COVER SHEET

The Role for E-learning in Engineering Education: Creating Quality Support Structures to Complement Traditional Learning

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Abstract

The use of information technology (IT) based *e-learning* has emerged as an all-pervasive complementary learning tool for undergraduate instruction in recent times. *E-learning* or web-based instruction is being rapidly embraced by most universities across the world as such media of instruction are economical, convenient and disbursable to a larger audience. IT-based engineering education is now an important profit market for universities from a socio-economic and political view point. Consequently, diverse models have been developed and implemented across various disciplines of engineering. However, these initiatives have been misaligned and not properly integrated with existing and the ever-changing IT infrastructure. In this paper, we identify the hurdles faced with adopting IT-based learning tools for the instruction of highly technical courses in Mechanical Engineering in the Faculty of Built Environment & Engineering, QUT. We propose some support structures that are required to improve upon the existing mechanisms to deliver better and improved *e-learning* content.

Introduction

A rapidly growing number of educational centres worldwide are now delivering education and training over the Internet. There are an estimated ten-million courses now available online, and the U.S alone reports about 700 *e-learning* companies apart from educational institutions [1]. In addition to college/university degree programs, some *e-learning* companies or institutions offer online tutoring to students at specific grade levels, ranging from primary through tertiary. Increasingly, training and support for teachers is occurring online and a number of institutions now offer either partial or complete secondary diplomas through *e-learning*.

E-learning or web-based instruction is being rapidly embraced by most universities across the world as this medium of instruction is proving to be economical, convenient and disbursable to a larger audience. At the tertiary level, *e-learning* based engineering education is now an important profit market for universities from both socio-economic and political view point. For example, Massachusetts Institute of Technology (MIT) recently announced that learning materials and syllabi for all courses were being put on the Internet for anyone to use, although students must be enrolled in the institution to obtain course credit. The MIT administration and faculty made this decision because they determined that knowledge is for sharing and the Internet is the most efficient transmitter of knowledge ever available. This is now the emerging trend in most universities across the USA, Canada, the EU, China and the Asia-Pacific Rim. Australia has taken to *e-learning* with great enthusiasm and educational institutions and learning centres are still early adopters of novel technology and methods that create the essential frameworks for *e-learning*. There are various Government initiatives such as Education Network Australia (EdNA), National Organisation for *E-learning* (NOEL), Australian Council for Open, Distance and *E-learning* (ACODE) amongst others. The

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common aim of all these agencies is to enhance policy and practice in open, distance, flexible and *e-learning* in Australasian higher education by [3] disseminating and sharing knowledge and expertise; supporting professional development and providing networking opportunities; investigating, developing and evaluating new approaches; advising and influencing key bodies in higher education; and promoting best practice. It is clear that Australia is well set to embrace the emerging and all pervasive concept of *e-learning* in a big way in the decades ahead. It is therefore imperative for higher educational institutions to closely follow and examine the current practices and continuously evolve better structures and strategies to deliver high quality learning products to the wider community.

E-learning in Engineering

E-learning is considered the successor of the over 140 year old "distance education" and supposed to occur in different forms and various levels. A general consensus amongst the practitioners of education is that *e-learning* is 'the use of processes and technologies to create, distribute, manage, and enable learning via an electronic network' [4]. *E-learning* thus involves a complex interaction of teaching strategies, instructional design and computer technologies with the ultimate goal of delivering high quality 'learning products.' Universities around the world have embraced or fast embracing this learning concept owing to potential benefits such as "just in time" training, uninterrupted access to learning material with both synchronous (real time) and asynchronous (archived) delivery modes to a much wider and larger number of audiences simultaneously [5]. *E-learning*, in this way has become a cornerstone profit generator for the academia mainly from an information delivery approach.

