Teaching throughTechnology for Engineering Technology: Case Study Approach

Muge Mukaddes Darwish
Texas Tech Universty , Lubbock ,TX , USA mukaddes.darwish@ttu.

Bolanle Olaniran
Texas Tech Universty , Lubbock ,TX , USA , bolanle.olaniran@ttu.edu

ABSTRACT

Case studies are an increasingly popular form of active teaching and have an important role in active learning, developing the skills and knowledge of students in engineering and engineering technology. It is a well known fact that engineering technology students are expected to be industry- ready and are increasingly being asked by potential employers to demonstrate "soft" skills (such as problem solving, team working, decision making, and business skills) in addition to their "hard" technical skills. Reflecting these expectations, the Accreditation Board for Engineering Education (ABET) has defined a set of accreditation criteria for Engineering Technology programs. The Laboratory for Innovative Technology and Engineering Education (LITEE) team at Auburn University obtained funding from the NSF and, working with industrial partners, has developed multimedia case studies to address these expectations (Raju & Sankar, 2006).
We will examine common methods of technologies in use and how they can impact and enhance student learning. Further, this paper will provide information about the use of multimedia developed by LITEE to model ways the students can be more involved in and more responsible for their education and for partnering with instructors. We will also show the results from using these case studies in classes where an evaluation will show that the students improved their problem solving and business skills.

Keywords: Active learning, LITEE cases, Engineering education.

Introduction

In the 1980's, a series of experiments was done on the effectiveness of several teaching methods in higher education as well as in engineering education. Research shows that traditional instructor-centered teaching is less effective than student–centered learning in preparing engineering students. (1991; Khurfiss, 1988; McKeachie et al., 1986;National Research Counsel, 1996; Raju & Sankar 1999; Sankar and Raju, 2003; Tribus, 1992;). Research has also shown that active student-based learning methods improve abilities in communication, leadership, ethical decision making, and critical thinking (Steven et al., 2002), in addition to achieving learning objectives related to content. Active learning, partnered with the instructor in traditional engineering classrooms, can generate powerful results for the learner by teaching how theory can be put into practice.

Events of this decade have created a dramatic paradigm shift in engineering and technology education. The changing demands and expectations of employers, as well as revolutionary technological, economic and other challenges and opportunities such as new developments in Information Technology (IT), are continuing to strongly influence the content of engineering practice, which in turn, influences the engineering education of the future.

In this paper we briefly review paradigm shifting from traditional lecture-based delivery to student-based active learning methods and describe implementation of the active learning method paired with technological delivery.

Results of using cases developed by LITEE are also discusses in this paper. Media includes television, video, digital cameras and computers, world –wide web couple of Engineering Technology classes.

Background

Although achievements in technology and IT have demanded paradigm shifts in engineering and engineering technology, still lectures or "teaching by telling" is the traditional and the most widely-used mode of instruction in engineering colleges. The most frequently cited drawback of the lecture method is that it usually results in long periods of uninterrupted instructor-centered, expository discourse, relegating students to the role of passive spectators in the classroom (Halpin , G et al.; 2004) This method, however, continues to be used in most engineering classes. For example, most engineering technology design courses make the students work on oversimplified theoretical representations of real-world problems. Students may obtain in-depth understanding of the principles of design but they lack the knowledge and ability to link the theories for solving practical real life problems. Therefore, we investigated the use of the case study method of teaching in order to communicate real-world industrial experience in engineering technology classrooms.

Engineering Technology differs from engineering education by teaching applied science and engineering knowledge. Therefore teaching methods must be combined with theory and technical skills to support engineering activities. The engineering technologist's role is to be an implementer rather than an inventor, and to support engineering functions. In Materials Technology and Engineering Economics classes at the sophomore level, courses are offered in the Engineering Technology department. The instructor has the opportunity to teach theory accompanied by applied aspects of science and engineering. Students are exposed to problems involving the simultaneous mix of mathematics, physics, chemistry, computers, and common sense in creative and challenging ways.

Perspective adapted

In order to implement the above mentioned, we first considered the issues of how an instructor can improve the quality of instruction that leads to students' effective learning. Then we approached the more difficult: how can we improve students' active involvement in learning in and out of the classrooms? In the subject of how to improve Engineering education, there have been 395 papers written from 1997 to 2002 in the proceedings of the American Society of Engineering education and many more were added during last 2 years (Steven et al., 2002). Literature offers methods of implementation from small changes in existing courses to a complete restructuring of the curriculum (Carroll, 1997, Koen, 1993). Because of the easy nature many researchers advised modification of existing teaching style by incorporating additional forms of active learning activities. (Buchanan, 1991; Cambell and Smith, 1997; Felder, 1995; McKeachchie, 1986; Thscumi, 1991).

