AC 2008-1704: TEACHING ELECTRONICS ENGINEERING TECHNOLOGY DESIGN USING CASES: A STUDENT PERSPECTIVE

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Abstract

For engineering educators, cases are excellent teaching tools which can be effectively used to provide high quality instruction for students with opportunities for exploration of real world situations. Previous research has primarily focused on educators' evaluation of cases as a pedagogical tool. Evaluations have indicated that the tool positively affects student learning in a variety of ways and recommendations for the extensive use of cases have been made. An exploration of current research indicates very little indication of how engineering students feel about the impact of the case method on their learning. To fill this gap in research this paper presents the students' perception of the use of cases as a teaching tool. The aim is to enhance engineering education coffers through inclusion of the students' perspective on case teaching as additional support for the use of cases as an effective teaching tool in engineering education.

Introduction

All educators must be concerned about quality instruction. This fact is continually emphasized and applied to all fields of study as educators are encouraged to incorporate a variety of teaching-learning approaches to enhance student learning [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]. The field of Engineering is impacted as much as all other fields of study. Tomorrow's engineers must be able to first understand theoretical material but additionally apply the material to life's situations as these occur. Engineering students, like all other students, must be able to analyze situations, critically examine situations and context, identify and implement strategies to solve problems, and evaluate the success of recommended strategies. To be able to successfully complete their educational assignment students must be trained and taught; exposed to real-life occurrences in the field of engineering where their abilities can be tried and tested. Many forums provide opportunities for these students to learn the essential skills. The classroom, Internships, and Co-operative employment are settings best suited for teaching students these essentials skills. The foundation for their training however, begins within the school environment. As a result it is increasingly important that within the school environment students are provided with a learning experience that prepares them, as much as possible, for the real world experiences in engineering and provides them with the tools and capability to effectively begin, maintain and succeed in chosen careers [11, 14].

A variety of teaching methods are available for teaching effectively at the tertiary level; many of which have been tried and tested. Almost all methods on teaching presented by educators from various fields can be applied to Engineering education. The traditional lecture; interactive lecture; action memos; case analyses; varied forms of arts-based learning; e-learning tools; and direct design and implementation of curriculum and support technologies are all methods which can be used in ensuring quality teaching and learning takes place in the engineering classroom [2, 3, 4, 6, 7, 8, 9, 11, 14].

There is strong support for the use of cases in the engineering classroom. For engineering educators, cases are excellent teaching tools which can be effectively used to provide high quality instruction for students with opportunities for exploration of real world situations.

Through case analysis students are able to apply the knowledge and information taught in classes to problem solving case activities and exercises [8, 16]. The learning process is enriched because the learning environment supports the development of required job skills such as critical thinking, analytical, and problem solving skills [8, 12, 15]. Case studies are effective tools for teaching teamwork, creative problem solving, and communication skills [13, 15]. It is the continual development of these skills which provides the foundation for growth in students and ensures that they achieve a well-rounded learning experience [13, 15, 17].
The focus of previous research has been on how cases can be used to teach courses in engineering and on how learning is positively affected through use of cases in teaching; primarily, the educators' perspective. What is crucial, yet has been omitted from such research, is the students' perspective on the effectiveness of cases when used as a teaching tool in engineering studies. To fill this gap in research, this paper presents the students' perception of the use of cases as a teaching tool. The presentation will be based on results from an undergraduate electronics engineering technology class in which case studies are utilized. Examples of the cases used, their sources, and the method used to incorporate these cases into classroom teaching and learning are provided. In addition, students' comments on the benefits associated with the use of cases as a learning tool will be provided and a general summary of the comments will be presented.

Developing Cases for Use in the Engineering Classroom

A case is a narrative account of a situation, problem or decision usually derived from actual experience. Cases are often a reflection of real world situation and issues which decision makers, such as managers and engineers encounter in formulating plans aimed at finding solutions to a given problem(s) [6]. In this engineering technology class cases were developed from engineering journal accounts of engineering business and research. Each journal account used was presented to the students for analysis and presentation. Students were encouraged to base their analysis and presentation on core course concepts and to expand their knowledge base by exploring other core issues and challenges that may arise with designing and implementing various systems. The aim was to encourage learning in an environment that allowed students to incorporate everyday life issues and elements in the case accounts provided. We present examples of the cases used, the sources and the analysis and presentation format used.

