2006-1446: USING MULTI-MEDIA COURSEWARE TO ENHANCE ACTIVE STUDENT LEARNING IN THE CLASSROOM

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Abstract

More innovative ways of instruction and learning are beginning to infiltrate the field of engineering education. This is motivated by industry demand for entry level employers having more practical decision making experiences, more exposure to realistic and real world engineering problems, the need to improve the learning and retention capacity of students as they matriculate through today's condensed engineering curriculum, and the emerging global competition of the production of engineers. The use of multimedia and information technologies has provided a tool for learning delivery in engineering education, and this project provides a methodology to incorporate real-world experience with decision making in an academic setting. The use of a multimedia case study is used for an engineering design course to encourage team work, improve presentation skills, and simulate real world decision making. An evaluation of the project suggests that students are susceptible to this pedagogy for engineering instruction, and that it can promote critical thinking and team work in an academic environment.

Introduction

The industry foghorn continues to resonate across the engineering academy on the need and desire to reduce the gap in student learning and real world problem solving as graduates enter the workforce. The National Academy of Engineering has appealed to engineering programs to integrate theory and practice in the curriculum, and introduce more innovative learning methods that simulate industrial decision making in the classroom and laboratory [1]. Hence, the challenge for engineering educators is the use of more innovative methods for instruction and learning to replicate real world problem solving, and provide an environment for intellectual exchange of ideas and solutions in a classroom setting. This is further reinforced by the Accreditation Board for Engineering and Technology (ABET) to encourage the use of a cadre of tools and techniques for student development and enrichment in learning.

With the continual desire to shorten the matriculation of engineering training by the reduction of credit hours, and the compactness of technical content, the traditional methods of instruction will not be able to effectively transfer the technical knowledge needed for tomorrow's engineer in four short years of matriculation. With the rapid and emerging developments of information technology (IT) and multimedia tools available for learning, one approach to addressing the above challenge is to use IT software for instruction and learning in engineering education. We define multimedia tools as computer-based communication systems that deliver heterogeneous and compressed/coded/encrypted content (text, audio, video, graphics) from a source or storage device to be interpreted by an end user. This information can also be transferred over a heterogeneous channel like the internet to another user as well [2]. The use of multimedia software can capture learning scenarios or case studies from real world environments, and this information can be delivered and shared within the engineering curricula to expose students to practical problem solving for enhanced learning [3]. We seek to expand on this application of multimedia courseware in the classroom, and validate its effectiveness for active student learning.

Case Study Approach in Engineering Education

This project defines active learning such that it involves a mutual exchange process of participants for problem solving through discussion, team work, brainstorming, and debate within a confined area to formulate a consensus solution. Though the process of active learning is well documented [4, 5], we defined the activity within the context of the use of multimedia courseware to address and solve a specific problem. In this case, the active learning exists between students, faculty, practicing engineers, and research findings. The project also integrates the concept of cooperative learning in which students do work on teams to deliver a final solution as well.

Therefore, the project seeks to study the use of a multimedia case study in the classroom and assess its impact on student learning and relevance of the pedagogy. Though it has had limited applications in the engineering curriculum, more schools are recognizing its value to improving cognitive skills for students. This paper describe applications of using multi-media courseware in a engineering design course to (a) introduce students to decisions practicing engineers encounter; (b) promote teamwork and critical thinking; and (c) expose them to the profession while they are matriculating as engineering students. The evaluation and assessment of the project shows that students did receive educational value in this unique approach to instructional delivery. The project software also provided faculty resources and support for implementing the case-based instructional method.

The use of case studies is to integrate the theory of engineering curricula with a scenario of real world problem solving. Ranju and Sankar [3] have developed a number of real world case studies to use in the classroom for the engineering education community. The Laboratory for Innovative Technology and Engineering Education (LITEE) at Auburn University, AL. has been involved in this emerging technology for almost a decade. The application and implementation of this methodology is slowly being adopted by a number of universities after a thorough assessment of its value to learning and opportunities to look for more unique methods of instruction. One of the case studies in their library was chosen for this project and was used for a typical engineering design course in a bachelors of science program in engineering. This course was interdisciplinary in nature, consisting of students majoring in engineering science with concentrations in mechanical, biomedical, environmental, and electrical engineering. Twenty-three students are enrolled in the course.

