LT^2-ET: Learning Through Technology for Engineering Technology

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Abstract

The traditional instructor-centered teaching process has proven to be less effective as compared to the use of active, cooperative learning methods. Students can learn more effectively when involved in the learning process. Researchers consistently have shown a paradigm shift in engineering education from traditional instructor methods to active learning methods.

Engineering Technology students are being asked to demonstrate problem solving and communication skills in addition to technical skills by their potential employers. The Accreditation Board for Engineering and Technology Education (ABET) has defined a set of accreditation criteria (3a-k) which identifies eleven requirements expected of engineering graduates to fulfill industry expectations. It is therefore important to know the nature of active learning, the empirical research on its use and how faculty should make the necessary paradigm shift in Engineering Technology education to prepare students for 21st century markets.

This paper will discuss the paradigm shift from teaching to learning. We will examine common methods and technologies in use and how this technology can impact and enhance student learning. Further, this paper will provide information about how to get students more involved and be responsible for their education thru the case study approach.

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. (Buchanan,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 base delivery to student based active learning methods and describe implementation of the active learning method paired with technological delivery. Media includes television, video, digital cameras and computers, world –wide web couple of Engineering Technology classes.

Background

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. Fluid Mechanics and Materials Technology classes' sophomore level, courses are offered in the Engineering Technology department they offers the instructor 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.

The current text books available for both courses are primarily written for engineering students; they include detailed theory which creates uninteresting academic difficulty for many engineering technology students. However when theory is accompanied with technological educational tools, and teaching media, conceptual understanding is enhanced. Active/cooperative learning methods produces higher achievement more positive relationship among students and also increase mechanics of course effectiveness well beyond the traditional instructor base teaching methods.

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; Campbell and Smith, 1997; Felder, 1995; McKeachie, 1986; Tschumi, 1991).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
- Students must do more than just listen to truly learn. (Figure1).

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
- Students were exposed to real life engineering problems by using the case study approach which is briefly explained in following section.

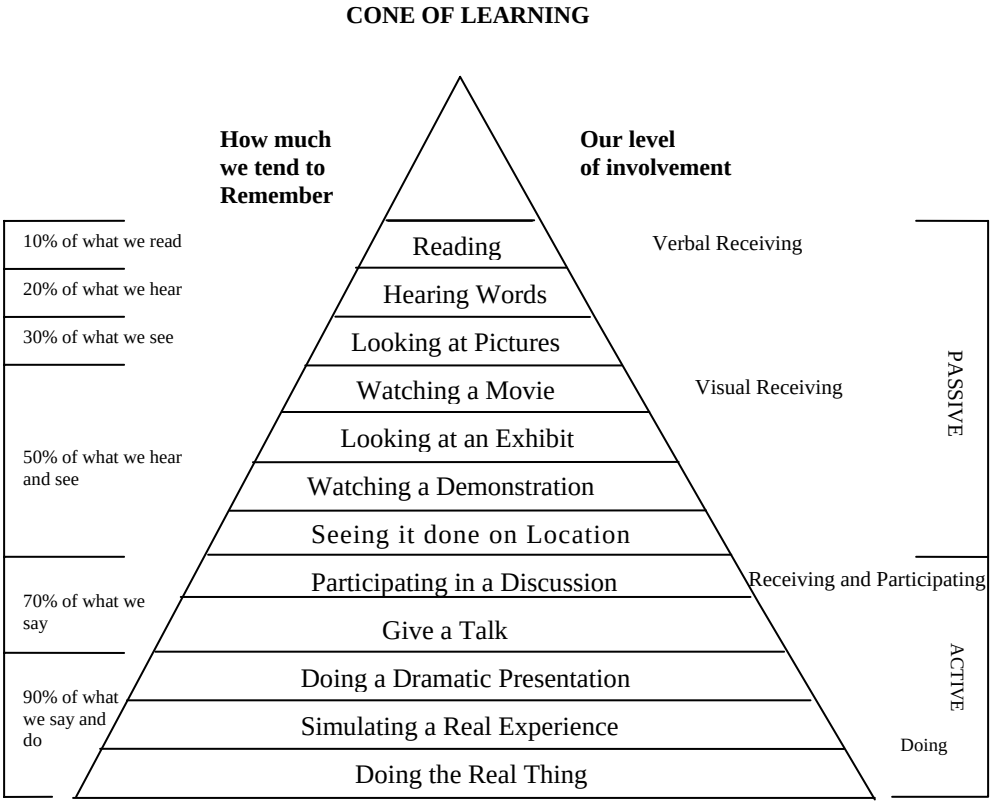

Figure 1. Cone of learning

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. Research on the web can yield many other definitions of case study.

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 real life engineering problem is assigned to each group and asked to prepare a detailed review, capturing the background of the situation and explaining the process, and outcomes. Each group's works independently of other groups and each team member is obliged to rely on one another 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. Some students find more comfortable use of pre-edited video tape while other used power point

presentations. Students are encouraged to contact real companies and use the web as well as the scientific journals and other supplementary books for gathering information. Minimum of three case studies were assigned during semester. Team members instructed to meet minimum of twice a week to discuss and exchange knowledge. 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 worked better and are advisable. At the begging of the course some students were reluctant to case study approach and complained about having to spend extra time on preparing presentations but their view changed at the end of the course and most of the students comments were positive. Their comments included such as *"Oral presentations improved my communication skills; public speaking is improved; confidence built up about the subject and general; I earned deeper understating about the subject etc*".

Does it Work?

There are many forms of case study techniques available and can be applied in Engineering Technology classrooms, because the nature of each classes 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 won't 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 and 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 spite of difficulties described above, improving the quality of classroom instruction is worthwhile goal. In this short term 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 is improved, therefore the quality of the institutional teaching program be improved if as many faculty members as possible implements this type of instructional methods in their classes.

Summary and Conclusions

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 and technology students should be prepared for real-world problem-solving skills, and prefers 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, learn information gathering and analysis, improve time management and presentations skills and more important, gain 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. The use of technological tools and implementation of active learning methods were well received by the students.

Acknowledgement

Authors extend their gratitude for the help in editing of this paper to Ms. Carolyn Kennedy, Texas Tech University.

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)

Fry, H., Ketteridge, S., and Marshall, S., 1999, A Handbook for teaching and Learning in Higher Education. Enhancing Academic Practice. Kogan Page, Glasgow, pp 408

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

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.

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