Freshman Level Course Online:
Courseware and Student Performance

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Abstract

According to a 2008 report on online education in the United States, in Fall 2007 more than 20% of all students in higher education were taking at least one online course. Currently, universities offer online courses in a wide range of disciplines, however, online courses for credit towards a degree in engineering are only available in limited selection. Faculty in engineering programs believe that while many courses are enriched by online courseware that includes lectures, quizzes, and laboratory experiments, in engineering programs, many types of instruction and student exercises do not lend themselves to effective learning through virtual experiences. Moreover, group projects constitute a significant factor of the engineering educational experience, and those have shown to be a challenge in the effective implementation in online courses.

This paper describes activities in a freshman level course required by all freshmen including engineering and computer science majors. In all course sections a custom designed textbook was used as well as courseware developed by the textbook publisher. The courseware provided an electronic copy of the textbook, study tools such as quizzes and tutorials, and test banks from which homework assignments and exams were developed.

The paper examines student performance on online homework assignments and on online exams in view of student preferences, the use of the online learning tools and course materials, student interaction with the instructor, and collaborative activities required in the course. The discussion of the results, among other issues, addresses the challenges involved in designing, implementing, and supervising the Internet-based group activities in online courses.

Introduction

A 2008 Sloan Foundation report on the state of online learning in higher education in the United States found that over 3.9 million students, or, over twenty percent of all U.S. higher education students, were taking at least one online course during the fall 2007 term. Moreover, for the past several years, online enrollments have been growing substantially faster than overall higher education enrollments [1].

It has been suggested that the recent economic downturn and its side effects, such as the need for career change or retraining, diminished financial resources, relocation in search of jobs, etc., have contributed to the increase in enrollments in online courses. However, it should not be overlooked that the characteristics of the student population have been changing rapidly with the quick adoption of the latest Internet-based technologies that foster a desire and the need to be connected to people and information from anywhere at any time. Such technology also promotes the concept of having an option with regard to the time learning takes place and is dependent on the type of Internet connection. Online courses thus become attractive not only for geographically dispersed students, but also for on-campus students who take online courses from the university they attend as regular in-class students. The Sloan Foundation report says that the number of students taking at least one online course continues to expand at a rate far in excess of the growth of overall higher education enrollments, indicating that many students choose on-campus as well as online courses in their academic programs.

Online learning has shown extraordinary growth in the past several years although e-learning enrollments have not been uniform across all types of higher learning institutions. The highest growth is shown in large public institutions in bachelor level programs, although intense growth of online course offerings has been demonstrated in all disciplines except engineering. In fact, engineering is the only discipline where in the context of online education, online course offerings and selection, as well as enrollment in online courses, remain low and much lower than in

any other discipline.
Engineering educators recognized from the beginning the potential of the Internet and the Web in the design and delivery of educational content, training, and assessment in-class, as well as via the online environment. However, engineering educators have also recognized the challenges of implementing online courses which include: costs, limited features, slow adoption rate, student computing skills and their attitudes towards complex Internet tools, and lack of infrastructure that would support effective delivery of online courses [2, 3].
Although the number of online engineering courses remains small in comparison with the number of courses offered by other disciplines, today many engineering schools offer many engineering courses on the Internet. A quick web search for online engineering programs in the United States generates an extensive list of universities that offer a limited variety of undergraduate and graduate programs in engineering. Some universities only offer some online courses, while others offer complete engineering degree programs online.
In the process of developing of online engineering education, engineering educators attempt to apply tenets of the current theories of education, particularly the constructivist theory which presents teaching and learning as elements in the construction of knowledge. "Within the constructivist learning environment, learners are active explorers of their environment where they seek new information and construct personally meaningful elements of knowledge; the creation of knowledge occurs in a social setting and in interaction with other people and the environment" [4]. The ultimate goal of knowledge construction is the ability to develop metacognition which is a foundation of problem solving skills in all domains of academic endeavors, particularly in science, mathematics, and engineering, and, indeed, in many life endeavors in general.
A constructivist learning environment is "a place where learners may work together and support each other as they use a variety of tools and information resources in their pursuit of learning goals and problem solving activities" [5]. The constructivist approach recognizes that different professions, or communities of practice, have different ways of knowing, different interests in, and thus different choices of, information, and different knowledge constructs which are added to the collective body of knowledge and understanding. Constructivism also includes the principles of problem- and project-based learning. The recent trends in online learning pedagogies turn to the constructivist epistemology to formulate models that include collaborative learning environments in which they promote practice, thinking, and coherent knowledge construction.
It appears that although not articulated in constructivist theory terms, teaching and learning in engineering have always been consistent with the constructivist approach. The challenge that engineering educators face when designing online courses is how to transfer the tools, content, methods, problems, and projects specific to engineering education to an online environment that embodies constructivist principles of education. The challenges for the online delivery of engineering courses are often specific and reflect the nature of engineering education (Bourne et al.).
In the past years many challenges have been overcome as evidenced by the number of engineering courses and degree programs offered online. However, more challenges remain and many tools still need improvement if engineering educators are to attain the online course quality goal: that the quality of online courses is comparable to or better than traditional bricks-and-mortar classes. While developing online engineering courses educators must strive to maintain the basic characteristics of engineering education meaning that it is: content-centered, easily adapts to the new discoveries and developments in science and engineering, design-oriented, focused on developing problem solving skills, and project-based in a collaborative context. The challenge for online courses is that they should offer an educational experience fostering life-learning skills, social responsibility, and professional ethics. Furthermore online courses must provide an education that would include features equivalent to the core engineering educational experience, which are the skills and knowledge gained through hands-on laboratory exercises, using instrumentation, equipment, and machines, working on individual and group projects, and learning professional as well as people skills, collaboration and cooperation.
Following the principles of constructivist theory, online courses must be conducive to forming learning communities, engage active learners, and promote construction of knowledge and individual skills through personal exploration within a collaborative context. Such educational objectives in online courses are often in conflict with learners' personal objectives, namely, the freedom to engage in independent work, anytime, anywhere. To implement educational objectives that include building a learning community and developing a culture of cooperation and collaboration, instructors have turned to course management systems, such as Blackboard, which offer tools that permit asynchro-