Case1
Title: Doc at a Distance (dubbed 'ROBO DOC')
Source: IEEE Spectrum; October 2006 volume 43, number 10.
Incorporation: Class discussion – Students were allowed to freely express how they would approach the design process. Their approach had to account for the resources which would be needed (resources included personnel) and the integration of the resources into the design process for maximum effectiveness. In the first phase of the case analysis, the integration of core course concepts was emphasized. The students discussed the design of the system through use of conceptual design (using block diagrams) to show how each block related to the other and identified the type of resources required for each block. In the second phase, students were encouraged to explore and identify other core issues or constraints related to the engineering work presented in the account. Issues related to societal acceptance/resistance to this new approach to surgery (the surgeon performing the operation is probably hundreds of miles away)

and challenges which were considered in the design of the system were time delay (depending on the distance) and design constraints related to time delay (depended on the distance involved) were presented and discussed.

Case 2
Title: Road to green vehicles
Source: EE Times; October 8, 2007, issue 1496
Incorporation: Students were given a copy of the article and assigned to work in small groups to discuss the challenges involved in designing cars which are truly green (i.e. produces zero polluting emission). After discussing in their small groups they were to present their findings to the class. The class got an opportunity to critic each group's presentation and offer suggestions for overcoming the challenges which would be faced by the engineers doing the actual design. Their approach had to account for the integration of electronics. In the first phase of the case analysis, the integration of electronics in the design was emphasized. As each group presented their analysis, other groups were allowed to critic the presentations, provide support for the issues they identified and present their suggestions for improvement. In the second phase, the general class discussion, students were encouraged to explore and discuss the benefits which would be derived from the production and use of green cars.

Case 3
Title: The next voting debacle- database problems may disqualify legitimate voters in upcoming U.S. election
Source: IEEE spectrum; October 2006, volume 43, number 10
Incorporation: Students were given the article with instructions to (1) identify and explore all the design problems associated with the database which could result in the possible exclusion of legitimate voters from elections and likely fraudulently include illegitimate voters, and (2) discuss solution methods and challenges associated with these. Their approach had to account for the integration of electronic system design concepts; the integration of electronics in the design of the database system was emphasized. As each group presented their analysis, other groups were allowed to critic the presentations, provide support for the issues they identified and present their suggestions for improvement. The solutions proposed by the students determined that any system would have to be localized and also state-wide because a nation-wide approach would be exorbitantly expensive. The system would have to be linked by county to county and city to city to prevent multiple voting by any one person.

Case 4
Title: Wind Power: A mighty wing or a lot of hot air?
Source: EE Times; June 25, 2007, issue 1481
Incorporation: Students were given the article and asked to discuss how wind power can be integrated into the power system grid. The assignment required students to discuss the article and then (1) identify and explore all the design possibilities for integrating wind power into the power system grid, (2) identify all resources required, and (3) discuss design methods and challenges associated with these. Their approach had to account for the integration of electronic system design concepts; the integration of electronics in the design of the database system was emphasized. As each group presented their analysis, other groups were allowed to critic the presentations, provide support for the issues they identified with the design approaches presented

and present their suggestions for improvement of the designs. Students presented their findings to the class and an open class discussion ensued. Students indicated a major problem associated with relying only on wind as a source of energy. One solution was to balance the forms of energy used so that in the event of little or no wind power there would be an alternate source (possibly as back-up). Another major observation presented and discussed was to view wind power as form of energy to reduce the demand for fossil fuels rather than as a form of energy to replace fossil fuels.

The Effectiveness of Using Cases to Teach Engineering Technology – The Students' Voice

More often than not student voices are heard as they question and answer; read and write papers; and debate and critique topics during the teaching-learning process in purely academic settings; the classroom – traditional or virtual. Formal evaluations are the basis for feedback on how student's felt about the course and the instructor's approaches to teaching and organization of the course. Usually formal evaluations capture the basics through responses that are measured using various scales and administered at the end of the semester. Most students avoid the sections on the evaluations forms provided for additional comments on the course; many because at that time they are anxious about course outcomes – research papers, final exams, and grades. To capture students' voice on the effectiveness of teaching styles a different approach is used. Students are requested to provide feedback on the course at specific times during the semester. The aim is to evaluate the use of various teaching methods at the learner's level. The comments below represent the students' voices as compiled from individual feedback.

