EFFECTS OF TEACHING ENVIRONMENTS AND THE DIGITAL MEDIA: THE CASE OF A PARAMETRIC DESIGN SYSTEMS COURSE

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ABSTRACT: The information and communication technologies (ICT) and the digital media have created excellent conditions for changing the learning, training and teaching environments. New modes of teaching in higher education subjects can enhance ones ability to proactively constructing his or her personal learning universe. These developments have contributed to distant learning becoming widely available and accessible. In this regard the idea of lifelong learning has started to pave its way towards the knowledge driven society of the future. This paper identifies and evaluates issues relevant to the emerging eLearning paradigm. These observations are based on an ongoing experiment on effects of such environments. The goal is to discuss the widely perceived scope provided by these technology-based learning environments for increased pedagogical opportunities in order to enhance student learning, institutional objectives for growth in the face of intensified competition in the higher education sector and the expansion of mass education throughout the world. This paper reports some experiments that are carried out in the framework of the undergraduate and postgraduate elective course of Parametric Design Systems at Delft University of Technology.

KEYWORDS: elearning, distant learning, life-long learning, digital media.

1 INTRODUCTION

Web based learning, Wireless technology and the digital media have created profound effects on the learning, training and teaching environments at all levels of education and training. These have exerted significant influence on modes of teaching higher education subjects. These environments are modelled to enhance ones ability to proactively constructing his or her personal learning universe. According to the Pedagogical Praxis these technology-based learning environments are used in both educational settings and professional practices to develop a deeper understanding of particular domains. The issue of eLearning is to this end increasingly influencing university education and training at the workplace. These virtual leaning environments involve the production, deployment, exchange and brokerage of learning resources (method and content) as well as their usage for professional training and university education. In this regard eLearning provides a technology-enhanced knowledge transfer via a large-scale service-oriented learning infrastructure. Here the term knowledge denotes any kind of instructional resources used by the learner to achieve knowledge or skills (Beheshti & McKechnie; 2005, Zreik, 2000; Beheshti & Dado, 2005; Bruner, 1966, 1988;).

This paper identifies and evaluates issues relevant to the emerging eLearning paradigm based on an ongoing experiment on effects of such environments and in the light of changing cultural tends, social behaviours, learning habits and teaching modes of all societies. The goal is to discuss the widely perceived scope provided by these technology-based learning environments for increased pedagogical opportunities in order to enhance student learning, institutional objectives for growth in the face of intensified competition in the higher education sector and the expansion of mass education throughout the world. In addition, results of Bales' Pyramid of learning have been considered, showing diminishing productivity of traditional systems (Bales, 2001). The combination of all these issues has led to the rapid adoption of eLearning technologies into the learning and training processes. This has been transforming the learning environment, internationally and is predicated upon expectations of the communications' capability, declining costs and continuous improvements in ease of use of these technologies. The potential for greater interactivity, flexibility, more functionality and lower delivery costs are powerful drivers and have put eLearning on top of the educational agenda in institutions around the world (McKechnie, 2005; Collins et al, 2006; Delhoofsen, 1991, 1996; Bartlett-Bragg, 2005; Forbes, 2005; Laurillard, 1993). They highlight the impact of a decade of profound changes in education across the world and the proliferation of the complexity and strengths of forces acting upon us. As a result educational environments are altered and adapted. The features of these new and emerging landscapes of our universities are changing with new and emerging technologies (Savery & Duffy, 1995; Negraponte, 1995).

2 LEARNING AND TEACHING ENVIRONMENTS

Preparation of multimedia learning resources requires selecting the most appropriate media for any task and makes a reasonably detailed analysis of the strengths and weakness of the chosen media (Collins et al, 2006). In this regard the purpose of selecting and using a digital learning environment is not necessarily making an exact translation of the course materials into the format of the chosen media. "The implementation of new technology methods cannot take place without the system around it adjusting to the intrusion of the new media. To preserve what is good traditionally and also preserving its mission to develop knowledge and educate others, the higher education system needs a more robustly adaptive mechanism (Laurillard, 1993; Scott & Bradley, 2005). Making use of the new media is taking up the challenge of the technology in the interest of education with the desire to widen access to education and promote lifelong learning (Ingraham, 2001; Prochaska, 1992; Rosenberg, 2001).