While *E-learning* is carving a niche in mainstream education, it is still finding its footholds in engineering education. The reason for this slow progress is the lack of certain frameworks that are able to deliver true dynamic 'learning products'. Almost all the deliverable products being generated in the market masquerade as high quality learning aids which can be considered as mere static information delivery products [6]. For example, if one can consider a set of fancy PowerPoint slides as facilitators of learning, a closer inspection reveals the apparent lack of theoretical and practical depth or distinction in one line dot points. Additionally, engineering education has to deal with multiple levels of intelligence needing intensive and one-on-one interaction so that the lecturer might stoop low enough to raise the collective knowledge of a given class of students. Consequently, *e-learning* in engineering in many aspects can be devoid of any inherent value if the instructional material is not adequately designed to facilitate learning at all levels. Developing *e-learning* structures for engineering education thus poses unique challenges as compared with other fields.

E-learning at Queensland University of Technology (QUT)

One of the University's core ambitions as articulated in the QUT blueprint is to "provide outstanding learning environments and programs that lead to excellent outcomes for graduates, enabling them to work in, and guide, a world characterised by increased change." The blueprint also outlines the objectives "to strengthen our reputation for quality teaching and learning and provide one of the best learning environments in Australia," and to "integrate information and communication technology into our teaching, research, business support functions and infrastructure." [8]. QUT's efforts to embrace *e-learning*, like other universities around the world, began with the intention of offering learning tools that enhance choice and flexibility, increased access and better quality, mainly to external and off-shore students. With QUT's student populations becoming more and more diverse, the university has recognised the need to respond to its students' needs by providing learning supported by not only the

Internet, but also by many emerging mobile technologies. The vision set out in the QUT blueprint and related documents such as the Learning and Teaching Plan takes into consideration these expectations placed on the university by our students and the community at large.

Development of Online Teaching and Learning Systems at QUT

E-learning at QUT began in the form of *Online Teaching and Learning* (OLT) in 1994, with the Faculty of Information Technology hosting a web site on the University's intranet where various types of 'learning' materials were made available to students from their faculty. Soon, other faculties and schools joined the band wagon by using some of the then commercially available infant online learning systems, resulting in a depository for learning materials for many units ever since. Most of the material found on the site was predominantly PowerPoint slides of the lectures so transcribed to capture the essence of the concepts discussed in the lecture with various directives to students for further readings and references. Contrary to the vision of the policy makers, the OLT site has been a mere repository of learning information for students to motivate themselves to study or read or browse the material, depending on their characteristic disposition to a subject/topic/concept. The first generation OLT system was very static with very limited file sharing space which prevented the hosting of any interactive modules, discussion forums or even quizzes.

Developments in the Online Learning Systems

With progressive increase in the capabilities of open source and commercial Learning Management System (LMS) software, unit and course management, content upload and management features, communication tools (i.e. forums, chat rooms, etc.) as well as assessment tools (i.e. quizzes, polls, assignment submission) were incorporated into the OLT system. Since 1998, many improvements have been incorporated into QUT's OLT site with marginal increases in space leading to the setting up of interactive modules, multimedia based lectures and dynamically driven menus. However, we still have not overcome the inherent drawbacks of small file sizes, delays in information uploading and retrieval and limited access times due to the need for constant maintenance requirements. A recent review by the Teaching and Learning Committee led to the recommendation that a commercial system be incorporated as QUT's driver of the OLT system. This is expected to be implemented in two phases commencing January 2007. In the first phase, a few schools will be given the opportunity to test-drive the new system and in the second phase, all other schools will follow suit.