The use of case studies is widely known in the business school education community. However, it has limited or no use in the engineering education community as we know it. Case studies have the value of immersing students into a real world scenario in which they must simulate or act as participants themselves to solve the problem describe in the document. There are also other activities in engineering education relating to case study implementation [6,7,8]. In most of the discussion of case studies, they advocate the flexibility of delivery, discussion, assessment, and evaluation. This is because every instructor may have different objectives and specific outcomes desired from the case study and the makeup of the classroom participants. We share this philosophy in this project. In addition, the case studies provided by LITEE can be delivered and implemented in many ways, with factors such as participants, duration, content emphasis, and assessment playing a critical part of the project approach. We designed the case configuration for this project based on time, engineering curricula, and content of the case study.

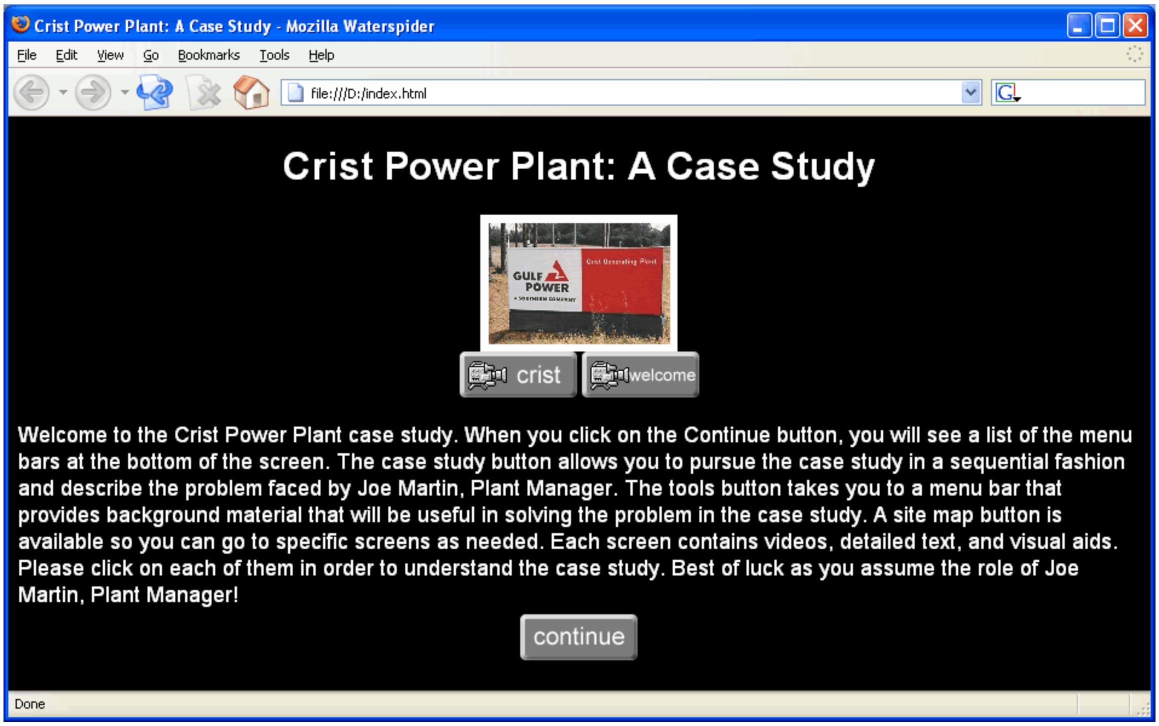
Multimedia Courseware Delivery

The case study chosen for this project deals with a power plant facility in which the problem deals with a mechanical engineering concept [9]. The Crist Power Plant is a facility which supplies utilities within a southern region of the U.S., and is confronted with issues in electric utility deregulation and maintenance problems with one of their turbine generators. These issues and problems are presented in a multimedia compact disc (CD) with digital video and audio of vignettes, technical data, photos, background, and other supporting material to describe the facility and present the problem confronted by engineers, managers, technicians, project manager, and a specific team of engineers to address a immediate problem. A CD screen capture is shown in Figure 1 of the Crist Power Plant multimedia software used in the project.

