preliminary results

At present, levels 1 and 2 of the environment have been developed and initial findings are positive. We have three cohorts of students taking the Fundamentals of Database Systems module: a full-time face-to-face cohort consisting of 920 students, a part-time face-to-face cohort consisting of 177 students and a fully online part-time cohort (no face-to-face contact) consisting of 14 students. Using the experimental design criteria identified by Joy and Garcia (2000), the prior knowledge and ability of the students in the three cohorts were similar, the instructor effects were minimal and the time on task was the same for each cohort. In the interests of impartiality, exams were blind marked and because of large class sizes, courseworks were marked by a number of staff with no prior knowledge of the students. Only the online students were given access to the games-based learning environment. To determine whether there was any observable difference between the three cohorts, we used the University’s grading system. Figure 3 shows the module percentage by mode of attendance. A Chi-squared test using the crosstab frequencies was performed. This test can be seen in one of two ways: it is either a test for independence between mode of attendance and grade or that each mode of attendance gives the same profile across grades. In Figure 3 the percentage in each grade is shown with the corresponding result for the test. It is noted that a highly significant result is detected.

6. Summary and future directions

This paper has discussed some of the pedagogical issues underpinning the development of a constructivist learning environment using problem-based learning and a simulation game and inter-
active visualizations to help teach database analysis and design.

Future work will include completion of the development of level 3 of this environment and evaluation of the appropriateness of this environment for different groups of students (undergraduate and postgraduate, full-time and part-time). The evaluation will include both quantitative and qualitative measures to examine the effectiveness of the environment, looking not just at any perceived grade improvements but also at any perceived levels of improved satisfaction from student and instructor perspectives (Joy and Garcia, 2000; Hiltz et al., 2000). The current aim is for the game to maintain a journal of student interaction that will aid this evaluation and provide a source of information for further reflection. Additional work will be necessary to consider the applicability of this environment to online students, particularly the collaboration element of the activities.

Acknowledgements

The authors would like to thank the following people from the University of Paisley for their contributions in discussing ideas relating to this paper - Evelyn McLellan (School of Computing), Judith Ramsay (School of Social Science) and Ewan MacArthur (School of Engineering and Science), as well as John Sutherland (Moray House School of Education) Edinburgh University.

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