

Introduction to Chemical Engineering - A New Course for Freshman Students

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Abstract

Oftentimes entering freshman students know little about the major they have selected. Furthermore, the transition from high school to university is not straightforward and may create serious problems impacting retention. In order to address the foregoing issues we introduced a new course for freshmen that entered in Fall 2001 and indicated chemical engineering as their intended major. The course runs on a pilot basis.

“Introduction to Chemical Engineering,” runs as a seminar type course for one hour every week. The objectives are to expose students to various aspects of chemical engineering in general and career paths in particular, and to ensure that the students form a real connection with the department right from the early phases of their college life.

Each week the students meet with either faculty members or alumni (both recent and well-established graduates) to discuss topics varying from the department history and administrative structure to careers in the pharmaceutical industry and independent consulting. Students visit the labs they will work in later years and also discuss issues of advisement.

To ensure a seamless transition to the university life, we have instituted the Peer Mentoring program. Each freshman student has been paired with either a sophomore or a junior student and they interact primarily outside of the classroom. Mentors were selected, on a voluntary basis, from students that have a good academic performance and are involved in student societies such as the student chapter of the American Institute of Chemical Engineers.

A special questionnaire has been developed with the help of the Office of Institutional Research in order to assess the course in a qualitative way.

Experiences and results from this course will be discussed.

Introduction

In recent years, the retention of students within the various engineering majors has been a concern for the administration of both the engineering college and the various engineering departments. Many freshman students were changing to other majors, often outside of engineering. When questioned they would often cite dissatisfaction with, or newly discovered lack of interest in, their original major. These types of responses were hard to understand, since freshman students have little or no contact with their major department.

The only exposure to engineering at all was in the freshman engineering design class. That course is taken as part of the nominal freshman year for all students in engineering. However, only a fraction of the new freshmen actually take that course in their first semester. Most take it in their second or third semester. Reasons for this can vary; some have scheduling difficulties, some are advised to delay it as it requires a substantial amount of work, and still others may need to complete remedial courses in English or mathematics due to inadequate background in high school.

As a result, the freshman engineering design class could not be regarded as either the problem or the solution to the problem of retention of freshman students. Many of the students in question had not had even that course yet.

Depending on advisors to prevent the problem was not regarded as likely to succeed either. In many cases, engineering students are assigned (by the university) to advisors who are not even in engineering. Reasons for this also vary: lack of sufficient numbers of willing advisors, desire to expose students to broader range of influences, and other reasons. But even if all freshman engineering students had advisors in their major, there would still be insufficient contact between student and advisor to affect attitudes unless additional effort is made.

This issue was much debated by the college and the departments during the academic year 2000/2001. Experiences of other universities¹⁻¹¹ were considered. Eventually, most of the engineering departments decided to try a pilot program in which they offered a one hour per week class to their new freshmen about their major. This paper will describe the course developed and given by the chemical engineering department at New Jersey Institute of Technology entitled “ChE 101 – Introduction to Chemical Engineering”.

Motivating Reasons

As mentioned above, retention was the main motivating factor in developing the course. But in order for it to be effective, the course had to counter the reasons/perceptions that led to students opting to change their major. Several students from the previous few years were interviewed. Some of the more common themes are summarized below.

“Chemical Engineering is not relevant to the world these days”. Many new students have no idea what chemical engineers do or what a diversity of jobs are available to chemical engineering graduates. This is unfortunately common even among groups that should know better. Colleagues and students from other colleges or divisions within the university often have no

more idea than the new freshmen. When the freshman student asks them for their (presumed-to-be unbiased) opinion, and the (unbiased) answer is “Gee, I have no idea” it does not generate confidence on the part of the freshman student in his/her choice of major. And the answer is even less helpful if the respondent, for some private reason, does not give an unbiased answer; there is no one the student can turn to for refutation.

“Chemical Engineering is just Chemistry, I want to be an engineer”. Again this comes from a lack of understanding as to just what chemical engineering is. Freshman students do take freshman chemistry, and they think that must be what chemical engineering is all about. They are surprised to learn that only a part of chemical engineering practice actually deals with chemical reactions, and that most of a classical chemical plant is devoted to other operations such as separations.

“Biology is a better preparation for medical school”. This and similar statements for other majors/choices of future careers show little or no research into the facts. Freshmen have no real training yet, so they make decisions based on their gut instincts. Sometimes they are right, sometimes they are not.

“I feel no connection to the department”. Chemical engineering at NJIT is a relatively large department in terms of faculty, but a relatively small department in terms of undergraduate enrollment. Thus the freshman student sees a large list of faculty names in the department, and yet nobody he/she knows has ever had or met any of them. Whether this is justifiable or not, it creates a negative impression of the department in the student’s mind.