Lecturing is a long standing tradition for transferring knowledge to university students. For some time the efficiency of this method has been questioned. For instance a closer look at the Learning Pyramid of Bales (Figure 1) indicates the average retention of knowledge with respect to several methods of transferring knowledge and learning modes (Bales, 1996). His research has revealed that the traditional lecture as mode of teaching provides the least retention of knowledge. This is a rather passive way of learning and in particular with decreasing usefulness with the increasing of number of attending students where the opportunity for dialogue makes place for monologues. This has always been compensated by stimulating students to learn by reading (learning by self study), audio/visual/live demonstrations (learning using senses), discussions (learning by dialogue) and exercises (learning by doing).

Method of education	Average retention
Traditional lectures	5 %
Reading	10 %
Audio-visual	20 %
Demonstration	30 %
Discussion group	50 %
Practical applications / exercise	75 %
Self teaching	80 %

Figure 1. The Learning Pyramid of Bales (after Bales National Training Laboratories, Bethel, Maine, USA, 1992).

The potentials of digital media can be exploited for creating effective learning environments that are capable of responding to new cultural and social developments as well as being able to facilitate all modes of learning. Nevertheless the most important and crucial element remains to be the commitment and motivation of students. This is an essential factor in increasing effective learning. This also means that the learning environment needs to be flexible and inviting. It needs to take into account conditions and possibilities of individual students. Arguably a range of personal modes and moments of learning can be defined that are suitable for different types of passive or active learning. This environment introduces a greater degree of self learning. Digital media (and eLearning facilities) will be used as an enabler for creating the personal freedom for a student who will be able to study at the most convenient time and using the most appropriate personal mode of learning. The role of the lecturer is influencing the exploitation of this freedom by offering different modes of knowledge transfer and learning modes. In other words this is a well thought of process that is offered to students counting on their motivation and commitment. In an eLearning framework the learning process may be either a solitary individual activity or a collaborative group activity where both synchronous and asynchronous communication can take place or a combination of these (Smit et al, 2006; Wall et al, 2006; Veerman et al, 1995; van der Drift & Vos, 1987). Knowledge driven societies will profoundly revolutionaries the concept of learning and teaching. Lifelong learning will inevitably dominate the future of human educational systems.

Teaching and learning in isolation in order to memorize for the examination should become obsolete because they only reinforce short-term knowledge. Knowledge acquisition and application of the knowledge need to take place and repeated at the same time and in different variations (VanDerVleuten et al, 2000, Stutt & Motta, 2004;). Understanding theories, methods and techniques of active learning provides an important context for defining teaching strategies and the potential importance of practices such as working in small groups, learning by doing, working with real-life problems, and interactive exchanges (Prochaska, DiClemente & Norcross, 1992). The learning strategy should be designed for developing insight and understanding of the theoretical framework of subjects and constructing meaningful didactics for a computer-based learning environment. In this regard the starting point is the business processes, i.e. the education process starting from subscription till becoming an alumnus. The information processes will be defined in terms of which functions are needed and considering the use of open specifications and standards (i.e. providing interoperability). With respect to the interoperability issues, it is important to broaden the discussion to look at the architecture as a digital learning and working environment (DLWE) and not solely as the classic virtual learning environment. The information process that is required to support a student's learning process should not be hindered by technical barriers. Even if the underlying systems are different, the front-end interface for the end-user may still be one coherent environment. Furthermore the technical processes will be defined in terms of which tools are required, the client/server architecture, an integrated system or a combination of interoperable technical components, etc. (Dado, et al, 2007).

3 ONGOING TEACHING AND LEARNING EXPERIMENTS

At the faculty of Civil Engineering and Geosciences, the Division of Design and Construction Processes offers various courses on processes in the Building and Construction industry but also some courses on the application of ICKT (Information, Communication and Knowledge Technology) for the BC industry. The students are