E-learning in Engineering Schools

Teaching highly technical subjects using the common *e-learning* tools is a challenging task. The general rules that may apply to the arts and social sciences fail miserably as learning in engineering occurs in discrete quanta and the failure of a student to grasp certain basic fundamentals will not foster further learning in a given subject area or topic. This is found to be very common in the first two years of undergraduate studies where we have noticed a high level of attrition from students who were instructed to refer to "certain lecture material" on the OLT site as further reading. Some of the main problems with directing undergraduate engineering students to any potential *e-learning* media are:

1. Lack of Preparedness – a general attribute of students is to get over and done with a set of tasks by reading what is 'required' to get the job done. Everything else is considered a mere waste of time;
2. Attrition [9] & Impatience – what begins as an enthralling learning experience often dwindles midway due to apparent lack of further interest or the students lose their way as they progress from basic to advanced concepts. A case in point is students trying to grasp difficult topics for the first time, rendering the experience akin to TV channel hopping and surfing. The mouse could be clicked on the various hyperlinks with great impatience turning the student from a concentrated reader to an abstract browser of the content;
3. Limited Computer skills – some students face steeper learning curves than others in using computers and associated learning software which may impede their progress or cause them to end up doing a rush job in trying to keep up with their fellow students/class;
4. Information Retrieval & Assessment – perhaps the major catastrophe as a large percentage of students do not read and understand the instructions 'carefully' and are consequently unable to interpret the problem at hand correctly. Cultural and linguistic disparities further compound this problem.

Support Structures for E-learning in Engineering Education

In order to overcome the aforementioned problems, academics must place a greater emphasis on better teaching and learning strategies and design courses that enable the delivery of a true learning product rather than serve as a mere repository for reading material somewhere in cyberspace. In the drive to use certain processes and computer technology to develop and deliver a learning product, it is important to accurately identify the "processes" that will help establish effective learning media. *E-learning* must be a self-paced exercise which should result in greater retention of the content over longer periods of time. However, even in the learner-centred approach that *e-learning* fosters, lack of learner skills in terms of computer knowledge, self discipline, patience and time management can initiate adverse effects on the potentially slow learner [10, 11]. Poor course design can result in:

a) Incomplete assimilation of course content resulting in either little or no learning occurring
b) Misconceptions of the theoretical and practical implications of the course content
c) Negative perception of the value of technology-based learning leading to attrition and
d) Gross wastage of resources that universities invest for such learning initiatives

If we are to churn out more competent and smarter engineering graduates via *e-learning* strategies, there are some immediate goals that must be incorporated into the scenario:

1. The learning media must not serve as a mere depository for learning material;
2. The learning content must be designed so that it captures the interest of the learner in such a way that it generates a desire for further learning;
3. While being more informative, the content must be more interactive and prompt the learners intermittently to reflect on what they have read or seen on their screens;
4. Unit content must be made more visually captivating and for this, unit coordinators must break the monotony of one color or graphic style and bring in more 'flash' oriented presentations which will convey the concepts more lucidly;
5. Academics themselves must first discover the methods of programmed learning structures within the *e-learning* systems. For example, if a student is good enough to advance in some concepts at a greater pace, there should be mechanisms within the *e-learning* repository that are able to discover such a trait and direct the learner to the advanced topics much earlier.

Within the School of Engineering Systems at QUT, we are trying to incorporate many of the above features into the on-going development of *e-learning* systems. Based on feedback from all years of engineering students, we are now incorporating regular mock online tests to give our students a 'feel' for what they can expect when they take a real test in the unit. These may also include class surveys, feedback and forums which urge the students to access the various online features from time to time and familiarize themselves with the way of *e-learning*. Additionally, we are developing more and more interactive online tutorials that never give away the answer if a student fails in the first attempt but prompts them to try again and again by providing hints towards the answer progressively. All these efforts are simultaneously leading to the creation of a knowledge base which will be used to incorporate more learner adaptability in *e-learning*.

We opine that the ultimate goal of any *e-learning* system is to possess an ability to adapt the learning environment itself to the student's acumen and capabilities. The *e-learning* system should be a virtual intelligence teacher capable of recognizing the competence and adapting itself to the needs of the student accordingly. Academics will have a major role to play in developing such *e-learning* systems by beginning to develop a knowledge base of intelligent learning based on their experience and collective perspectives which will result in the delivery of a true learning system capable of training and teaching a learner in the absence of the learned.

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