An excellent way to learn and understand a theory is trying to see whether one can apply the theory. Engineering is problem solving by applying results from engineering research. Engineering technologist must be able to implement and apply the results for practical way. Therefore, it is obvious to try to combine the fundamental learning process and engineering problem solving. This brings to mind that inside of teaching too much theory why not teach ENGINEERING?

Real life problems are not defined in engineering terms. Thus, necessary to provide information on problem analysis, definitions and formulation in engineering terms before starting with the problem solving. Therefore a case study that will integrate all this components and also will include finance, marketing, communications law etc will be very useful teaching tool for engineering and engineering technology students in order to prepare them for the competitive global market place. Therefore using case study methods in engineering and engineering technology classroom is very valuable tool to provide information about finance, marketing, communications law that many knows little or if not. In the competitive global market place this information are no more added value but it is necessity. Through case studies, students can learn basic principles while gaining experience with engineering practice and interdisciplinary knowledge throughout their undergraduate years and be ready for the industry.

Olaniran, 2007 also argues that one thing that case study approach offers students in general and science and engineering learners in particular, is the ability to make connection between what is being learn and how to transform what is being learn into solving practical and realistic problem (i.e., reflection and critical thinking). Granted that culture plays significant role in how students learn and how they use technology to learn One cannot deny the fact that students themselves create and co create meaning (make sense of learning). Per chance this is the area where the constructivist ideology makes its most contributions in most Western cultures that fosters the individualistic cultural tendencies toward learning and represents the major platform for which electronic learning is developed and encouraged.

Our implementation was based on the following concepts;

- Professors should be designers of learning experience and not teachers.
- Education is a cooperative enterprise that works best when cooperation between instructor/student and student/student is allowed,
- University students are adults. If the students are not the given opportunity to practice adult behavior, they will not able to learn such behavior,
- Instructors are experts/helpers. Instructors help student to learn how to be independent and take responsibility for their own learning,
- Most students learn outside of the classroom. The instructor's aim is to provide the basic knowledge needed in the classroom, while stimulating and guiding students to learn outside the classroom so students can have the ability to continue learning.

Instructional strategies

- Instructional objectives written and student have been told that the accomplishment of objectives is partly their problem. At the end of the class students are asked to summarize the important points in the lecture just concluded.
- Active learning methods used in the class to maintain students' attention through the class session. This is achieved mainly by small group exercises. At some point during the class, students have been told to get into groups of three or four and short question or problem is assigned to the groups. After a suitable period has elapsed teams are called to present the solutions. Calling on student than asking volunteers are essential to make sure all students are involved in the thinking process.
- Analytical, critical and creative thinking is provoked. Students were asked to write a strategy to solution of a problem, or complete the solution of problem has been half worked by the instructor in the class, or asked to find alternative answers or different methods to solve problem if there is any.
- Technology was integrated into delivery of the instructions. The delivery media include television, videotape, computer, and World Wide Web.
- Students were encouraged /or for most of the activities required to use of electronic data base search, electronic mail asking questions and submitting assignments. Several mathematical problems assigned to be solved by mathematical software (TK solver) and spreadsheets.
- Through the courses several real creative real world engineering problems were introduced in the classes. They were presented in the form of lecture, video, multimedia and simulation software. Integrating theory into practice was by using the case study approach which is briefly explained in following section.

Case Study Approach

There are number of definitions for the term "*case study*". Case studies are actual examples requiring the synthesis of a large amount of different kind of information, and the making of recommendations or decisions. Yin, (1994) defines case study as "A case study is an empirical inquiry that investigates a significant event within its real world environment, the boundaries between event and environment are not clear, and in which multiple evidence are used. Fry et al., (1999) describes case studies as complex examples which give an insight into the context of a problem as well as illustrating the main point.

Due to (Raju and Sankar 2003) a case study typically is a record of a technical and business issue that actually has been faced by managers, together with surrounding facts, opinions, and prejudices upon which management decisions have to depend. These real and particularized cases are presented to students for considered analyses, open discussion, and final discussion as to the type of action that should be taken.

