IS BLENDED LEARNING THE SOLUTION TO WEB-BASED DISTANT ENGINEERING EDUCATION?

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ABSTRACT

The term "blended learning" is being used increasingly to describe the learning and teaching activities which involve a mixture of online teaching and face-to-face teaching. This paper describes the requirements of distant learning engineering courses, and proposes that a blended learning model suits best to the needs of such courses where the lectures are delivered using the well known learning management system based web teaching tools, and laboratory sessions are carried out at the university campuses.

Keywords: Engineering Education Blended Learning, Distant Learning.

ENGINEERING EDUCATION

The emergence of worldwide communications networks and powerful computer technologies have increased the interest in distant education (Allen and Seaman, 2003). In recent years, there have been major advances in the field of distant education and educational technology and many new tools and new terms have been introduced in this field. Some keywords, such as Technology Based Education (TBL), Computer Based Training (CBT), Distance Learning (DL), Web Based Learning (WBL), and Collaborative Learning (CL) are some of the commonly used ones.

The vision of bringing education to anyone, anywhere, and anytime has been very attractive especially to adults who can not attend to universities on a full-time basis as a result of family or work commitments or financial difficulties. Distant education has traditionally been used in the teaching of topics such as languages, history, geography, law and similar topics where all of the course content can be studied away from the university (Grose, 1999).

Engineering has the reputation of being one of the more difficult disciplines to master (Peterson and Feisel, 2002). Are there significant differences between engineering education and other disciplines, such as social sciences that make engineering difficult to teach online? Engineering education is science and mathematics based and these subjects are traditionally the hardest to teach online because of the need for laboratories and equation manipulation. Engineering education has two major factors to consider: the course notes, and laboratory sessions. Traditionally, engineering education has been content-centered and design-oriented where students attend classes on a full-time basis and carry out the laboratory experiments at the universities which forms an important part of the overall course requirements. Consequently, engineering education has special needs when offered in a distant mode, including consideration of how best to provide laboratory experiments (Feisel and Rosa, 2005).

For an engineering education to be broadly accepted and utilized it has been suggested by Bourne et al. (2004) that the following points should be satisfied:

- The quality of online courses must be comparable to or better than the traditional classroom
- Courses should be available and be accessible from anywhere by any number of learners
- Topics across the broad spectrum of engineering disciplines should be available

The above three attributes – quality, scale, and breadth form the basis of work of the Sloan Consortium, a group of more than 900 primarily United States based academic and corporate institutions dedicated to making online education a part of everyday life.

Acceptance of online education as a major component of higher education has grown dramatically, however there has not been a significant increase in distant engineering degrees granted. Why has undergraduate engineering education lagged behind other fields in adopting online teaching methodologies? The answer to this important question is that some of the special needs of undergraduate engineering education have not been well served by current methods of online education. Specifically, laboratories are difficult to provide online and distantly because of the desire for the direct interaction with the laboratory equipment. Laboratory work is recognized as an efficient method for engineering students to assimilate knowledge and to develop skills for solving real world problems.

The current ABET (Accreditation Board for Engineering and Technology) engineering criteria states that all engineering programs must demonstrate that their graduates have the ability to:

- Design and conduct experiments, as well as to analyse and interpret data

- Design a system, component, or process to meet desired needs
- Use the techniques, skills, and modern engineering tools necessary for engineering practice

The criteria further states that:

- Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning; and
- The program must include college-level mathematics and basic sciences, some with experimental experience, appropriate to the discipline

In 2002, thirteen objectives for engineering lab sessions were drafted by ABET in consultation with thirty-five educators (Feisel and Rosa, 2005) from thirty-one institutions offering engineering degrees. It is generally accepted that most of these criteria may be met easily online, except perhaps the laboratory sessions.

Engineering students are expected to set-up and carry out laboratory experiments using real hardware instruments (Steinemann and Braun, 2002). The traditional way of conducting experiments is to go to a university laboratory where students work in teams and receive help from the laboratory technicians or from their teachers. There is no doubt that nothing can replace synchronous learning in a real laboratory environment where students can physically handle the equipment.

