2006-1817: CASE STUDY REVEALS SEVERAL BENEFITS INCLUDING DEVELOPMENT OF SOFT SKILLS FOR ENGINEERING TECHNOLOGY STUDENTS AND ASSESSMENT OF KEY TAC-ABET PROGRAM OUTCOMES

Mohan Ketkar, Prairie View A&M University

Dr. Ketkar is an Assistant Professor and coordinator of the Electrical Engineering Technology program at the PVAMU, TX. He received MS and PhD in Electrical Engineering from the University of Wisconsin-Madison. His research areas include communication electronics, instrumentation, and numerical methods. He has been the instructor for senior project courses at University of Houston, TX and PVAMU. He is a member of the College Committee for ABET at the PVAMU. He has participated in several workshops on 'Bringing theory and practice together in engineering classrooms' at the Auburn University, AL.

CASE STUDY REVEALS SEVERAL BENEFITS INCLUDING DEVELOPMENT OF SOFT SKILLS FOR ENGINEERING TECHNOLOGY STUDENTS AND ASSESSMENT OF SEVERAL TAC-ABET PROGRAM OUTCOMES

Introduction

Accreditation of Engineering and Engineering Technology Programs is of prime importance for the graduates, employers, and the institutions. Accreditation is based on demonstration of successful achievement of essential skills by the graduates of the program. The program outcomes are defined by the TAC-ABET. Assessment of the predetermined measurable outcomes in a course by the instructor becomes a primary assessment. Assessment of most of the criteria described in the TAC-ABET can be carried out by identifying and selecting students' assignments. Few of the criteria such as ability to engage in lifelong learning, ability to understand professional responsibilities, and respect to diversity of knowledge, need careful design of the assignments. Several engineering failure case studies have been developed by the Laboratory for Innovative Technology & Engineering Education (LITEE) of the Auburn University (AU), AL for implementation and dissemination. These provide an excellent tool to assess above mentioned criteria.

Accreditation

In the US Accreditation Board for Engineering and Technology (ABET) ¹ evaluates the quality, content, and success of the undergraduate engineering and engineering technology programs. Two commissions within ABET are called the Engineering Accreditation Commission (EAC) and the Technology Accreditation Commission (TAC) for Engineering programs and Technology programs respectively. As a coordinator of the Electrical Engineering Technology program at the Prairie View A&M University (PVAMU) ², I had an opportunity to prepare and present the Electrical Engineering Technology (ELET) program for accreditation to the TAC-ABET evaluators' team during fall 2004.

The program outcomes are described in the 'Criteria for Engineering Technology Programs' ³. An Engineering Technology program must demonstrate that graduates have:

- (a) an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,
- (b) an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
- (c) an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,
- (d) an ability to apply creativity in the design of systems, components or processes appropriate to program objectives,
- (e) an ability to function effectively on teams,
- (f) an ability to identify, analyze and solve technical problems,
- (g) an ability to communicate effectively,
- (h) a recognition of the need for, and an ability to engage in lifelong learning,
- (i) an ability to understand professional, ethical and social responsibilities,

- (j) a respect for diversity and a knowledge of contemporary professional, social and global issues, and
- (k) a commitment to quality, timeliness, and continuous improvement.

The program criteria are established by the lead society in the discipline. For Electrical Engineering Technology programs it is the Institution for Electrical and Electronics Engineering (IEEE). The goals are also to be linked or aligned with the University mission. Continuous improvement is expected and can be achieved by monitoring the students' progress, effectiveness of teaching, observed shortcomings, and recommendations for improvement in future offering. Multiple assessment methods are essential for reality check. The alumni, their employers, and industrial Advisory members can provide additional assessment.

Prairie View A&M University Assessment Plan

Various programs in the College of Engineering at the PVAMU went through assessment and site visit by the ABET evaluator team in November 2004. This included two programs in the Engineering Technology Department. Few years before the visit preparation process started. The first step was to identify three major measurable outcomes in each of the required courses in the major area. This is tabulated as a matrix in Table 1 for the Electrical Engineering Technology program. Secondly many programs in college had to redefine their goals and publish in the catalog and on the university web site.