The scenario describes a reoccurring problem with a turbine generator that must be corrected due to vibration at high speeds, and a team of engineers must decide on one of six alternatives to solve the problem during a scheduled maintenance outage. The case study contains a decision making tool (expert system) for the participants to use to help solve the problem based on the alternatives, and requires the team to use technical and project management skills.

The case study was implemented in an engineering course entitled "engineering design". This course is focused on enrolled bachelor of science students addressing a real world project which involves problem-based learning, and the opportunity to promote team dynamics, communication skills, project management, and technical learning. This case study was used as a primer before another semester-long project. Therefore, this project was implemented over a two-week period facilitated and instructed by one of the authors, and five teams of students. Each team was to address one of five alternatives to the case, which was presented in the case itself. They were to each justify the alternative based on data and information presented in the case and researched material, and present their results in a final presentation. The instructor/author provided overviews of the case study content, and was available for consultation during the two week period.

Figure 1. Screen capture of multimedia software case study.



Classroom/Case Study Results

After analyzing the power plant turbine generator problem, each team was required to present their results on one of five alternative solutions to the case study. Another solution to the case study would be to do nothing. Each team presented their results and justification, and the final decision implemented by the power plant was presented by the first author and discussed with the students. A common factor in each of the presentations was an analysis of "costs and risks" of each alternative. Each team used a decision support system tool supplied with the multimedia software, and presented their conclusions to several professors in the engineering program.

The assessment and evaluation survey method used for the case study project was based on two types of tools for active learning. These tools have been standardize by the LITEE for their multimedia case studies, and was used in this project only as a post-test evaluation assessment. The first tool will be of the multiple choice tests (MCT) format. The purpose of the MCT is to test for specific learning and/or knowledge of concepts from the case study. Though another approach would be to implement a pre-test and post-test, it was preferred to do only the post-test based on the duration of the project. Hence, the only true measurement of this post-test approach is to examine the learning performance of the students from their examination, review, and study of the case study to retain the knowledge after the project is completed. Twenty-one (21) surveys were returned and completed.

The second tool is based on the Print Exposure Checklist (PEC) methodology initially used to assess literacy and to measure the learning of a second language [10, 11]. A Yes-No test format is also used as a type of recognition test for student learning. The survey test is presented with a list of items containing equal numbers of real terms (yes) and foils, or pseudo-terms (no). Items can be names, book titles, journal titles, authors, key terms, dates, and concepts. The students are instructed that some items are "real" and might have been encountered in the reading of the case study or other supporting material. The other items may look or even sound real, but are not. Research results from this format has been shown to correlate with multiple choice and identification examinations, short-answer essays, term papers, final exams, and course grades [12].

The Yes-No test format consisted of eighty terms in which the student would indicate if each term was real or not real. On the average, the students were able to recognize 80% of the terms and their relevance to the case study. We believe if the students worked longer than a week on the case study, their results would be better. Evidence from previous projects supports this hypothesis. However, on the multiple choice test, the average was 90% correct responses. To be exposed to the new material in only two weeks, it appears the active learning process does have some positive impact. Approximately 75% of the students were Caucasian, and the remaining 25% were African American/Black or Asian. Ninety percent of the students had a grade point average of between 3.0 and 3.5, and the remaining students were higher. The case study was done in a class with 95% Juniors. Due to the advanced standing of these students and the highly selective nature of the student body as indicated by the average ACT score (1500), the survey responses were somewhat mixed. Unfortunately, we believe the students felt that the case study was not very challenging. Hence, based on the duration of the project, it may be more appropriate and more valuable for underclassmen such as Freshmen.

A third component of the student survey was to evaluate student perception of the case study content, impact of participation, and provide feedback. This set of questions asked the students to respond to indicate the extent of their agreement with 16 evaluation statements on a 5-point Likert scale. The response scale progressed from a rating of **1** which represented the least positive or least favorable response of **strongly disagree**, to a rating of **5** which represented the most positive or favorable response of **strongly agree**. Two additional questions were added to request feedback on strengths and weaknesses of the case study and suggestions for improvement.

