Freshman Engineering Courses: Discipline Specific vs. Interdisciplinary Approaches

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Abstract

This paper contains a contrast and comparison between two approaches to introductory engineering courses. One approach is for each engineering department to offer its own distinct freshman engineering course independent of all other departments. The other approach is to offer an interdisciplinary freshman engineering course common for all engineering students regardless of department. In order to take advantage of the benefits of each approach a new freshman course has been developed at the University of Texas at Arlington (UTA). The developmental process from problem identification to final course description will be discussed. Also discussed will be the advantages of the newly developed course as compared to the other structures.

Departmental Specific Freshman Courses

This section discusses the advantages and disadvantages of each department within the College of Engineering (COE) having its own distinct freshman engineering course. One advantage of this approach is that each department sets the content of their course. This allows each department to teach the skills and tools that will be needed for students to be successful in the chosen discipline. The Computer Science and Engineering (CSE) Department, for example, could present a segment in contemporary issues in computer science, while the Civil and Environmental Engineering (CEE) Department would introduce CAD/CAE applications. Departments could also choose the structure of the course that would best fit the specific departmental objectives. For some departments lab time might be a necessary component while for other departments class lecture time might be a more appropriate format for the course. Again, departments could fit the course to their own objectives.

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Another advantage of a departmental specific course approach is the ownership in the department the course allows to students. Retention of students within the COE is always a concern for faculty and staff. Engineering students must endure many credit hours in general math and science in their first two years on campus, before they are prepared to take many engineering courses. Those students often become impatient or misinformed about engineering as a degree and a career before their departments have much of a chance to educate them.[1] During the early years the freshman class is often the only chance that departments have to "hook" a student on engineering. An early opportunity to feel a sense of belonging to a department is very important. Students in a department specific freshman class are allowed the opportunity to become introduced to faculty and staff in the discipline that they have chosen. They get to know the instructor, lab assistants, and the physical layout of the department. Similarly, faculty and staff are introduced at an early stage to the entering students. This early opportunity for name and face recognition is important for the retention of students.

While there are advantages to discipline specific freshman courses there are also problems with such a structure. One frequent problem involves students who want to go into engineering but don't know enough about the different disciplines in order to choose a specific department. Students in this situation are forced to make an uninformed choice, because there is no option. If there is no general engineering freshman course; students who know they want to study engineering but are undecided as to which specific area are forced to choose a discipline blindly. And then to compound the problem, once the student chooses a specific department he or she has no way of knowing if the department that best fit his or her interests was chosen, because no discipline specific course includes an introduction to the other disciplines. This could potentially cause students to flounder for several years in the "wrong" department instead of flourishing in the right department for them. Students unhappy in a department either left engineering all together or transferred disciplines late in their academic careers. Neither of these are acceptable outcomes.

Many concerns revolve around those students who do end up transferring between departments within the COE. Any student transferring into an engineering department would need to complete the department specific freshman course even if he/she were coming in as a sophomore or junior. Students switching departments often resent having to take another freshman course, which in most cases covers much of the same material that they had already covered in their previous discipline's offering. While it is true that much of the information was identical, the courses each had department specific numbering and therefore the graduating department's course number would need to appear on a student's degree plan in order to graduate, requiring students to "re-take" freshman courses.

Another problem transferring students encounter is the satisfaction of the University's computer proficiency requirement. Beginning with the fall 1999 semester, all UTA undergraduate students needed to satisfy a computer proficiency requirement prior to their graduation. Students could satisfy this requirement by taking a test or by completing a course designated by their major

department. Many of the departments within the COE designated their freshman course as the satisfying course for the computer proficiency requirement. Students transferring between engineering departments would often be required to repeat the proficiency information.

This duplication of information could cause other difficulties as well. Many of the faculty responsible for the freshman courses enlist outside speakers for parts of their course curriculum. Where content overlaps, speakers often overlap as well. UTA reference librarians are one example of this. Each of the department specific courses likely has a research component. Library staff are often tasked to familiarize the students with the resources available at UTA. While more than willing to do this multiple times per semester, it is an unnecessary burden, when the information could be presented fewer times if the classes were coordinated among the departments. Library personnel are not the only ones affected by the non-coordination. Topics such as engineering ethics, technical writing skills, and using the Microsoft Office suite are repeated through most departmental offerings. Experts on these common topics are also often tapped for multiple lectures throughout the semester.

Students who never switch departments could also be adversely affected by the course arrangement. An engineering student could conceivably graduate having little or no appreciation of engineering disciplines other than their graduating discipline. In the professional world engineers are required to work in multi-disciplinary teams using a variety of skills.[2] ABET acknowledges the importance of this concept by including "an ability to function on multidisciplinary teams" as one of the required Program Outcomes and Assessments for program accreditation.[3] The COE feels that fostering this engineering community is important not only during the students' time at the University but also in preparing them for successful post-academia careers.

Interdisciplinary Freshman Courses

The other approach to freshman course structure is the interdisciplinary approach. This approach involves having one freshman course that is taken by all students regardless of their engineerng discipline. This allows students unfamiliar with specific engineering disciplines to become introduced to all disciplines. This aids in the choosing of the department that best fits a student's interests as well as fostering interdisciplinary teamwork. Because all freshmen would take the same freshman course, a student transferring between departments would receive credit in any department for the freshman course once they had taken it. This would cut down on the amount of material which needed to be repeated by a transferring student. The structure would also make better use of outside resources needed for presenting materials. Library staff would have only one class to cover as opposed to classes from each department.

The biggest disadvantages to the common freshman course approach are the lack of ability to teach departmental specific material as well as the lack of ownership of student with department and department with student. There would not be time in the semester, nor need, for all material

from all departments to be taught to all students. While the common material is easily handled, what about the contemporary issues in computer science that CSE students need and the CAD/CAE applications that CEE students require? Students are not offered the opportunity to learn the discipline specific tools and techniques required to make them successful students under an interdisciplinary course approach.

