Evolution of an Interdisciplinary Freshman Engineering Course

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Abstract

This paper contains a description of the evolution of the interdisciplinary freshman engineering course at the University of Texas at Arlington (UTA). The new class structure was implemented in the fall semester of 2003. In previous semesters, each department designed and offered its own freshman course independent of the other departments. The College of Engineering at UTA decided to change to an interdisciplinary structure with hopes of increasing satisfaction and retention within the College and to provide an early experience in multidisciplinary teaming and an early exposure to ethics. The format of the class will be described as well as its evolution over time, with emphasis on continuous improvement of the course. Student learning outcomes include appreciation of ethics and professionalism and the ability to function in multi-disciplinary teams. This fall, a team of experienced faculty members not previously associated with the course is conducting an evaluation of the course, with results due in early spring 2006. Results of this review will be presented at the conference.

Introduction to Engineering at UTA

Prior to the fall of 2003, all freshman engineering students at the University of Texas at Arlington enrolled in their own department's introductory course. This plan allowed students to be introduced to discipline-specific course content, and at the same time to be introduced to the department itself. The College of Engineering at UTA, made up of five departments with undergraduate majors, thus taught five separate introductory courses. These courses varied widely: there was a range in credit hours from one to three, some courses had associated labs while others did not, content varied, grading structure varied, etc.

Disadvantages of this course structure were many and had COE retention consequences. Students interested in engineering but who had not yet decided on a major were nonetheless asked to choose a freshman course for their first semester at UTA. If they later decided on a different major, the freshman course in the new major had to be taken. Furthermore, no course provided an introduction to the other disciplines in engineering so students who had blindly chosen an engineering discipline and weren't happy with their choice, had no information on other disciplines to help them get into the discipline that matched their interests. Many times these students chose to leave the college entirely.

In order to try to retain the advantages and mitigate the disadvantages of the existing course structure, a planning committee was formed. The committee was comprised of the faculty member responsible for the freshman course within each department. While courses varied from discipline to discipline, the main objectives for each course were to introduce students to the discipline and to prepare them for success at UTA. The committee agreed that these, along with the goal of creating and retaining a community of engineering students, should be the main objectives of any freshman course structure. With these objectives in mind, the committee proceeded to examine the current structure of freshman courses and to propose changes to allay the previously mentioned concerns.

The format which resulted from this process is a hybrid, using a one-credit-hour common component and a one-credit-hour department-specific component. The interdisciplinary course, meeting one hour per week, involves team-teaching, multi-disciplinary teamwork, and active learning activities. The departmental component is in a laboratory format. Discipline-specific labs allow departments to assign problems related to their own discipline and introduce non-common content. Most importantly, it also provides departments with the opportunity to get to know their students and allows the students to feel connected to a department.

Continuous Improvement

This format was first implemented in the fall semester of 2003. At the end of that semester, as well as every semester since, the faculty committee has gotten together for a "postmortem" review of the successes and failures of the past semester. The committee reviews student evaluations of the course, looks for trends in exam scores and discusses their own observations on the level of success of the content of each class period. This review leads to changes in format, content, and administration of the course for made for the coming semester.

The most improved areas of the class since its inception are discussed in this paper. They include: the presentation of ethics materials, the administration and content of the interdisciplinary teamwork modules of the class, and methods employed to aid in COE retention.

Ethics and Professionalism

One of the important accreditation issues addressed in the course is ethics (ABET outcome (f) an understanding of professional and ethical responsibility.). Naturally, ethics should be routinely discussed in many courses and in fact it is specifically targeted in several

courses in each engineering program. Introduction to Engineering, however, is an ideal time to provide a first exposure to critical ethical issues at the university and professional levels. One exposure that the students enjoy is discussing engineering disasters such as the Challenger space shuttle disaster, and learning about what went wrong and how the problems might have been prevented. Several required chapters in the course book deal with ethics.

Another popular session is when the large class breaks up into small classrooms and discusses engineering ethical case studies. The students discuss first in their small interdisciplinary groups and then present their conclusions. These discussions can get quite lively, as the students debate all sides of the issues. An at-home assignment follows where students must individually address important points of university ethical behavior. This assignment is a "key assignment", meaning it must be completed in order to pass the course, regardless of the student's other grades. In their course evaluations from fall 2005, 58.4% of the students reported that ethics was one of the most useful topics of the course, a larger percentage than with any other single topic.

Multidisciplinary Groups

Another important accreditation issue tackled is the ability to function in multidisciplinary groups (ABET outcome (d) an ability to function on multi-disciplinary teams). Again, this is addressed in other courses as well. From the very first day, the students are assigned to groups of four students, each group with at least three of the engineering departments represented. There is a corresponding seating chart, so that students must sit with their groups during the entire semester. A number of small group activities take place during class. For example, after a lecture on team building, the students confer and develop a team contract. This outlines the group's expectations and the students' individual responsibilities to the group, in the areas of attendance, preparation, timeliness and quality of work.