Based on the 36 questionnaire items, some of the questions were combined to represent a particular construct. Therefore, seven constructs were identified and categorized or mapped as shown in Table 1 [13,14]. Scaled values for the constructs were computed by averaging the responses across the items identified as best representing the constructs. The means for the constructs are shown in Table 1 representing the student's reaction to the case study. Given that the scores fall on a 5-point continuum with a score of 5 representing the highest possible response and a score of 3 represents the midpoint, the means are on the positive side of the continuum for most of the constructs, indicating the students had a relatively positive reaction to the case study.

Table 1: Mapping of Constructs and Questionnaire

Constructs	**Items**	**Average**
Important and Valuable	Successful at bringing real-life problems to the session, Challenging, Helpful in learning difficult concepts, Helpful in transferring theory to practice, Helpful in providing a sense of accomplishment	2.94
Instructionally Helpful	Clear, Easy to comprehend, Straightforward, Well organized, Sensitive, Humanizing	3.24
Perceived Skill Development	Identify, Integrate, Evaluate, Express, Interrelate, Solve	3.30
Self-Reported Learning	Improved understanding, Learned new concepts, Identify central issues, Found connection between concepts and case, Identified various alternatives to the problem	3.56
Intrinsic Learning and Motivation	Discussed outside class, Did additional reading, Did thinking for myself	3.07
Improvement of decision-making skills	My decision-making skill improved	3.14
Improvement of problem-solving skills	My problem-solving skills improved	3.04
Difficulty Level	Easy to locate data, Exact meanings were obvious, Easy to find data	3.00

The highest perception of the students was that they did have an opportunity to learn new concepts (self-reported learning) and skill development, but the least valuable construct was the importance of the exercise. For the most part, the actual case did not appear that challenging to these upperclassmen, which may have contributed to these responses. Reviewing the survey results based on the scale of **agree** to **strongly agree**, selected questions for the percentage of respondents is listed in Table 2. Listed below are the main highlights from the student survey evaluation overall.

Table 2. Summary of selected student case study questions.

Case Study Evaluation Survey Question	Percentage of Respondents
Case study brought a real-life problem to the classroom	**60%**
Case study integrate theory to engineering practice	**50%**
Case study provided look into managerial issues	**55%**
Introduce new concepts of the Power Utility Industry	**80%**
Did additional reading to support the case study	**25%**
Learn from other members of the project team	**90%**
Decision making skills were improved	**50%**
Material in the case study provided enough information	**60%**

The results from the student survey would indicate that only about half of the students thought the case study provided an opportunity to simulate a real world decision making engineering process in the classroom. Though most of the students agreed it provided more insight into the electric power industry, half did not feel it helped them with their decision making skills. However, a large majority did see the value in working in teams to actually make decisions, and learned from the other members of their project team. Some of the comments on the strengths of the case study was the opportunity to work in groups focusing on team dynamics, but some of the students thought the project was to simplistic, and the quality of the case study should have been more rigorous.

Conclusions

The objective of using multimedia courseware in the classroom is to simulate real world decision making for engineering students. This new and emerging pedagogy would provide more engineering students to practice decision making, and be exposed to practical problems for the engineering workforce. The activity would also improve the ability to work in teams and presentation skills.

This project however had mixed results in which approximately half of students had opposing viewpoints (Table 2). Based on the survey results, the case study would have probably been more appropriate for a Freshmen course of students. The upperclassmen of engineering students thought the case was to simplistic and not challenging. Though the students valued the team dynamics and the opportunity to work on their presentation skills, it is recommended that case studies be specifically designed for certain levels of students as they matriculate through the curricula. The power plant case study is also best for Freshmen and Sophmore classes, and the content could be more technical for engineering students based on student classification. The instructor could have also directed the teams to focus more on the technical content as well. The student survey perception results from the project were less than expected, preferably above 4.0 median.

However, the authors believe there are some controllable factors to actually improve the impact and more favorable results from the multimedia case study experience. For example, more advanced topics or subject matter is appropriate for junior/senior level students, duration of the case study, and case study delivery. This advice will be shared with the LITEE group, and improvements will be made before future case studies are implemented in the classroom.

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