Table 1. ELET Matrix

Outcomes Measured in each Course in ELET Program required courses											
Course Number and Title	ABET Criteria										
	a	b	c	d	e	f	g	h	i	j	k
ELET1111 DC Circuits Laboratory			x		x		x				
ELET1113 DC Circuits	x	x				x					
ELET1141 AC Circuits Laboratory			x		x		x				
ELET1143 AC Circuits	x	x				x					
ELET2221 Basic Electronics I Laboratory			x		x		x				
ELET2223 Basic Electronics I	x	x				x					
ELET2251 Basic Electronics II Laboratory			x		x		x				
ELET2253 Basic Electronics II	x	x				x					
ELET3023 Computer App. to Electrical Problems	x	x				x					
ELET3241 Network Analysis Laboratory			x		x		x				
ELET3243 Network Analysis	x	x				x					
ELET3451 Robotics I Laboratory			x		x		x				
ELET3453 Robotics I	x	x				x					
ELET3521 Instrumentation and I/O Transducers Lab			x		x		x	x	*	*	*
ELET3523 Instrumentation and I/O Transducers	x	x				x					
ELET4082 Senior Project I		x		x	x		x		x	x	x
ELET4092 Senior Project II		x		x	x		x		x	x	x
ELET4241 Op Amp Theory and Applications Lab			x		x		x				
ELET4243 Op Amp Theory and Applications	x	x				x					
TECH1002 Applied Sciences Seminar								x	x	x	
TECH1103 Computer Aided Drafting	x			x							
TECH3203 Eng/Technical Communication							x		x	x	
CPET1013 Computer Applications I	x					x					

CPET1023 Computer Applications II	x					x					
CPET2111 Digital Logic Circuits Laboratory			x		x		x				
CPET2113 Digital Logic Circuits	x					x					
CPET4181 Single Chip Microprocessor Lab			x		x		x				
CPET4183 Single Chip Microprocessor	x	x									
MCET3103 Math Applications for Technology		x				x					

Criteria ‘a through g’ above can be usually covered in most of the lecture and lab oriented courses. Identifying or designing assignments appropriate for these criteria and assessment is usually not difficult. Criteria h, i, j and k need careful consideration to define appropriate student assignment. Case studies is considered as possible topic to cover there outcomes.

Case Studies developed at the Auburn University

Several case studies have been developed by the Laboratory for Innovative Technology & Engineering Education (LITEE)⁴ of the Auburn University (AU), AL funded by the NSF for implementation and dissemination. As a part of the pilot project of the proposed NSF proposal for national dissemination, a case study was included in one of the upper level courses in the Electrical Engineering Technology program at PVAMU. The primary objective of implementing a case study was to test the success of case study approach in diverse environment. However it was observed that case study revealed excellent opportunity to assess outcomes which are difficult in the regular lecture/lab courses. Typical case study consists of well documented real life problem with various personnel involved making evaluation of the problem and recommend an approach. Students are able to develop decision making and problem solving skills through the case study.

Case studies and ABET TAC criteria

Case studies have been shown to benefit Engineering and Engineering Technology students to develop and practice various skills at all levels from the freshman through the senior year. It was proposed to utilize a case study to assess the outcomes such as h, i, j and k.

Each case study has various implications such as engineering design, operation and maintenance, management, business, economics, social, and environmental. Decision making is involved at each stage and recommendations are made to solve the problem. Active participation from each team members makes the presentation very exciting. After the deliberations students are told how the problem was solved in real life. Students evaluate each others’ participation. The grades are based on the success of making a convincing argument.

Case study for ELET

The Prairie View A&M University (PVAMU), TX is a member of a pilot project for a new proposal for implementation and dissemination of case studies being submitted to the NSF by the LITEE of AU. PVAMU is a HBCU campus and a member institution of the Texas A&M system, offering undergraduate degrees in Engineering and Engineering Technology. The case studies developed by LITEE will be introduced to College faculty through workshops under this new proposal.

A case study was implemented in a junior level course, Instrumentation and IO Transducers, of the Electrical Engineering Technology (ELET) program. Della Steam Plant⁵ case study

developed by the LITEE was selected considering the background of the students. This case deals with experiencing excessive vibrations observed during restart of a turbine after routine maintenance. The case deals with the manufacturer's representative, the maintenance supervisor, plant manager and future technology group. For implementation in to this course, four student teams were formed and assigned a particular role. In addition five students were appointed as external observers/judges. The case study objectives and actual problem was explained to all Teams. Each team was given with the documentation and one week for research and preparation for presentation. The deliberations were carried out in professional manner.