Many institutions providing distant engineering courses have attempted to solve the laboratory problem using one of following methods (Fernandez et al., 2002):

- Providing simulations of laboratory experiments
- Providing real-time access to the laboratories remotely
- Providing small portable laboratory kits to students

Simulation

Some institutions have attempted to solve the laboratory attendance problems by providing computer based simulation tools which imitate the operation of real experiments (Campbell, 2002). During the last decade there has been a trend towards increased use of simulation in engineering education. One reason for this is that physical experiments are expensive to purchase and to maintain. Another reason is the belief that simulation can replace physical experiments. Simulation is carried out by using *simulators*. A simulator is a software package that can imitate the behavior of a real hardware. For example, SPICE simulators are used by electrical/electronic engineering students to study the behavior of electronic circuits. In a typical application students can set up an electronic circuit by placing the components on the screen and then connecting them as required. Although simulators can be invaluable aids in teaching the behavior of systems, they can never replace the real equipment. For example, using simulators students can set values which are not feasible in practical world. In summary, although simulators can not replace real experiments they can provide an alternative to them.

Simulations do not satisfy several of the requirements of ABET criteria. This is because simulations provide some, but limited, capability for experimentation, and they can not always accurately demonstrate the application of theoretical concepts to the physical world. Figure 1 shows a typical simulation.

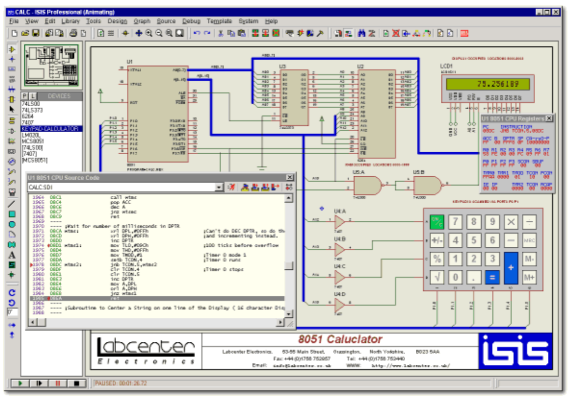

Figure 1: Simulation of an electronic circuit (Labcenter Electronics Ltd, 2006)

Remote Laboratories

Some universities attempted to solve the laboratory problems by providing so-called remote laboratories (or virtual laboratories) where students can access the real laboratory equipment and carry out traditional laboratory exercises from their own places of study (Fjeldly and Shur, 2003). In a remote laboratory setup the laboratory equipment is connected to the internet using special interface devices. In addition, cameras are usually placed in the laboratory for viewing the experimental setup. Students access the laboratory from their own computers by connecting to the internet and selecting the experiment to be performed. Students can then manipulate the equipment and carry out the experiment remotely by following the instructions. Real-time pictures of the equipment are transmitted to the students continuously so that they can see the experiment in real-time. Although remote laboratories are useful, they are very limited and can only be used for simple experiments and for experiments where the student involvement is minimal. Perhaps one biggest disadvantage of remote laboratories is the fact that experimental setup is readily given to the students and this can not be changed. In addition, students can not physically handle or configure the real equipment.

Remote laboratories have limited scopes and as such currently they do not satisfy several of the requirements of ABET criteria. It remains to be seen, however, if they will be accepted as more complex and more advanced remote experiments are developed. Figure 2 shows a remote laboratory used in distant engineering teaching.

