AC 2008-2237: USE OF CASE STUDIES AT HAMPTON UNIVERSITY: RESULTS OF IMPLEMENTATION

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Abstract

The nation's current and projected need for more Science, Technology, Engineering, and Math (STEM) workers, coupled with the chronically lagging participation of students from ethnically growing segments of the population, argue for policies and programs that will increase the pathways into engineering. Past research has indicated that compared to traditional instructional methods, student-oriented instructional methods such as multi-media case studies that encourage student participation and active involvement in learning are better ways to accomplish these objectives. This paper discusses the results of implementing the Laboratory for Innovative Technology and Engineering Education (LITEE) case studies in an engineering class at Hampton University (HU), a HBCU. Two case studies, Mauritius Auditorium Design and Lorn Textiles, were used in an Introduction to Engineering class. Students were given one class period to analyze the case studies and then required to make presentations during the second class period. Questionnaires were administered at the conclusion of the experiment. Analysis of the student responses show that the students at Hampton University perceived that they had achieved the goals of improving team working skills, showing strong interest in engineering subjects, and improving their higher-order cognitive skills. The instructor reported that the students were engrossed on their work and had lively debates. The results show the need for incorporating multi-media case studies in engineering curriculum.

Introduction

The nation's current and projected need for more Science, Technology, Engineering, and Math (STEM) workers, coupled with the chronically lagging participation of students from ethnically growing segments of the population, argue for policies and programs that will increase the pathways into engineering. Enhancing the curriculum is recognized to be an important way to improve overall diversity in engineering. Retooling curricula to prepare students for the innovation age requires them to explore open-ended problems, thereby acquiring higher-order cognitive and teamwork skills and equipping them with the tools they will need to become successful engineers. Past research has indicated that compared to traditional instructional methods, student-oriented instructional methods such as multi-media case studies that encourage student participation and active involvement in learning are better ways to accomplish these objectives [1]. Many of the new skills needed to succeed in the innovation age can be achieved through the case study pedagogy. This pedagogy may be particularly effective for African-American students, who prefer team-based interactive environments and whose learning styles might be different than those of traditional engineering students [2]. The Laboratory for Innovative Technology and Engineering Education at Auburn University (LITEE) has developed

a set of multi-media case studies that can be used in engineering program. This paper discusses the results of implementing the case studies that are designed by LITEE at Auburn University. The results serve as the evidence to prove the strengths of the case studies.

Why Apply Case Studies at Hampton University

The instructor applied Case Studies to the class *Introduction to Engineering* at Hampton University for two reasons:

1. The ongoing project implemented by the LITEE team is in investigation of proving that case studies help minority Engineering students in achieving academic standards. The results obtained at HU could serve as the evidence that the case studies (a) improve the higher-level cognitive-based problem solving skills of the students, (b) improve persistence of students to stay in engineering programs, and (c) improve the team-working skills of students. These three goals (a)-(c) are the measurements to assess student learning via case studies.

2. HU has its own needs for case studies. Each semester at HU, *Introduction to Engineering* is offered to students from School of Engineering and Technology, and School of Business. More than one session is given. And a typical session of this class has thirty students, two thirds from Business department, and one third from Engineering departments. A concern whether separating Business students from Engineering students is necessary arises because those business students come to this class with weak Mathematics background, have no idea of what Engineering is about, and have little interest in Engineering. Therefore case study would be a more attractive and efficient tool to assess student learning than just teaching them on how to apply fundamentals to solving problems from textbooks. What is more, the case studies could better serve the course objectives. The *Introduction to Engineering* course objectives clearly state: after taking the course, the student will be able to
    a. define the engineering profession, and various engineering disciplines;
    b. cite reasons why they have decided to become engineers;
    c. identify and formulate engineering problems;
    d. solve problems on engineering systems applying the laws of conservation of mass and energy, mechanics, and thermodynamics;
    e. apply various mathematical methods for the solution of engineering problems;
    f. write engineering reports on projects;
    g. make an oral presentation on an engineering project;
    h. collect information and data in the library and world wide web and compose an article using the collected information;
    i. apply the basic engineering design methodology;
    j. apply basic concepts of statistics related to engineering problems;
    use ethics; societal, environmental and safety considerations to make engineering design decisions.