Freshman Course Approach at UTA

The COE at UTA is comprised of five undergraduate departments. In the past each department within the college had its own required freshman course. The courses varied widely within the college; there was a range in credit hours of each of the courses, some had labs others did not, content varied, grading structure varied, etc. In reviewing the course structure the COE considered both keeping the discipline specific format as well as adopting an interdisciplinary format. The college decided that an hybrid approach that took took advantage of the benefits of each approach would be optimal for both students and departments. The college therefore started a process of developing a new freshman course structure that would ensure that students received the best opportunity possible to become successful engineers.

Method of change

A committee of faculty was formed to address the concerns. 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. Changes were then approved by the Dean of the COE as well as all Department Chairs.

In discussing different directions to explore, the committee considered the curricula at other engineering colleges in the United States. This benchmarking resulted in consideration of much literature lauding the benefits of interdisciplinary freshman courses.[4,5,6] A freshman course common to all disciplines would immediately solve the lack of interdisciplinary knowledge concern that led to the review of the curricula. Once it was decided that an interdisciplinary approach should be used, there were still many questions that needed to be answered. These issues are discussed in the next section.

Issues to solve

While studying the problem and drafting changes, the committee encountered many issues and obstacles. One such issue was the fear that large lecture type classes can often result in

uninspiring presentations. To remedy this, a team teaching approach will be employed. Faculty will share the teaching load, allowing lecturers and topics to be matched in the most interesting way possible. The professional community will also be involved in lectures. Each department will recruit a young professional to lead lecture and discussion of an introduction to their discipline. This will allow students not only to become exposed to all disciplines within engineering, but to also get a glimpse of "life after college." This common lecture period will also allay the concern of over tapped resources. Library personnel, for example, will be able to present material to all departments' students at once, instead of being called in by each individual department.

The committee felt that while the benefits of a common course were many, there were problems as well. For retention purposes, it is vital that engineering freshman be involved classroom participants. To ensure that students were not merely bystanders in their educational experience, thought-provoking, entertaining lab exercises needed to remain a part of the freshman course experience. Additionally, each department had department specific content that was necessary for their students to be successful in their academic careers. This content varied from department to department. There was not time in the semester to give all content to all students. It was agreed that there still needed to be a departmental component to the class and that component needed to be in a laboratory format. Discipline specific labs would allow departments to assign problems related to their own discipline and introduce non-common content. Most importantly, it would also provide departments with the opportunity to get to know their students and allow the students to feel connected to a department.

Another question that needed to be answered was the one of students transferring between departments. How could the new course structure limit repeated material while still ensuring that students received all of the necessary coursework? A student who started in the Mechanical Engineering Department and transferred to the Electrical Engineering Department will have had the common lecture course but the ME as opposed to the EE specific lab. To ensure coverage it was decided that students would be required to take the new department's lab but will not be required to repeat the common lecture component. The course numbering was designed to make this eventuality possible.

The final issue was to work out the content of the common lecture course. Each departmental representative on the committee presented a list of topics covered in their discipline specific course. This data was accumulated and then comparisons made so that a list of topics common to all disciplines could be assigned to the lecture section of the course, and discipline specific content could be assigned to the appropriate lab section. The catalog description of the newly developed Experiences in Engineering course, with a topics list, is presented in the next section.

Experiences in Engineering Course

The stated goals of the lecture/laboratory course sequence are as follows:

"Students will gain an understanding of engineering approach (design, ethics, problem solving and creativity) and engineering disciplines, using the textbook, lecture material, and laboratory examples and experimentation. Emphasis is placed on team-building."

The catalog descriptions of the lecture course, Experiences in Engineering, and the lab course, Introduction to X Engineering are given in Figure 1 below. The X in the lab title represents the offering department. For example, there will be an Introduction to Mechanical Engineering course, an Introduction to Computer Science Engineering course, etc. The lecture courses will be co-listed in each department.

XE 1104 (1-0) 1 hour credit.	Experiences in Engineering: Introduction to basic engineering concepts. Students will become familiar with engineering and its many sub-fields, ethical responsibilities, creativity and design. XE1105 is required co-requisite.
XE 1105 (0-3) 1 hour credit.	Introduction to X Engineering: Introduction to basic engineering concepts. Opportunities are provided to develop skills in oral and written communication, and department-specific material. Case studies are presented and analyzed. XE1104 is required prerequisite or co-requisite.

Figure 1. Catalog Descriptions for Developed Courses

A list of topics for the Experience in Engineering lecture course are presented in Figure 2. Each of the first six topics will be delivered by a different member of the UTA faculty, several in multiple weeks. The remaining topics will consist of guest lectures by chosen professionals.

1. Introduction, History of Engineering
2. Computer Literacy I (Library, Internet Searches)
3. Computer Literacy II (Word Processing, Excel, Web Page Construction)
4. Oral and Written Communications
5. Creativity and Design
6. Engineering Professionalism
7. Civil Engineering
8. Computer Science and Engineering
9. Electrical Engineering
10. Industrial Engineering
11. Mechanical and Aerospace Engineering

Figure 2. Topics for the Experiences in Engineering Course

Summary and Conclusions

The College of Engineering at UTA undertook the process of improving the freshman year experience for its students. In order to address specific problems that had been encountered with the prior course structure, as well as to improve retention, a committee was formed to examine the structure of the curricula for freshman students. The outcome of this assessment was the development of two new courses, a common lecture course and a department-specific lab course. The new course structure introduces a common thread for all engineering students. Students become part of an engineering community through interdisciplinary teamwork, yet still get the advantages of being attached to a specific department.

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