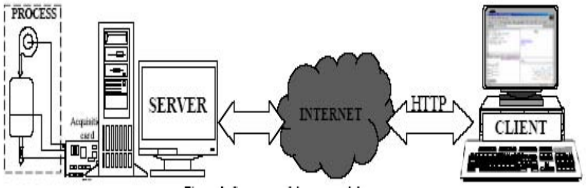

Figure 2: A remote laboratory used in distant engineering education (Chiculita and Frangu, 2002)

Laboratory Kits

Another solution adopted by some universities is to provide small portable laboratory kits to students so that they can carry out the experiments from their own places of study. This method has the advantage that students can handle, configure and use physical components in their practical exercises. One disadvantage of this method however is that the type of experiments that can be carried out is rather limited and only small experiments consisting of portable equipment can be carried out. For example, laboratory kits can be useful in teaching digital electronics, microprocessors and microcontrollers, circuit theory courses and so on. The kits can either be provided on loan to the distant learning students just like a library loans books, or students can be asked to purchase the kits. Although the existing laboratory kits do satisfy the ABET requirements, it is not economical or practical to develop complex bulky laboratory kits for home use, and as a result, only a partial satisfaction of the ABET requirements are met at present. Figure 3 shows a typical microprocessor teaching kit.

Figure 3: Microprocessor teaching kit (EMAC Inc.)

BLENDED ENGINEERING LEARNING

Blended learning is the combination of multiple approaches to learning (Dziuban, Hartman, and Moskal, 2004). For example, using a combination of web-based learning techniques and face-to-face sessions. It should be noted that some authors talk about “hybrid learning”, or “mixed learning”. However, all of these concepts broadly refer to the integration of web-based learning techniques with traditional methods. The term “blended learning” is also used to describe learning in which conventional offline, non-electronic teaching happens to include some form of online tutoring services. Blended learning is commonly used in the teaching of non-engineering subjects. Language learning schools use a combination of face-to-face teaching and electronic practice activity.

Dziuban et al. (2004) at the University of Central Florida report that they found blended courses to have the potential to increase student outcomes while lowering attrition rates in comparison with equivalent fully online courses. They report that the blended model is comparable to or in some cases better than face-to-face teaching. In a three year study between the face-to-face, fully online, and blended teaching methods they found that the percentage of students succeeding (Grades A, B, or C) were over 90% in all cases and blended teaching always gave the same or better success rates than the other two methods of teaching. In addition, they found that blended learning resulted in success and attrition rates comparable to the face-to-face modality for all ethnicities.

In this paper we propose the use of blended learning in the teaching of engineering courses. What is proposed here is a teaching method where the lectures will be delivered using web-based techniques such as learning management systems (LMS) and collaborative tools, and students will be asked to attend the university for their practical laboratory sessions. Thus, all the requirements of ABET will be satisfied.

A learning management system (LMS) provides the platform for the web-based learning environment by enabling the management, delivery, and tracking of learning. LMS are often viewed as being the starting point of any web-based learning program. Some of the important issues when evaluating a learning management system are (Hall, 2003): high availability, scalability, usability, interoperability, stability, and the security. A good LMS should be 100 percent web-deployable, requiring no additional client applications. It is also important that the LMS should support various sources from different manufacturers and it should be based on open industry standards for web deployments, and should support the various learning standards.

The success of LMS systems and collaborative learning tools in teaching, especially in the teaching of programming languages are well known (Cavus, Uzunboylu, and Ibrahim, 2007). MOODLE is a popular open-source learning management system that is used widely by many educational institutions around the world. Similarly, GrewpTool is a popular collaborative tool that is used to support the distant learning studies in many universities throughout the world. It is expected to implement a pilot study at the Department of Computer Engineering of the Near East University to assess the success of blended engineering learning as compared to the traditional methods of teaching. It is proposed that the practical laboratory sessions should be held at the university, preferably during the summer holidays, or at some other times commonly convenient to students and teaching staff.

CONCLUSIONS

The recent coverage of blended learning in conferences, books, journal articles, and magazines would make one to believe that a new educational method has been discovered. In fact, the blending of face-to-face teaching and non-classroom teaching have been known and practiced for over the last several decades. Engineering education is based on science and mathematics which are traditionally harder to teach online because of the need for formula manipulation and practical laboratory work.

This paper proposed that blended learning is well suited to engineering education, where the lectures can be delivered using learning management systems and experimental parts of the course could be carried out at the university campus.

A pilot study shall be carried out in the next semesters at the Department of Computer Engineering of the Near East University to assess the success rate of blended engineering learning.

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