A paperless, all digital engineering design class

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Abstract

Technology has brought changes to classroom instruction in such ways as "smart boards", instant polling or feedback, accessibility to on-line resources and other digital content, social networking technologies, and others. Some have improved the educational experience while others have proven to be nothing more than gimmicks actually consuming additional time and not improving the quality of discussion. In the 2004 Purdue Spring semester, CE 526 – Design of Temporary Structures was taught as an all digital, paperless, class. In the 2009 Spring semester it was revised and offered again in the same format at Purdue University. And in the 2009 Fall semester it was offered as an on-line course at Indiana University Purdue University Indianapolis. Based on these experiences this paper describes an approach that can alter the role of the instructor producing time savings and productivity improvements that will lower costs for academic institutions. The key to this is delivering educational content in less time consuming fewer resources and giving instructors the ability to deliver more courses saving salaries and overhead which typically consume 90-95% of budgets.

Keywords: digital, productivity, engineering, on-line, multi-media

1   Introduction

Funding for public higher education institutions primarily come primarily from three sources: 1. tuition fees; 2. government funding; and 3. endowments and investments. Due to the recent economic recession sources 2 and 3 have diminished while tuition has increased significantly faster than costs for other goods and services. Data published by Purdue University show that in the ten year period 1994 – 2004 tuition costs more than doubled and student debt loads increased on average from $10,800 to $19,043. Purdue University is not the exception, other universities and colleges have similar trends. A 2006 (Journal and Courier) article stated that using projections developed by Finaid, an online financial aid site, showed that for a newborn , a four-year in-state college education would cost $50,000 their freshman year. Clearly these statistics point out that higher education is on an unsustainable course and in trouble. Fundamental changes must be explored and developed.

When organizations are faced with this situation one course of action is to look at ways to reduce costs and improve productivity. There are numerous studies on how to measure and improve productivity in higher education but very little practice primarily due to academics penchant for turf protection and academic discussions without forming conclusions and action plans.

Real productivity improvement can occur when the "instructor's role" is dramatically changed without sacrificing quality. Through the effective application of technology, this focus can change

and the role of the instructor altered providing real opportunities for productivity improvement. This paper describes an all digital "paperless course" developed and delivered at Purdue University. It is the author's intent to demonstrate with this approach how instructor roles can evolve and provide opportunities for productivity improvement in the delivery of educational content.

2   Course description

Targeting graduate and senior undergraduate students, CE 526 discusses the design of temporary structures used in the construction industry. The course describes not only design issues of temporary structures such as formwork, tieback system, shoring, scaffolding, cofferdams, bracing and guying, and others, but it also covers business aspects associated with the design and construction of temporary structures in the real world such as business practice, legal aspects, and design philosophy. All the course content has been developed by the author and is available through the course website. One of the course goals was to determine how technology can be used to deliver content and create an interactive educational experience.

In developing the course content, the author utilized diverse multimedia resources that may provide efficiencies in learning that have already been verified by several researches (Issa et al. 1999; Radford 1997), proving the impact of multimedia on student's learning and retention. Taking this into consideration, the author paid more attention to appropriate use of multimedia resources when developing the course content. Utilizing the wireless classroom environment and students equipped with tablets, the course has on-line, in-class lectures, tests and quizzes. Through the use of wireless technology this course design method is expected to offer a new paradigm of computer-based learning in engineering education.

Figure 1 - CE 526 Home page

Figure 1 is a view of the instructor's class home page with some overlap with the student page. The page design is grouped into three areas. The left area provides access to course administrative functions for posting course information like lectures, homework and quiz solutions, and editing

student records. The top area contains information on course description, calendar, links to timed controlled tests and quizzes, and links for releasing electronically graded tests and quizzes. The website is comprehensive from the standpoint that other administrative tools such as "Blackboard or OnCourse" are not needed until the end of the semester when posting grades. The bottom area contains the topic links where each topic is organized into the sections: Introduction, Content, Examples, and References. This organization patterns an object based learning model utilizing Kolb's Experiential Learning Theory (ELT) (Kolb, 1984). This is important because it provides the student an organization that stimulates interaction with content in a Why, What, How, and What if experience.
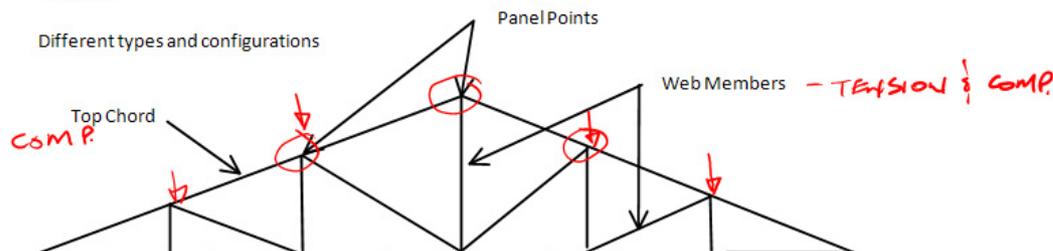

Figure 2 - Lecture Notes

Figure 2 shows a portion of a lecture. Lectures are performed through Microsoft OneNote because it offers an open flexible format for adding text, internet links, images, video, animations and other supporting content. Content can easily be copied from other sources and it is a more natural lecture environment than a slide based approach (e.g. Powerpoint), especially for design content. With a tablet the instructor can add comments and sketches with the pen to the lecture notes. The lecture note is available before the lecture starts through a download on the website. After the lecture is completed the lecture notes are saved and released to the students through the class website.