nous and synchronous interaction between the students, and between the students and the instructors. Chat is one of Blackboard collaboration tools. The Chat allows the users to interact with each other via a text-based chat in a real time.

Coursework, Courseware, and Chat on Blackboard

This study examines students' activities in a freshman level on-line course, Analytical Reasoning, which include performance on and use of courseware based materials, group work in Chat Rooms on Blackboard, and students' attitudes towards the course requirements. The course is one of the five foundation courses in the University Studies program, which is required by all freshmen at the subject university. The course comprises three parts: logic, hypothetical/scientific reasoning, and quantitative reasoning. The objective of the course is to provide the students with a foundation for their subsequent university courses and with life-long learning skills. The course has several on-campus sections as well as two on-line sections. All sections cover the same course content material and use the same delivery schedule.

During the time period of the study, in addition to a custom designed textbook, the course utilized custom courseware developed by the textbook publisher, and the Blackboard Learning System – an Internet-based course management system. Summative assessment included homework assignments and exams developed from question pools available on the courseware website. Exams and homework assignments had a web-based test format, and they were completed on the courseware publisher website. For on-line course sections, course participation grade points were earned through collaborative work in recorded Blackboard Chat Room sessions.

The total number of students registered on Blackboard in both on-line sections was 51; out of those only 43 students registered in classes on the courseware website. By accessing the courseware website, students could use various course resources, complete and submit assigned homework, and take exams. Six students registered in the courseware web-based classes but did not take any exams or submit any homework assignments. Out of the 37 students who registered in the courseware classes and submitted course work as required, 6 students withdrew at various points in time, and, in the end, 31 students took the final exam. All students who took the final exam received passing grades in the course.

To examine a possible pattern related to the type of student who persevered in the course, the students who registered in classes on the publisher's courseware site and who throughout the semester completed course work there were divided into student type categories as follows: 23 traditional/degree seeking students, 14 non-traditional (age 24+) students, 12 re-admitted students, and 2 international students. The students who took the final exam could be classified by the following type categories: 17 traditional/degree seeking students, 8 non-traditional (age 24+) students, 4 re-admitted students, and 2 international students.

From the above numbers we can determine in terms of percentages of students in each student type category that: 74% of traditional/degree seeking students, 57% of non-traditional students (24+), 33% of re-admitted students, and 100% of international students completed the course successfully. The student numbers in each category are small and they do not allow for broad generalization or strong inferences, however, the relatively small percentage of re-admitted students who successfully completed the course suggests that a further investigation might provide some clarification about the reliability of the observation obtained in this examination of student success in on-line classes.

The original enrollment list on Blackboard allows the following classification by college: Business and Economics: 6; Technology: 14; Engineering: 4; Arts and Sciences: 13; Agriculture: 7; Education: 2; Nursing: 5. The students who took the final exam and successfully completed the course, classified by college, and showing their success rate, were: Business and Economics: 4 (67%); Technology: 9 (64%); Engineering: 2 (50%); Arts and Sciences: 7 (54%); Agriculture: 4 (57%); Education: 2 (100%); Nursing: 3 (60%). The low passing rate for engineering students is probably due to not liking the course rather than the lack of ability to conquer the course requirements.