offered an introduction into the ICKT and different modelling techniques for solving problems in the Building and Construction industry such as Geographic Information Systems (GIS), CAD systems, numerical models, etc. During the course a wide range of ICKT applications are discussed because the faculty of Civil Engineering and Geosciences has several disciplines such as building physics, material science, water management, coastal engineering and transportation engineering. During this course, students learn the fundamentals information modelling using UML and writing a software program in Java. They develop an application capable of solving a specific (civil engineering) problem for instance in the Building and Construction domain. The students also can choose from several elective courses such as the Parametric Design Systems or a mathematical modelling and simulation. The students with an interest in the Building Informatics are stimulated to follow elective courses on Product Modelling and Knowledge Technology for the BC industry that is followed by two courses in Advanced Design Systems. Blackboard offers the basis eLearning environment for all courses at Delft University of Technology. In addition there is a need for experimenting with new learning and teaching approaches to accommodate changing conditions, individual situations and new digital media. Particularly attention is given to knowledge driven personal learning environments that necessitates deviating from conventional (often lecture room based) approaches. In other words new tools require new rules, new approaches and new environments. Our observation of the results of current and emerging education methods points to its usefulness and positive effects on the study results of students. For instance the students are offered more flexibility in terms of choosing courses. They can make their study plan based on combining relevant and desired courses. Technically this produces a problem for the courses administration, time planning and allocation of resources (allocation of lecture rooms, planning of the courses and assignments of lecturers). In addition the students often are confronted with choosing parallel running courses. Digital learning environments often help to reduce these problems. Also, an initial and tentative observation of these methods shows an increased enthusiasm on the part of students and willingness to study beyond expected requirements. The possibility of studying at flexible hours that are not bound by time-table and location of lectures, allows them to pay more attention to the content. In some cases they increased the content of the study by further research of the content via the Internet (for instance Google Scholar or library search). Our observation was also acknowledged finding of Bales regarding effects of learning. The following section describes one of the experiments regarding changing conditions of the learning environment that encourages individual time management as well proactive learning based on personal requirements and conditions. This ongoing experiment proved to be more effective in terms of insight, understanding, engagement and commitment of students.

4 THE CASE OF THE PARAMETRIC DESIGN SYSTEM

The Parametric Design course allows students to learn about the basic principles of computer graphics and in particular creating parametric design systems. The principles of computer graphics are presented during several lectures where the students learn different theories, methods and techniques for modelling graphic information such as vector formats, pixel formats, solid modelling, etc. Also the students learn about graphic transformations of these formats such as scaling, moving, copying, mirroring, Boolean operations, etc. In addition, some database concepts are explained such as relational databases and object-oriented databases. These database concepts form a bridge for theory about product modelling. Students learn roughly the ideas of feature models and semantic product models. In this course the basic principles of product modelling is explained including object diagrams using Unified Modelling Language (UML). At the end of the course, students should be able to read UML object diagrams and even be able to create their own object models. A practical exercise forms a large portion of the course. The students build upon their previous knowledge of a CAD system and construct a solid model of an object (a building in this case). They are free to choose the object of their design they wish to create and are also free in the set-up of their design drawings.

The second part of the exercise is to develop a parametric design system by programming a CAD system (AutoCAD). The solid model they created in the first part of the exercise needs to be 'parameterised' and programmed using the 'Visual Basic for Applications' within the CAD program AutoCAD. Other CAD systems like Microstation or ArchiCAD can also be used when the students have the working knowledge these systems (respectively JAVA and GDL). The students have to define the parameters that are relevant for their design and have to discuss with the supervisors their plan for programming the system. Although the students may have some skills in computer programming and UML, they are still offered two crash courses in AutoCAD solid modelling and VBA programming. Groups of two students work on the exercise at least ten hours a week and are supported by the exercise supervisors. The experience shows that a group of two students always creates the most effective condition for learning.

The problem with an elective course is its time planning that in most cases coincides with obligatory courses, preventing students from being present during the lectures and exercises. The eLearning environment Blackboard is used to provide the students with all documents related to the course. Following the experience with the ITC-Euromaster, an experiment was conducted to tackle the problems facing the course of Parametric Design Systems. The lecturer and the students collectively agreed upon the most suitable time for the lectures (most students were at home). Some lectures were delivered in a traditional fashion but the Click-To-Meet environment replaced the lecture hall (Figure 2).

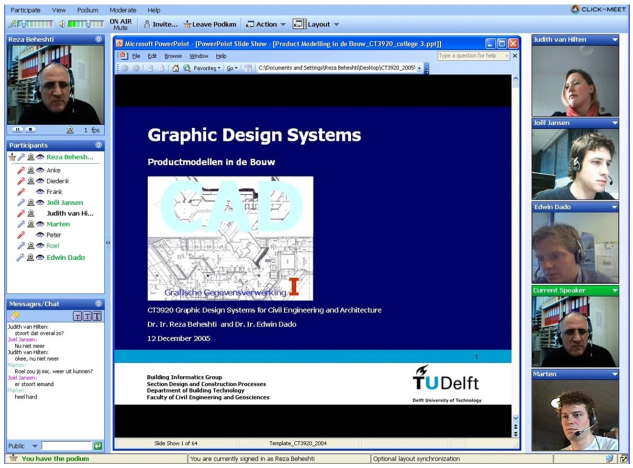

Figure 2. Snapshot from an eLecture.