“I am more interested in another major”. The choice of another major can of course sometimes be the correct step for all involved. Nobody would like to see a student persist in a major only because it happened to be the one for which he or she first signed up. Some students do take the time to research the different possibilities. If they are making a knowledgeable decision, then of course everyone should be happy.

Although other comments came up, these were the most common. The course was set up to try and address these issues.

Concerns about Course

There were also some concerns voiced about the introduction of a new course for freshman engineering students. Some of these are addressed next.

“Too many courses are required of freshmen”. The most common concern was that freshman students already are required to take several one-credit courses. These include laboratory classes in both physics and chemistry, two freshman engineering design classes, physical education courses and the freshman seminar course, discussed below.

“Too much work is required of freshmen”. Freshmen come to college used to the workloads of high school. It is a big adjustment, and there should be a reluctance to add to that load. The

'normal' freshman taking English composition, calculus, physics, chemistry and freshman engineering design already has a heavy load.

"Too much work will be required of the faculty assigned to the course". Faculty have demands on their time as well and are reluctant to take on a course that is so different from anything else in their experience.

"There will be a problem scheduling the course". Finding a time when all of the freshmen can attend may not be possible.

"The students will not be interested in such a course". Students often are not interested in a 'soft' course where there is no homework, no exam, nothing that is required. They prefer courses that have credit associated with them; otherwise it is presumed to be a waste of their time.

"The course will duplicate the freshman seminar course". For many years, NJIT has required freshman students to take a non-credit, one-hour-per-week course titled Freshman Seminar. This course is intended to introduce the student to college life. Typical topics include time management, study skills, workshops on how to use the library, how to deal with roommates, alcohol and substance abuse, how to use campus computer resources, and other similar topics. Since the intention of both Freshman Seminar and the Introduction to Engineering course is to facilitate student success by making them comfortable in, and familiar with, their new environment, there is a perceived overlap between them.

All of these concerns were valid to some degree, and were addressed in the way the course was offered.

Course Format for Fall 2001

ChE 101 - Introduction to Chemical Engineering ran in the Fall 2001 semester as a zero-credit, one-hour-per-week class. It met on Tuesday afternoon from 5:00 until 6:00 in order to avoid conflict with other regularly scheduled freshman classes. The class was always held in an informal manner. Most weeks there was some form of refreshments, as it was intended to create a social atmosphere for an open discussion of that week's topic. The course coordinator was the associate chair for undergraduate studies. Each week was devoted to a separate topic, as described below:

Introduction to Department and Department Procedures. The first week was devoted to introducing the students to the key people in the department. These included the department chair, the associate chair (who is also their advisor, as well as the course coordinator), the administrative assistant (who, as anywhere, is a very good person to know and who can help solve most of the day-to-day annoyances that come up) as well as the department office personnel. The course coordinator moderated this week.

Students and Student Organizations. During the second week, the officers of the very active student chapter of the American Institute of Chemical Engineers gave a presentation about the various chapter activities. The course coordinator supervised this week.

Co-op Opportunities in Chemical Engineering. During another week, the co-op advisor discussed all of the different possibilities from co-op. Points raised the ability to earn a respectable salary, get experience that will be quite valuable to other future employers, the ability to form contacts in industry, the chance to compare different industries. Each year in the chemical engineering department there are far more co-op openings than there are students to fill them. Thus, the students have many possible types and sizes of companies to work with. The associate chair responsible for industrial liaison moderated this week.

Introduction to the Chemical Engineering Laboratories. Another week was devoted to a tour of the department chemical engineering laboratories. Freshman students are quite unfamiliar with the various types of equipment, and are quite interested in learning about them, and are intrigued by the idea of being able to design such equipment by the time they graduate. The department laboratory supervisor moderated this week.

Introduction to Flowsheets and ChemCAD. During another week, the students were given a tour and demonstration of the department simulation laboratory. The department is currently using ChemCAD (and other programs), especially in the senior design course (but also in earlier years). The senior design instructor moderated this week.

Undergraduate Research Opportunities. Yet another week was spent discussing the various opportunities for undergraduate research, primarily within the department but also throughout NJIT. The associate dean of engineering moderated this week.

Historical Perspective on the Department. This week was devoted to sharing the history of the department. Included was a mention of the notable faculty and alumni of the past, as well as information on how long the program has existed and comparisons with other programs about the country. A former chair of the department who is also our most senior colleague moderated this week.

Curriculum Changes in the Future. A discussion was held one week about the possible changes that may occur to the curriculum in the future. Feedback, both immediate and in the future, was sought from the students. The associate chair for undergraduate studies moderated this week.

Invited Speakers from Industry. During the remaining weeks, which were spread evenly through the entire semester, speakers from various industries were invited to talk to the students and describe their jobs. All of the speakers were graduates of the chemical engineering program, but not all of them were still working as chemical engineers. However, all did speak highly of the wonderful preparation that their chemical engineering degrees had provided them for their careers.