One entire class is dedicated to breaking into groups to design and build a "water tower" out of dry spaghetti and masking tape. The goal is to build a tower capable of holding various sizes of water balloons. At the end of class, the towers are judged based on height and amount of weight supported, although credit is given based solely on participation. This is the students' first experience in brainstorming and collaborating on design. It is a very popular activity, with students especially enjoying the competition and observing the performance of their peers.

The capstone group activity for the course is to design, build and test a significant engineering project. This is an out-of-class assignment, with the final performance and judging done in class. This grade does depend on success and accuracy. Also included is properly documenting the project through a preliminary design specification and a final report complete with appropriate diagrams and graphs. In fall 2005 the project was to build a water timer using flowing water to cause state changes at 1, 2, and 4 minutes. Previous projects included building a trebuchet, a Rube Goldberg machine, and an edible car. Completing the final group project is also a "key assignment", meaning that nonparticipation guarantees failure in the course.

All of the multi-disciplinary group projects are very popular. End of semester evaluations cite working together, getting to know more people and making friends, working

with other engineering majors and learning how to work in a group as major benefits. The most common complaint is that scheduling outside of class is difficult. This is not surprising as UTA draws both traditional on-campus students as well as commuter students from a large geographical area, the latter often having fulltime jobs and significant family obligations. If there were more class periods, it would be nice to be able to provide more in-class times to work on the large project.

Retention / Interdisciplinary Issues

One of the obstacles to retention often cited is that beginning engineering and computer science students feel disconnected from their discipline and isolated from fellow students. Further, they have little appreciation for the "big picture", and have a somewhat narrow or no understanding of what graduates actually do. Introduction to Engineering tries to address these concerns in several ways. First, the attempt is made to make the class as engaging and participatory as possible. For example, one of the first assignments is to read fairly dry material from the university catalog (so that incoming students are aware of important policies). This is followed by an in-class "quiz bowl". For each question asked, each of the preformed groups confers and then holds up a placard with their answer (A, B, C, D). This soon turns into a congenial but rousing competition among the students. As noted earlier, many of the in-class assignments involve hands-on design and/or cooperative work. The students enjoy the break from straight lectures and get to interact with fellow students.

To address the "big picture" issue, one class period each is dedicated to the five engineering departments. The corresponding instructor from the department talks about careers, areas of research, professional organizations, student activities, etc. In their course evaluations students routinely express that they find these lectures useful (individually or as an aggregate, together 68.4%), not only to learn more about their own chosen field and department, but to learn about the other areas as well. They also get important exposure to many of the engineering student activities available on campus, such as building race cars, racing concrete canoes, getting involved in programming competitions, etc. Another new component of the course is to require attendance at two approved engineering talks over the course of the semester. Typically these are outside speakers, usually representatives from industry or academia, speaking about their careers or areas of research. Only a short write-up is required from the student, but this gives him/her an added exposure to what post-university life may entail. As with the group projects, the biggest drawback is ensuring that events are scheduled at all times to allow nontraditional students with serious time constraints to attend.

Assessment

In Fall 2005, with the completion of two years using the new course format, a committee of experienced engineering faculty members not otherwise associated with the course was assembled by the dean to evaluate the freshman course. Specifically they were asked to conduct an internal assessment including the following broad issues:

> Are the stated outcomes of the courses being achieved? Are the outcomes of the courses appropriate? If not, what should they be?

Additionally, some more operational issues were to be addressed, including:

Are the courses organized and coordinated in an effective manner? Should the course be continued in this general format?

Finally, some specific issues were to be considered, including:

Are topics being effectively delivered to the students: engineering as a profession, ethics, teamwork, the engineering design method? Are the team design projects meaningful and fun for the students?

The Assessment Committee worked during Fall 2005 to attempt to address the questions. They began by developing a SWOT (Strengths / Weaknesses / Opportunities / Threats) analysis, before any systematic review of the course as it was being taught, based on their observations as faculty members in the college. Strengths identified included exposure to different disciplines, engaged and dedicated instructors, stressing important issues such as written communications, ethics and team work. Weaknesses included vague objectives and outcomes of the course, difficulty in keeping students engaged (due partly to large class size) and lack of linkage between the common course and the department-specific course in some departments. Opportunities focused on involving local high-tech/engineering companies for project sponsorships and visits, and continuing to involve experienced and highly motivated instructors & GTAs in this course to improve the quality and experience for the students. "Threats" or potential hazards to be kept in mind include the possibility of this becoming an ineffective course which could significantly impact the student pipeline.

As raw data for the Assessment Committee, the course evaluation asked specifically questions such as whether the students felt they clearly understood at the end of the course what engineers do in CE, EE, IE, etc. (88% felt they did). Students were asked if at the end of the course they clearly understood the concept of engineering ethics (88% agreed with this statement also).

Recommendations are being developed by the Assessment Committee, and should be available at the time of presentation of the paper. These recommendations will be factored into course plans for the Fall 2006 freshman courses at U Texas Arlington's College of Engineering.

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