In our teaching we modified these ideas and definitions to suit our engineering and technical content. In a traditional class setting we have implemented student activities based on the topics that demonstrate theoretical concepts in applied setting. A case study developed by LITEE that includes a real life engineering problem is assigned to each group, and groups are asked to prepare a detailed review, capturing the background of the situation and explaining the process and outcomes. Each group works independently of other groups and each team member is obliged to rely on the others to achieve the goal. All team members are accountable for both doing their share of the work and for understanding everything in the final product. Each group presents their final product in a formal report and oral presentations to class. Students are encouraged to contact real companies and use the web as well as the scientific journals and other supplementary books for gathering information. Students used power point presentations or pre-edited videotape; some students are more comfortable preparing their video tape so they can have a chance to practice and edit on the video. At the beginning of the course, students seemed not to like the presentation part of the assignment, but their view changed at the end of the course and most of the students' comments were positive. Their comments included such as "presentations help us to improve communications, public speaking was improved, confidence built up about the subject and general, I earned deeper understating about the subject etc". Computer and other forms of technological teaching tools are provided in the classrooms. Teams with two people were not large enough to generate ideas and approaches; teams of five people were too large to do the job efficiently; therefore teams of 3 or 4 are advisable.

Does it Work?

There are many forms of case study techniques available and can be applied in Engineering Technology classrooms, because of nature of each classis different and must be handled its own way. In general our experiments showed that case study method improved students learning and provide students to improve their communication skills, students were exposed to real life engineering problems so that the made them experience their talents for making decisions and operating as self reliant engineer. Our experiments showed that if the implementation is done correctly active learning does work. Case studies implementation can see resistant by some students and also some instructor because of some students who used to getting information directly from their instructors since kindergarten, and do not appreciate the new learning methods nor taking the major responsibility for their own learning. On the other hand, some, instructors hesitate to apply active learning methods based on the myths of following:

1) It wont be successful in technical courses,
2) It won't leave enough time to cover the important concepts,
3) Students won't like to work together and won't like to meet outside of the school.
4) When students work as groups it is difficult to assess individual work,
5) Active learning means no lecturing,
6) Preparation of class time will be much longer,
7) Student's learning will not be effected by implementing active learning.

In our experience, an important factor in implementing of case studies into a course is the style or structure of the course itself. In fact that it tends to be very time consuming if it is not carefully managed and organized. Essentially most faculty members are already fully loaded with their present teaching, research and service obligations. The personalities of faculty are important, the more adaptable the better. Unfortunately there is no single formula on how to integrate this practice into engineering or engineering technology education. Most often, students consider the GPA rather than improving their learning, does not want to take the responsibility for their own learning. In our study we are convinced that properly implemented student centered active learning in engineering technology courses works. It can take more effort to prepare classes but in return the effectiveness' of teaching improves.

Evaluation of effectiveness of the method

We used Della- case study in Engineering Materials Technology class with main objective to show that good decisions require that managers become involved in understanding unfamiliar technologies and strike a balance between technical, financial, and management issues.

At the end of the class we administered evaluation form developed and provided by LITEE to the students at the end of the classes. Evaluation I consisted of 15 statements to which the students responded using a 5-point Likert scale ranging from (1) Strongly Agree to (5) Strongly Disagree. Percentages choosing each of the respective response options for each of the items are presented in Table I.

Table 1: Students Evaluation Results

Item	Percentage				
	1	2	3	4	5
Improved my ability to integrate technical and managerial issues	81	9	5	4	1
Improved my ability to evaluate critically technical and managerial issues	79	8	7	4	2
I became more confident in expressing my ideas	82	11	5	1	1
I learned to value other students' points of view.	89	8	2	1	0
I learned to interrelate important topics and ideas	83	12	4	1	0
I improved my understanding of basic concepts	72	21	5	1	1
I learned new concepts.	74	17	6	2	1
I learned to identify central technical and managerial issues.	70	14	9	4	3
I discussed technical and managerial topics outside of class	71	13	10	1	5
I did additional reading on technical and managerial issues.	67	22	6	4	1
I improved oral communication skills.	89	6	5	0	0
I improved my written communication skills.	73	13	11	1	2
I learned from other students in class.	65	21	9	3	2

1 - Strongly Agree, 2 - Agree, 3 - Neither Agree nor Disagree, 4 - Disagree, 5 - Strongly Disagree

Conclusions

The use of technological tools and the implementation of active learning methods were well received by the students. Engineering Technology curricula emphasizes the application of theory rather than pure science itself. The events of this decade (global economy, IT, international competition, diverse workforce, environmental sustainability, green manufacturing, etc), have shifted the focus of engineering and related technical education from a traditional approach to integrating theory into practice in the engineering classrooms. Industry stresses that engineering students should be prepared for real-world problem-solving and they prefer students with higher GPA's and communication and leadership skills. If the implementation is done correctly, small group methods with the case study approach can be very effective learning modes, providing students with skills and knowledge demanded by the industry and the changing needs of the 21st century. In engineering, experience plays a crucial role, therefore using case studies as a teaching tool helps student to gain valuable engineering experience while in school. In short, group activities help students prepare to be team players, improve their individual study skills, teach information gathering and analysis, improve time management and presentations skills and more important, provide practical skills. The active learning approach positively influences and strengthens student/faculty relationship, as faculty members share their engineering experience with students. Implementing active learning into the traditional engineering classroom is challenging for the faculty, but it offers the opportunity to teach engineering principles in a hands-on format.