Meeting the Department. The last week was a purely social event. All of the faculty and staff of the department were invited to come and meet the freshman students. We wanted the freshman to leave with a sense that the faculty and staff are approachable and are a sort of second family.

Student Evaluation of Course

Also during the last week, an evaluation of the course was conducted. The normal student evaluation form used for most courses at NJIT was not appropriate. Thus a specialized form was developed with the help of the NJIT Office of Institutional Research and Planning.

The form used a range of 1 to 5 for its responses, with 1 being the most negative response and 5 being the most positive response. Students were first asked to give their opinion of the value of each of the sessions, after which they were asked a series of questions about the course. The results (average score on the 1 to 5 scale) are given below:

Introduction to Department and Department Procedures	4.4
Students and Student Organizations	4.3
Co-op Opportunities in Chemical Engineering	4.4
Introduction to Chemical Engineering Laboratories	4.5
Introduction to Flowsheets and ChemCAD	4.0
Undergraduate Research Opportunities	4.7
Historical Perspective on the Department	4.1
Curriculum Changes in the Future	4.2
Invited Speaker #1	4.1
Invited Speaker #2	4.1
Invited Speaker #3	4.3
Invited Speaker #4	4.2
Invited Speaker #5	3.8
How well did course meet your expectations?	4.2
How well was course organized?	4.3
Did you like the format of the course?	4.3
To what extent do you know more about chemical engineering?	3.9
To what extent are you more interested in chemical engineering?	3.8
To what extent do you know more about the department?	3.9
To what extent do you feel the faculty and administration are interested in seeing you succeed?	4.4
To what extent do you feel more resolved to become a chemical engineer?	4.1
To what extent do you feel more prepared to explain chemical engineering to other persons of your age?	3.9
Do you feel you made the proper choice of a major?	100% - yes

In the comments section, students were asked which features of the course they most liked or disliked, and what recommendations they would make for the future. Most commonly mentioned 'likes' were the outside speakers, the laboratory tour, meeting the department and the refreshments. The only common 'dislike' was the meeting time for the class. The recommendations included a different meeting time, and including plant trips/tours.

It is interesting to note that certain comments did not appear. As indicated above, one concern with the course was adding an additional one-credit course to the burden on students. Although

the students did frequently comment during the semester about the heavy workload, none of them indicated that the ChE 101 course added to the problem. A couple of the students did comment during the week in which possible changes to the curriculum were discussed that perhaps if the course is to be required it should carry degree credit. However, all students seemed to consider the course quite worthwhile.

Another concern was the possible increase in faculty workload. From the point of view of the course coordinator, the only real 'work' associated with the course was arranging for the visitors, both internal and external. Also, certain weeks required minimal organization for the discussion of that week's topic.

Benefits of the Course

The students' interest in chemical engineering has been confirmed by the course. In past years, students would come into the advisement session at mid-semester and would often pose questions or make comments that indicate doubt about their choice of major. All of the students seem confident in their choice at the end of the semester. During the course of the semester, only one student transferred to another major, and that was very early in the semester.

Faculty/student interaction has been promoted. All of the students know their advisor well and feel comfortable talking to him, and the advisor knows each of the new students by name. That would often take a year or more before.

Regular student advisement has been facilitated for the above reason. Previously, students were expected to seek out this person who they likely had never met to talk about their progress and course selection. That can be quite intimidating for a freshman student. Now they know each other well from the weekly class meetings and discussions.

All of the freshmen from very early in the semester were added to electronic distribution list for the student professional society chapter. They thus received all the notices about the various meetings, and freshman attendance at those meetings was up over prior years.

The course also presented the opportunity to organize a student mentoring system. Several upper-class students (mostly juniors) were recruited to serve as voluntary mentors for the freshmen. They were introduced at the class meetings, but generally met outside of the class. This may have been as valuable as any of the other features of the class. It allowed the freshman students to develop one-on-one relationships with upper-class students. The upper-class students can provide advice about professors and classes, can assist with difficult topics, and generally lend moral support. All of these benefits can also help with retention in the long run.

All of the speakers for the course were volunteers, so the only costs associated with the course were one hour of load for the course coordinator and the cost of the refreshments. At present, the costs appear to have been justified by the benefits realized. The course will be continued for at least one more year. There will probably be more active involvement of upper-class students as well as small changes to the list of topics.

Summary

The course seems to have been a success, at least as this is written shortly at the beginning of the subsequent semester. The students all seemed to appreciate the course and to have enjoyed it, and it seems to have helped them to be content in their choice of a major. The department has gotten to know each of the students, and interactions between all groups – faculty, freshmen, and upper-class students has been improved, and an improved sense of community has been achieved.

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