The study proposition is that the LITEE case studies with its emphasis on open-ended problems might help minority students achieve the above course objectives c to k.

Implementation of Case Studies and Results

This section discusses the results of implementation using case studies at Hampton University. Two case studies, Mauritius Auditorium Design, and Lorn Textiles case studies were used in a section of Introduction to Engineering class at Hampton University in Spring 2007. This class was taught by a faculty member at Department of Electrical Engineering.

Mauritius Auditorium Design Case Study

K.P. Raghavan, Vice President of the Buildings and Factories Sector, Engineering Construction and Contracts Division, of Larsen & Toubro Limited (L&T) in Chennai, India, was invited to meet the Indian Ambassador to Mauritius, who told him that there was an opportunity for L&T to carry out a major project to build a new international convention center on the island of Mauritius. The conference center had to be ready in time for a United Nations meeting to review the implementation of the program of action for the Sustainable Development of Small Island Developing States that was to be held in Port-Louis, Mauritius, from the 10th to the14th of January, 2005. The budget for the project was Rs. 80 crores ($17.6 million)[i] and from conception to completion was expected to take no more than 15 months. L&T agreed to undertake the project and the center was completed in time for the conference. Mr. Raghavan heaved a sigh of relief and relaxed as he listened to the video of the Secretary General of U.N., Mr. Kofi Annan delivering the opening address to the assembled delegates in the polyvalent hall in January 2005. This hall was originally intended to accommodate conferences, trade shows, exhibitions, seminars, sporting events, and concerts. It was built specifically to deal with a unique set of requirements and includes retractable chairs, adjustable lighting, and the ability to host multiple events simultaneously, as well as being visually very appealing. The Vice President of Mauritius was very pleased, saying, “This center will be one of the gems of Mauritian architecture, and will stand out as an example of Indo-Mauritian cooperation.” Stephen Schwartz from the U.S. Embassy commented, “Fabulous building and quite an achievement.” .

A few weeks later, however, the architect for the project Mr. Sukumar Hebbar sat in his office at Larsen & Toubro’s headquarters in Chennai, India, pondering the phone call he had just received from the vice president, Mr. K.P. Raghavan. The polyvalent hall of the conference center was about to be used to host its first rock concert in February 2005, but during a rehearsal the musicians complained about the sound quality being not up to expectations in the hall. Sound quality had not been an issue during the U.N. convention, but the louder music was causing problems, and a representative from Chuttur & Partners Limited, the company which managed the conference center, had called Larsen & Toubro wanting to know how to solve the problem. There had been no specific sound requirements when the center was conceived, and Larsen & Toubro was under no legal obligation to solve the acoustic problem. Therefore, a decision had to be made as to whether the company would work to solve the acoustic problem, and if so, how the problem could be solved.

Lorn Textiles Case Study

This case study is an analysis of an actual accident that occurred in 1991. A man lost three of the fingers on his left hand during a routine maintenance procedure when the Lap Winder upon

which he was maintaining, suddenly came on. He sued for negligence in the design and manufacture of the Lap Winder. In a lawsuit such as this one, it is very possible that the plaintiff could be awarded as much as $400,000.

In many states, it may be found that both parties are guilty to a certain extent. In these cases, the defendant would be responsible for their share of the guilt; for instance, if the manufacturer is found to be 70% at fault, then he would owe the plaintiff 70% of the damages awarded by the jury. However, in the state where the accident occurred, Alabama, if it can be proven that the plaintiff was negligent to any degree, than he is guilty of contributory negligence and the defendant owes him nothing.