An examination of a proportional representation of students who took the final exam in terms of the enrollment figures [6] in the colleges were the students were registered found that technology students were well represented in the on-line sections, but engineering students were not. The total enrolment in a college and the number of students who successfully completed the on-line course could be represented as follows: Arts/Sciences: 2,808 – 7; Business/Economics: 1,406 – 4; Engineering: 1,258 – 2; Technology: 733 – 9; Agriculture: 690 – 4; Education: 449 – 2. The low number of engineering undergraduate students enrolled in the on-line AR course in that particular semester supports the general observation that the percentage of engineering students taking on-line courses is lower than the percentages representing students enrolled in on-line courses in other academic fields.

For each course section, there were twenty-two homework assignments developed for the on-line course sections and posted through the courseware learning website; completing the homework assignments generated grade credit points. The instructor also posted twenty-two "shadow" homework assignments. These assignments could be completed on the courseware website as practice tests for no credit points, or they could be completed in a collaborative manner in recorded sessions in Blackboard Chat Rooms. Each "shadow" homework assignment could earn each participating student "extra" points for a correct solution as well as "participation" credit points. In order to implement the collaboration component to the course, for each on-line section, the instructor built 3-person groups on Blackboard; the students were to use the chat tool to engage in collaborative goal oriented exercises. The meeting times were to accommodate individual students' schedules and thus encourage cooperation and building a learning group. The group membership could be changed during the course of the semester – that would give students an opportunity to interact with more classmates and thus promote creation a class-wide learning community.

The response to the collaborative work varied among the students. Some students responded to the work with enthusiasm, some experienced problems with non-cooperating group mates and eventually and had to change groups, some attended several sessions and then stopped participating in group meetings, and some never attempted to participate in chat room sessions. At the end of the semester, out of 31 who took the final exam, only twelve students received "extra" and "participation" grade credit points for their work in Blackboard Chat Rooms.

It should be noted that all students completed the "shadow" homework assignments, those who worked on them in chat rooms – for credit points, and those who worked on them individually and did not receive any credit points for that effort.

Discussion

During the 16 weeks of the school semester, the instructor received several hundred e-mail messages from the students. The record shows that the instructor sent about 470 messages to individual students and about 30 messages to the whole class lists. The literature in Science of Education emphasizes the facilitator function that an on-line instructor must assume in order to optimize learning outcomes.[7]. Matthews-DeNatale et al. say that the types of relationships that the instructor develops with the students are essential to the success of on-line classes. Matthews-DeNatale et al., specialists in on-line pedagogy, stress the importance of the contact between the instructors and students through e-mail. They recommend checking e-mail throughout the day and responding to e-mail as soon as possible, preferably within 24 hours. The Instructor in the two on-line courses described here, who responded to student e-mail messages very promptly, believes that the large number of e-mail exchanges between individual students and the instructor, have not only been not efficient but also not educationally effective.

Because the students could rely on a prompt response from the instructor, they have not sought interaction and/or collaboration from their fellow classmates. It may be concluded that individual messages actually fragmented the class and hindered community building, and ultimately prevented creating an appreciation for the need and opportunity for effective collaboration amongst students. Based on the investigation of the course activities described here, it is suggested that the use of e-mail communication in on-line classes may be more efficient as well as pedagogically and educationally beneficial if the instructor sets a specific schedule for reading and responding to e-mail messages from students. It is commonly acknowledged that freshmen need a considerable amount of structure in the educational environment. That structure allows them to acquire learning skills and discipline needed to progress through the university educational system.

Taking under consideration the type of the task, i.e., homework assignments, that were to be completed in the virtual rooms, it may be suggested that that type of task was not conducive to a collaborative effort because every student could complete and submit the assignments individually without necessary input from any other student. It may be concluded then, that the tasks designed and assigned for collaborative assignments need to be intra-dependent, and the student work should most probably be supervised.

Collaboration in engineering education as well as on engineering projects in an engineer's professional life constitutes the core and essence of engineering. As more engineering courses and programs are offered on-line, and as it is more recognized that the engineer of the future will need skills that will allow her or him to engage in collaborative endeavors using the Internet, it is important that those skills be introduced into engineering education as early as possible. University undergraduate foundation courses are taken by students in all disciplines, including those from engineering, and the opportunity for learning collaborative skills, cooperation, building domain specific as well as across domain learning communities in those courses should not be undervalued.

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