In figure 2 you will see lecture content containing an image, text, a figure, and links to an internet video and a reference manual. As the lecture is delivered these links can be opened, notes added by the instructor, and with the feature to create additional white space, notes can be expanded to deal with questions and their responses.   Another advantage with this approach it gives the instructor freedom to alter and change content on the go during the lecture and save it electronically.

Tests are released and submitted in a time window meaning the availability and submission times are controlled and restricted. Since this is a design course, test questions are design problems that must be solved with their corresponding calculations shown and OneNote works well. All tests are open content/notes, therefore with digital content retrieval is faster. Test grading and correcting is much faster than grading papers and the instructor has a digital copy when finished.

The Fall 2009 version, TECH 581, is different from CE 526 because it is an on-line class. The content is available through a website like 526. Lectures use OneNote with audio instructions added. The tests are performed on-line like 526. To provide for class room question/answer type interaction, Adobe Breeze is used during designated sessions. These sessions were held approximately every two weeks and done at a time where most students could participate. Sessions were recorded and made available through the class web site. Breeze is an on-line conferencing option that provides for sharing and discussing course material. OneNote, whiteboard, and other course materials can be displayed and discussed together in chat or audio format. This format encourages and removes some of the resistance that some students may have in asking questions or participating in discussions.

The time required to deliver the course and grade has averaged about 6 hours weekly. Approximately half the time is spent on recording the lectures. The next offering, Fall of 2010, the time should go down to 3-4 hours weekly. Using this approach significant time savings are possible for the instructor but what about the educational and student experience?

3   Course Evaluation

Standard student evaluations were performed and without revealing the exact numbers the course evaluations are very similar between the before and after the 2004 (digital) offering. The object-based approach or ELT was evaluated through a class survey. According to the survey data, more than 82% of students answered they are comfortable with the learning cycle. Looking at the learning cycle, most students have affirmative feelings that they obtain enough information and knowledge and learn the topics from Why (72%), What (68%), and How (64%). Many of them (39%), however, answered "undecided" and seem to be sceptical as to how the last step of the learning cycle, What-if, assists them in learning the topic. This limited survey has no statistical validity due to the sample size but it does indicate openness on the part of the students towards ELT and a different pedagogical approach.

Has the course undergone an extensive evaluation with the previous version or has the course been structured so that part is delivered the traditional manner and compared with the digital approach, and the answer to both questions is no. A before and after comparison was not possible since the last class offering was five years earlier. So a quality comparison is not possible. This leaves the door open for questions to measure if this approach has verifiable benefits or they are mere suppositions? The author acknowledges and recognizes this hole. At the same time through the experiences and description contain herein, the course represents an evolutionary step away from a traditional approach toward a new approach that will exist in the future.

Is this a new pedagogy? The answer is no. This format gives the instructor freedom to utilize their own style in presenting and explaining concepts. When content is in digital form, it provides numerous opportunities for repackaging and use in the course and other educational applications, for example continuing education classes. This has been done by developing a subset of the course content into an on-line continuing education class, Vertical Forming System.

Another advantage with this approach is the existence of a "green course." With all content in digital form no paper is required, duplication eliminated, grading performed electronically saving ink and corresponding supplies. Paper and duplication costs represent significant operating expenses for most universities and departments. Since all course records (homeworks, quizzes, tests) are electronic, this allows easier retrieval and cleaner records saving filing space and time. Also, new permutations

of course content are performed easier and the integration of electronic textbook material better accommodated.

4   Summary

The perception that this approach cannot work in these or other hard science courses is not valid. But there are several challenges that must be addressed.

One, content must be in digital form which is problematic for the majority of faculty. A conversion process is needed and this takes time and effort and requires staff resources to assist in the conversion. Since multimedia content enhances these courses, the conversion staff should have the capability to create this content. Graduate students are not qualified for this so the Institution would need to provide these resources through some sort of a "Digital Learning Center resource."

Once the conversion is completed, several benefits will occur. Instructors will spend less time on delivering and administering courses. Productivity will improve and costs will come down. There will be less need for support staff, i.e. clerical and teaching assistants. Content is easier to update and grading goes faster. It is anticipated that the next offering of 581 will require less than 5 hours a week for the instructor. Another benefit is the option of having a "hybrid" course which is a combination of on-line content and class room interaction of one session per week.

Another major obstacle is hardware. In CE 526, tablets were purchased by the academic department and made available to the students. For this investment to payoff, the hardware must be used in multiple courses.

The role of the instructor will change because of technology and student generational preferences by moving away from a "instructor-centered" approach to another form. This form will take on different shapes but will be heavily oriented around IT. The author has several shape ideas but there is not sufficient space in this paper to adequately discuss them. Also, these shapes will morph as technology advances occur. Also, using a digital approach opens opportunities for the development of new training theories and models that will exploit this approach by improving the quality while reducing instructor interaction time.

Support staff will change from the traditional "clerical" role to those having IT based capabilities. This will be delivered more economically through a team model instead of an area model that predominately exists now. The team will be comprised of software developers, multimedia content generators, hardware and network specialists, and other faculty support roles. The main objective of this group is to equip the instructor with the tools needed in this new model.

Even though obstacles exist, the "bite the nail" decision time is approaching for academic institutions. Institutions need to evaluate these new opportunities and implement them. This transformation will occur, it has to, or those institutions that choose not to will become uncompetitive and less efficient. We are at the start of the "digital revolution" which can significantly alter education as we currently know it by making it more efficient and affordable for future students.

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