There are many people that play an important role in this case study:

- Jim Russell – The Plaintiff
- Jason Michaels – Jim Russell's Co-Worker
- Ross Strutherland – Jim Russell's Supervisor
- Matt Tucker – Lorn Manufacturing's Representative
- Kristin Willis – Lorn Manufacturing's V.P. of Personnel
- Jeff Ledbetter – The Plaintiff's Lawyer
- Dennis Rodriguez – The Defendant's Lawyer

The first five people on this list serve to fill in the details regarding the accident itself, the training practices at WMS Clothing, Jim Russell's employer, and the history of Lorn Manufacturing Lap Winder. The last two people on this list are the lawyers involved in the case and serve to bring the case information to the reader in the form of personal interviews, thoughts and depositions.

Aside from these seven people, there are also two expert witnesses that serve to present many of the engineering and management issues to the reader. The expert witnesses are:

- Evan Morrison – For the Plaintiff
- Dr. Kevin Taylor – For the Defendant

These men are experts in their field and are able to describe many of the technical details of the problem. These include areas such as Lock Out/Tag Out procedures, Limit Switches, and the applicable Codes of Standards. Included with this Case Study is a CD-ROM that includes much of the technical information a reader will need to fully understand this problem. The CD-ROM includes information on:

- Lap Winders
- Lock Out/Tag Out Procedures
- Limit Switches
- Engineers as Expert Witnesses
- Codes of Standards

Implementation in a Class

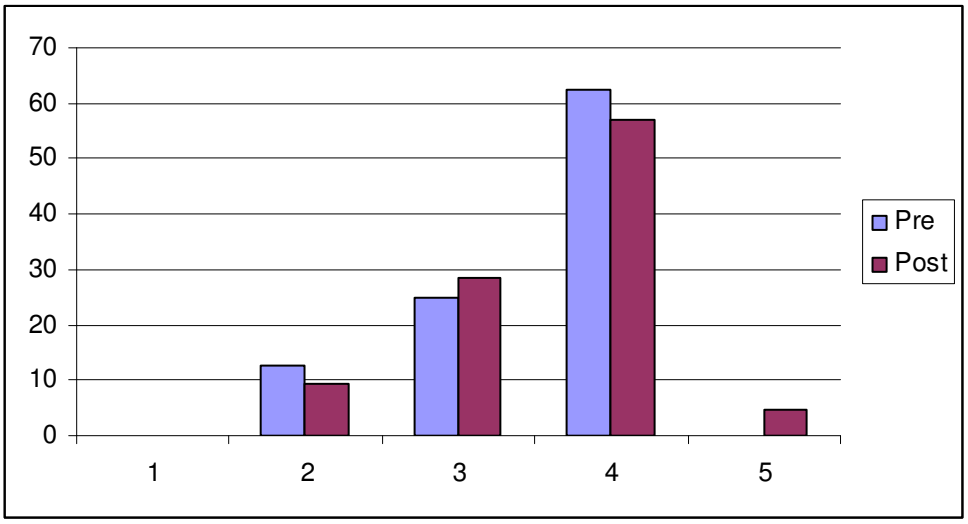
The two case studies were covered in two one-hour classes on April 16, and April 25, which meant students needed to do the research work on the case studies, and prepare for the presentations in one and half weeks. During the first hour class, the instructor spent only few minutes briefly introducing these two cases, and assigned the role to each student team. Each student team included an Engineering major and a Business major. And then student teams began their research on their assigned case studies by searching the information via internet or

the CD provided by LITEE team. During the second class period, each team made a presentation by defending the role the team was assigned. The winning team was expected to possess the following properties: appropriate knowledge regarding important technical terms, appropriate knowledge of the pros and cons for the role the team is defending, good communication skills and good team work spirits. Questionnaires were completed by the students at the start of the first-hour case study class and end of the second-hour case study class. The questionnaires are composed of the questions related to three goals: higher-order cognitive-based problem-solving skills, persistence to stay in engineering programs, and team working skills. The answers on a scale of 1 to 5 for each goal are combined to compute the mean and the standard deviation. Sixteen students gave the answers to the questionnaires. Seven of the sixteen students were female; one of them was white and the rest were African-Americans. The results, as shown in Table 1, demonstrate that the students in Hampton University perceived a modest achievement of the three goals as above average (above 3). For instance, the slight improvement for problem-solving skill could be seen by comparing the results of pre and post answers to question number 18: 'I improved my problem solving skills using the instructional materials.' Figure 1 shows that five percent of students strongly perceived their problem solving skills improved after the case studies while none of them strongly believed it before.