> The exercise challenged me. The challenge is to think of things others have never thought of before. I find myself always thinking of things no one has thought of before and trying to figure out what needs to be done to get these ideas out there. How to do them?
> I wish I could work with a group that is trying to find the answer to create or build a tool to better human living.
> I found I was able to relate concepts from class in analyzing the presented design. It benefited me tremendously and made me see what other people think about engineering.
> This is a great way to learn more about engineering and engineering design.
> It was a challenge to apply myself to research and to learning more about the evolving world of engineering and technology.
> It showed the depth of processing and the steps required in design processes. It increased my knowledge of engineering work and design.
> It made it real. It made the processes in the real world of engineering more apparent.
> Now I know much more about engineering from a different perspective. It inspires me to challenge myself.
> I have become better able to converse and understand signal processing. I can apply concepts in class to the real world. Developed countries are using DSP technology to provide medical services to military personnel in battle fields. Technology has likewise made the world a smaller place as people are able to communicate with people around the globe whether it is family, friends or

business partners. With more and more power technology in satellites the world powers are able to see and monitor areas in the world that could be a source of threat to human life or natural disasters.
It was fulfilling to see how engineers are helping to save lives through advanced technology. The way the article was set up it emphasizes what an engineer has to do and studies they must do to make things function.
The experience confirmed that the basics of engineering are applied in everyday life.
Cases involving technological advancement bring a lot of human issues to light.
I am more aware of the various issues facing engineers. For example, highways that have been built near homes have caused people living to move – societal issue; Computers in America are upgraded every couple of months so people sell them oversized to make money – human issues; Cell phone are popular nationwide but in some countries it is harder to get cell phones- cultural issue.
I understand how obstacles to advancement in engineering technology can arise from clashes among technical people and layman because of fear and prejudice.
I understand the issues with the government trying to avoid the real fact of why this investment in green cars won't work and how businesses come together to try to think of how solutions will benefit them rather than how it will help benefit the whole society.
I am excited knowing that as a person, an engineer, you can give ideas to society to better the ecosystem and preserve lives, then you feel like you have accomplished something for yourself but at the same time you are giving back to society.
Electronics and engineering technology is used everywhere; I am in a good field.

Discussion

The results from students' feedback presented above show resounding support for the use of cases in this class. Many of the positives from the learning experience point to students building awareness and appreciation for their field of study. Students also acknowledge the impact of their learning experience on their ability to identify issues and develop solutions for these issues. Such a skill is important to their further development as critical thinkers and workers. Students who graduate from engineering programs must be able to analyze problems, find solutions and implement and evaluate their recommended strategies. Critical thinking skills, once developed enable students to apply theoretical concepts more easily, in turn the ability of students to make application of concepts results in a profound understanding and appreciation of the knowledge shared with their educators and peers. Students' seemed to be more receptive to challenges geared at helping them to explore and critic every day life experiences of engineers. The awareness and appreciation for the nature of engineering and technology has infused students, not only with an intent to pursue careers in the field, but had excited them towards exploring engineering possibilities and opportunities; a great start towards completing their education at school and into the workplace.
Currently the focus of higher education is on active engagement and learning. This case approach to teaching and learning in the engineering classroom supports active engagement. Students are placed in the decision-making situation where relevant, real life issues are

discussed. The intent is to provide them with the skills needed to link theoretical material to real world, engineering activities, build an interest in these activities and their studies, and enable them to appreciate their learning and its importance in their future lives. This approach also supports the more effective interactive lecture format providing the forum for active learning in the engineering classroom.

Analysis of the students' responses indicates that cases are a valuable tool in teaching engineering technology. This supports previous research conducted on the effectiveness of cases as a teaching tool in engineering education. Most importantly, this support, provided by the students themselves allows for expansion of the pedagogical focus of engineering learning and research by including a critical voice in the evaluation of engineering learning. This inclusion of students' voices enhances engineering education coffers as it provides additional support for the use of cases as an effective teaching tool in engineering education.

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