End-of-course evaluations in the experimental classes showed that active learning was well received by the students and was beneficial in helping them achieve course objectives. Course evaluation also showed that the use of case studies in classes improved students' problem solving and business skills.

References

ABET Engineering Criteria 2000, Engineering Accreditation Commission of the accreditation Board for Engineering and technology, Inc., 1996

Buchanan, W.W., 1991, "An Experiment in Pairs testing with Electrical Engineering Technology "Students, ASEE Annual Conference Proceedings, pp.1764-1766, 1991.

Campbell, W.E., and Smith, K.A., (Eds.), 1997, New Paradigms for College Teaching. Edina, MN: Interaction Book Company.

Carroll, D.R., 1997, "Integrating Design into the Sophomore and Junior Level Mechanics Courses" Journal of Engineering Education, pp.227-231, July1997.

Felder, R.M., 1995, "A Longitudinal Study of Engineering Student performance and retention. IV. Instructional Methods. Journal of Engineering Education, pp. 361-367, October1995

Felder, R.M.., 1992, "How About a Quick One?" Chemical Engineering Education, 26(1), pp.18-19(Winter 1992)

Halpin, G. et al., Real-World Problems in the Classroom: Vital in Engineering Education. 34th ASEE/IEEE Frontiers in Education Conference October 20 – 23, 2004, Savannah, GA

Johnson, D.W., Johnson, R.T., and Smith, K.A., 1991, "Cooperative Learning: Increasing College Faculty instructional Productivity" ASHE-ERIC Report on Higher Education. Washington, DC: The George Washington University

Koen, B.V., 1993, "Toward a Strategy for Teaching Engineering design" " Journal of Engineering Education, pp.193

Kurfiss, J.G., 1998, "Critical Thinking: Theory, Research, Practice, and Possibilities" ASHE ERIC Higher Education report#2, Washington DC: Association for the study of Higher Education.

Martha. M., 1997, "The Connection between Cooperative Learning and Authentic Assessment" URL: http://www.sabes.org

McKeachie, W. J., Pintrich, P. R., Lin, Y.G., and Smith, D.A.F., 1986, "Teaching and Learning in the College Classrooms: A Review of the Research Literature" Ann Arbor: National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan.

National Research Counsel., 1995 Engineering Education: Designing and Adoptive system The Board of Engineering Education, National Research Counsel. National Academy Press,1995.

NSF: Educating the Next Generation of Information Specialist in Collaboration with Industry, National Science Foundation Report NSF#9455450, 1997

Olaniran, B. (2007). Challenges to implementing e-learning and lesser developed countries. In A. L. Edmundson (Ed.), Globalized e-learning cultural challenges. (pp. 18- 34). Hershey PA: Idea Group, Inc.

Raju, P.K and Sankar, C. S., 1999, "Teaching Real-World Issues through Case Studies" Journal of Engineering Education, 88(4) pp 501508, October 1999

Sankar, C. S., Raju, P.K., 2003, " Educating Engineers for the information Age" Proceedings of the 2003 ASEE annual Conference, Nashville, TN, 2003

Steven, R. H., Ian, W., Doris, R.B., Diane, H.S., and Reem, N., 2002, "Adoption ofIActive Learning in Lecture-Based Engineering Class" 32nd ASEE/IEEE Frontiers in Education Conference T2A-12Boston, MA, November 6-9 # 0-7803-7444

Tribus, M., 1992, Total quality Management in Schools of Business and Engineering. In Harry V. Roberts (Ed.). Academic Initiatives in Total Quality for Higher Education. Milwaukee, WI: ASQC Quality Press. 1992

Tschumi, P., 1991, "Using an Active Learning Strategy in introduction to Digital Systems" ASEE Annual Conference Proceedings, 1991, pp.1987-1990

Yin, R., 1994, Case study research: Design and methods (2nd ed.). Beverly Hills, CA: Sage Publishing

Wulf, W.A., 1998, "The urgency of Engineering Education Reform" The Bridge, 28(1), spring 1998.

MUGE MUKADDES DARWISH
Dr. Darwish currently serves as assistant professor and undergraduate advisor for Engineering Technology department at the Texas Tech University. Her professional interests include alternative water use in construction, waste water treatments, Sustainable construction and materials, geotechnical engineering as well as the enhancements of engineering education.

BOLENLE OLANIRAN
Dr. Bolanle Olaniran is a professor in the Communication Studies Department at Texas Tech University. His area of research and professional interests include: organizational, groups, and cross-cultural communication and especially the role of technologies in these a