	Mean	Standard Deviation
Higher-order cognitive-based problem-solving skills	3.3	0.3
Persistence to stay in engineering programs	3.2	0.2
Team working skills	3.2	0.2

Scale: 1 – Strongly disagree; 3 – Neither agree nor disagree; 5 – Strongly agree

Table 1: Mean and Standard Deviation for *Introduction to Engineering* Course



Scale: 1 – Strongly disagree; 3 – Neither agree nor disagree; 5 – Strongly agree

Figure 1: Percentage of students giving answers 1-5 to question number 18

Also, the instructor had the following observations on the implementation of the case studies:

- These case studies show students that in order to win over the opponents, they should not only understand the pros and cons of their defending role, but also the pros and cons of their opponents'. Business students learned that a decision making is not just what the boss says. It is also a complicated procedure where choosing the optimum solution could be interpreted as picking the maximum utility based upon the weighted sum of various factors.
- The Mauritius Auditorium case study provides limited technical data; in the Lorn Textiles case study the students can never know what really happened. These case studies show the students that engineering requires reasonable judgment despite limited knowledge, and uncertainty.
- In the Lorn Textiles case study, students realized their communication ability during the debate plays an important role. In the Mauritius Auditorium case study, students realized their own interpretation of technical terms means whether they truly understand the problem or not. These case studies stress the importance of team-working and communication skills.
- In the Mauritius Auditorium case study, students learned that the more technical information regarding "reverberation rate" they can find and understand, the better chance they can win. In the Lorn Textiles case study, students learned that understanding the legal statues in a particular state is the key issue. Thus, these case studies teach students on how to prepare themselves for their future careers as engineers and business persons.
- Given such a short time period (one and a half weeks) for them to do the research on the case studies, students' attitudes towards Engineering almost remained the same level based upon the analysis of the pre and post questionnaire results. The reasons could be

- Students did not have time to do the research work on the case studies.
- Students had so many things going on when it was near the final exam week.
- Students were overwhelmed by the questions during the question session of the presentation.
- Post questionnaires were taken right after the presentation. Students might not have time to reflect on their responses towards Engineering after questions asked by the instructor and other teams.

In conclusion, the results obtained at HU demonstrate that the case studies improve the higher-level cognitive-based problem solving skills of the students. Particularly, decision making, problem identification, and problem solving skills are more strengthened by using case studies than by the non-real problems from the textbooks. Case studies could improve the freshmen-to-sophomore retention rate. Engineering students showed more interests in Engineering and expressed their willingness to stay in Engineering after using the case studies. Even some Business students showed their intentions to change their major. Finally, case studies improve the team-working skills of students. Case studies are naturally fit for African-American students because they prefer team-based interactive environments and their learning styles might be different than those of traditional engineering students. Case studies make them learn more in teams.

Future Work

In the future, we will compare the case study with the traditional pedagogy that is used in introductory courses. Except for the questionnaires we will consider more effective assessment methods to evaluate students learning in case studies. In addition, we will also bring the case studies to our senior Engineering classes to see how much difference the case studies could make for senior level students as opposed to freshmen levels in terms of higher-level cognitive-based problem solving skills, persistence of students to stay in engineering programs, whether they would choose Engineering as their career or pursue graduate program, and the team-working skills of students.

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[i] A n exchange rate of Rs. 45.45 for a dollar has been used in this case study. The exchange rate varies considerably.