Survey Instruments

The student survey questions addressing assessment of skills, knowledge, and demographic data was obtained from LITEE. The survey instrument consisted of 36 following questions:

1. The case study was successful in bringing real-life problems to the session
2. The case study was challenging
3. The case study was helpful in learning difficult concepts
4. The case study was helpful in transferring theory to practice
5. I improved my ability to identify issues related to the power industry
6. I improved my ability to identify issues related to physics concepts
7. I improved my ability to integrate issues related to the power industry
8. I improved my ability to critically evaluate power industry alternatives
9. I improved my ability to critically evaluate alternatives
10. I became confident in expressing my ideas
11. I learned to value my colleagues' point of view
12. I learned to interrelate important topics and ideas
13. I improved my understanding of basic power industry and physics concepts
14. I learned new concepts related to power industry
15. I learned to identify central issues related to power industry
16. I learned to identify central issues related to physics concepts
17. I discussed topics related to the power industry outside the class
18. I did additional reading on topics related to the power industry
19. I did additional reading on physics topics
20. I did some thinking for myself about issues related to the power industry
21. I did some thinking for myself about physics
22. I learned from other colleagues during the session
23. I found connection between power industry concepts discussed and the case study
24. I found connection between physics concepts discussed and the case study
25. I identified various alternatives to the problem
26. My decision-making skills improved
27. My problem-solving skills improved
28. It was easy to locate data on the power industry, even if I had not used that data before
29. On the reports or system reports I dealt with, the exact meaning of terminology related to the power industry was either obvious, or easy to find out
30. On the reports or system reports I dealt with, the exact meaning of terminology related to the physics was either obvious, or easy to find out

31. The material provided in the case study helped me complete tasks within the given time
32. The manner in which the materials were presented in the case study helped me complete my tasks within the given time
33. It was easy to learn how to use the case study
34. The case study was convenient and easy to use
35. There was not enough training for me or my group on how to find understand, access or use the case study
36. I got the training I needed to be able to work on the case study effectively

In addition data on GPA, major, gender, ethnicity, and standing of each participant was collected for later use.

Peer-Evaluations

Each student was asked to evaluate presentations by all the teams except his/her own team. Few students who could not join any group were asked to evaluate all the teams' presentation. The eight questions in this part of the survey included to rate the quality of presentation, professionalism, use of multimedia, timeliness, and making convincing argument. The rating was on a 1-5 scale with 5 being excellent.

Survey Results

The Instrumentation and IO Transducers lab class had 21 students. The class had 24% female students and 79% African American with 21% Hispanics. 90% of the class had seniors standing.

The average of response for 36 questions on assessment of the case study is presented in the Figure 1. The overall average of achievement of skills was 3.97 with a standard deviation of 0.78. This indicates very good students' achievement of the skills listed under h, i, j, and k.

Figure 1: Averages of students' responses to 36 questions

Students' Comments

Students were also asked to provide written comments besides the team and peer-evaluations. Following examples of the comments indicate large success of the implementation of case study in the lab course. Many comments have constructive feedback.

Students' comments about the strengths of the case study:

- Case study was a positive agenda in this course
- Case study helped me transferring theory to practice
- Analysis of the problem and breaking down the terminology, pros and cons and cost effect
- The way to prevent any problems from occurring
- The packet provided great evidences on the case with figures and extra information
- It allowed students to do some research
- Class participation and real life experience
- Enough information for student to prepare their case
- The case study allowed us to solve problems that face the industry and our field of study
- It was an actual event that provided various situations and only one outcome, the desired one which has no safety hazard of a very low cost effective factor
- It was short and to the point
- It was a good case which gave us a chance to learn about things we would not know otherwise

Conclusions

Implementation of Case studies into various courses provides excellent tool to assess outcomes which are not covered by regular assignments such as tests, quizzes, and homework. Many engineering case studies which involve team work, research, and debate are available for implementation. Students enjoyed the presentations after going through research and preparation for debate. They were eager to know the actual approach followed in the real life case. Life long learning activities such as how to do research on a technical aspect, how to compare viable approaches with technical, economical, environmental impact and safety factors, and peer evaluations are covered in most of the cases.

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