The remaining lectures were recorded using MS Producer. These vLectures were posted on the Blackboard and the students were asked to prepare themselves at their own convenient time. The experience showed that students were able to learn the material because they were able to formulate questions and discuss the content of the lecture that increased their insight. One analysis can be the concentrated attention of the student to the lecture that provided a focused look at the screen and being cut off from the outside noise by the voice of the lecturer in the headphone (Figure 3).

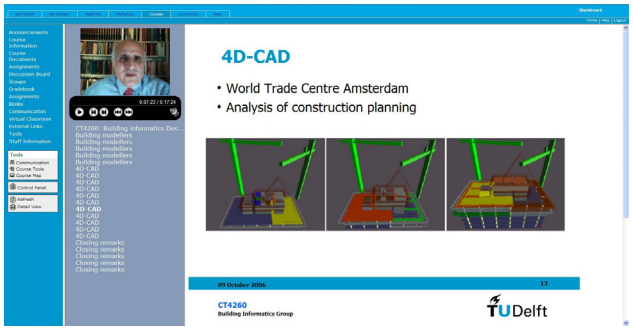

Figure 3. Figure 4 Snapshot from a vLecture.

At the agreed times eTutorial were held where the students and the lecturers had animated discussions the content of the course. The enthusiasm of the students was as such that each eTutorial was prolonged beyond the agreed time span of 90 minutes (Figure 4). The students in an assessment session expressed their preference for the mode of learning. In particular they noted that for the first time they spent time on studying a course on a weekly basis instead of leaving the study to a few days before the examination. Supervision of exercises was arranged as small group eTutorials and by emails.

The purpose of the exercise is to develop a parametric design system for a factory building. The parameters were defined as dimensional specifications for the building given by the client, value-comparison to specify which of the previous parameters has the higher priority and the requirement for the roof that can also be specified by the client. In this approach the parametric design provides the technical solutions for designers (i.e. cost and price) and functional requirements provide value for the client. This idea is based on the value-price-cost model developed by Hennes de Ridder at Delft University of Technology (Dreschler, et al, 2005; Özsariyildiz et al, 2006). The first task was a dialogue window for the requirements specification (Figure 5a).

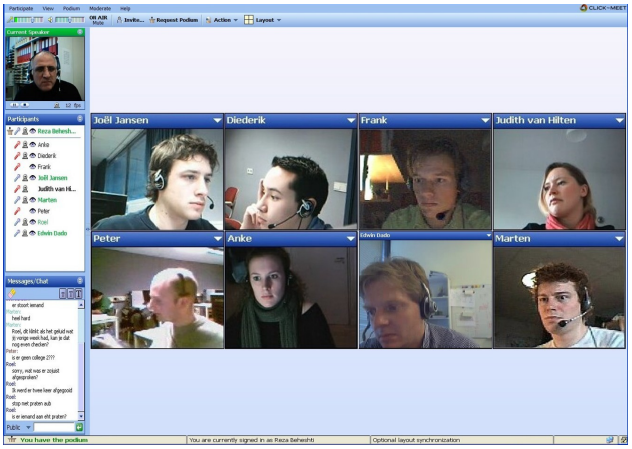

Figure 4. Snapshot from an eTutorial.

The next task is to provide a Solution Specification dialogue window. In this window

The priority of the requirement parameters is displayed at the top. Depending on the parameters specified by the client, the designer can input the proper dimensions for the building. When these dimensions are filled in, the program will automatically generate the proper amount of columns needed for the building. The width of the columns and the height of the floors are also calculated (Figure 5b).

Next stop is the dialogue window for the roof specifications. At this stage the designer provides more detailed parameters for the dimensioning of the roof depending on the requirement given by the client (Figure 5c).

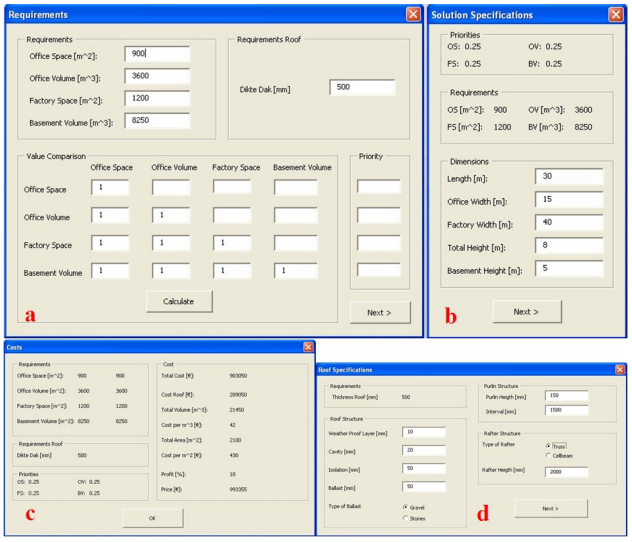

Figure 5. Snapshots from an application developed as part of the course requirement:

a The opening dialogue window of parameters (user requirements)

b The dialogue window of parameters (design specifications)

c The dialogue window of parameters (roof specifications)

d The cost specifications of the factory building

At this stage the program calculates the total cost for the entire factory building using the specified dimensions and some common cost parameters. The client and the designer are presented with the most relevant values. The amount of resources required per segment of the building (e.g. cost per m^2) and the total price of the building including the profit is displayed (Figure 5d).

Finally the program generates a three dimensional image of the factory building and its structural design using the specified and calculated dimensions (Figure 6). At this stage the students are able to expand their parametric design system to any level of detailing and specification but this is beyond the scope of this course. Such an exercise is the subject of the Advanced Systems Design course or part of the MSc graduation project.

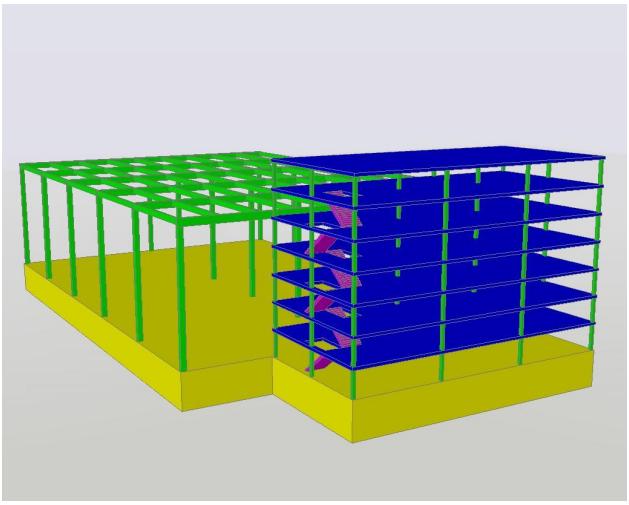

Figure 6. The preliminary design of the factory building and its structure.

Compared with previous years the students gained a deeper understanding of parametric design systems and principles of value-price-cost theory. They were able to be engaged in group discussions and location independent group work that necessitated acquiring additional information and knowledge with assignment results with higher quality and developed far beyond the course requirements. In addition the student experienced the proactive participation in the course and the individual time management as beneficial to more effective learning.

5 CONCLUDING REMARKS AND DISCUSSION

There are a great deal of indications that the information, communication and knowledge technologies exert influence on improving the quality, flexibility and effectiveness of all learning, teaching and training environments. In this regard the learning, teaching and training programmes have been profoundly enhanced. Most probably knowledge driven eLearning environments are crucial to the availability, accessibility and acceptability of distant learning and life long education. The development of these (virtual) learning, teaching and training environments requires thinking of a comprehensive strategy for the whole education sector, requiring rethinking of conventional and face-to-face teaching and memory based learning. These strategies will define the course of actions to be taken in order to provide high quality digital information resources as well as devising awareness procedures for discovering the value of personal learning environments. This paper examined attempts for making use of eLearning facilities through some experiments with a Parametric Design systems course at Delft University of Technology. The outcome of this experiment coupled with our experience from the ITC-Euromaster Distant Learning programme delivered some significant findings. Digital learning environments and courses using digital media provided the students with greater degree of freedom and time management by allowing the student to study at his or her convenient time. This was possible through the use of recorded lectures (vLectures). Also, the lecturer and students were able to agree upon a mutually convenient time for offering eLectures. The eLearning environment paved the way for replacing the lecture room and conventional face-to-face lectures (monologues) to dynamic discussions during eTutorials (dialogues). The new approaches and practical solutions supported by ICT and digital media are relevant for effective learning, teaching and training programmes and the acceptability of long life learning of the future knowledge driven societies. These knowledge driven societies will also profoundly revolutionaries the concept of learning, teaching and training. Lifelong learning will inevitably dominate the future of human educational systems. The ideas presented here were tested during a course on parametric design systems. This paper reports the evidence of increasing commitment and enthusiasm on the part of students that are crucial factors for the success, acceptability and usefulness of such environments.

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