

Factors Influencing Freshmen Retention in Engineering Programs

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Abstract

Student retention in engineering has long been an important issue for engineering educators. Despite improved recruiting practices and expanded first year programs, students are leaving the engineering disciplines and choosing other college majors. This study examines freshmen responses to 51 questions designed to assess their attitudes and opinions regarding their first semester experience in engineering. This survey was first piloted and addresses factors of motivation, time conflicts, family support, academic preparedness, and academic progress. The database contains responses from 1060 students' responses from 2 colleges of engineering.

Introduction

Less than 50% of students beginning in engineering continue in engineering and half of those leave during the freshmen year (Besterfield-Sacre, 1997) ¹. In engineering, the annual graduation rate decreased by approximately 20 percent in the 1980's. (Board of Engineering Education-National Research Council, 1992) ² Astin (1993) ³ found that only 43% of the first-year engineering students in his population graduated in engineering.

Seymour and Hewitt (1994) ⁴ examined engineering and science majors. Those science or engineering students that changed their major were found to be similar in attributes and ability. Their findings indicated that most students who changed from engineering or science to another major had the ability to understand science and math, as well as the drive to work hard. Their assertion was that switchers and non-switchers faced the same set of problems but differed in the strategies they employed to solve these problems.

Besterfield- Sacre, *et al.* (1997) ¹ developed the Pittsburgh Freshmen Engineering Attitudes Survey. This survey indicated that students leaving engineering often were not that different from those who stayed with regard to academic performance. Through use of a logistical regression model they¹ were able to predict students who may potentially leave engineering in good standing.

Method

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In an effort to better understand why students are leaving engineering, a survey instrument was developed to examine the attitudes of freshmen engineering majors towards their chosen area of study and to examine factors that may predict why they leave engineering. Pilot data was collected at the University of Florida and a medium, resident public research institution. Several factors were addressed in the survey, including motivation, time conflicts, family support, academic preparedness, and academic progress.

A survey was designed to explore these factors and first piloted with # students. Based on the pilot results, the survey was modified. The survey included 51 items designed to assess student attitudes and opinions regarding their first semester experience engineering. The survey was administered at the end of the students first fall semester. Student respondents were freshmen enrolled in an "Introduction to Engineering" course on each campus that is taken by essentially all freshman-engineering students during the first year. The students completed the survey as part of their course requirements. Those not wishing to complete the survey (% students) completed an alternate assignment.

Results

The data show that roughly the same percent of students from each college of engineering were contemplating leaving engineering and their responses to the other survey questions yielded similar results. This suggests that students at different sized institutions have similar problems and attitudes regarding their major choice. The database contains 1060 students' responses from both institutions. In the survey the students responded first to a question asking if they were considering leaving engineering. It was believed this question would be the most revealing and help better understand the responses to the other items. It was found that 26 % of the freshmen respondents were considering leaving engineering. Among the sample of University of Florida freshmen engineering majors 25.6% reported they were considering leaving engineering, while the 2nd college in our study reported 27% were considering leaving engineering.

Several interesting results were obtained from the overall sample. Seventy percent of the students were pleased with the quality of teaching they had received. Only 56% of the freshmen engineering majors surveyed agreed with the statement: "I am certain that I want to be an engineer." Nearly 84% of the responding students said their family supported their choice of engineering as a major while approximately 12% indicated their family pressured them to study engineering. There was concern that students leave engineering in their freshmen year because they have insufficient academic preparation in math and chemistry. Only 35.7% reported feeling they had adequate high school preparation in chemistry while 68.4% said they had adequate high school preparation in math. These results are consistent with the responses of students to similar questions. When asked if they were struggling with the material in their chemistry or math classes: 34% agreed they were struggling with the material in their chemistry classes while 18.5% claimed to be struggling with the material in their math classes. The students were also asked if they felt overwhelmed in their chemistry and math classes. It was self-reported that 31.8% of the students felt overwhelmed in their chemistry classes while only 18% had the same feelings of being overwhelmed by their math courses. Twenty three percent of the students indicated that their motivation for becoming an engineer had decreased during their first semester.

Non-academic variables that might contribute to engineering majors leaving engineering were also examined. It was found that for this sample only 10.6% worked more than 10 hours a week, 3% worked more than 20 hours per week, and 7% felt their work hindered their academic progress. When asked about balancing coursework with social life, 23% reported that they had difficulty. Financial incentives were found to be influential as 71% said they would choose their courses to keep a scholarship and 61% said they would take pre-engineering courses at a community college instead of their institution to preserve a scholarship. When asked if they participated in a student organization only 12% said they belonged to an engineering student organization, 11% to a sorority or fraternity, and 51% said they belonged to a non-engineering student organization. According to roughly 95% of the students none of these organizations required a significant amount of their time.

While the overall statistics are interesting, it is instructive to examine how the responses differed between those students who were considering leaving engineering as their major and those who were not. These results are summarized in Table 1. As anticipated, major distinctions exist between the responses of those who indicated they were considering leaving engineering and those who were not thinking about leaving. For instance, for those thinking about leaving engineering only 4% agreed with the statement "I am certain I want to be an engineer." In contrast 75% of the other student respondents agreed with the statement. When asked about whether poor performance in calculus, physics or chemistry would make them change their major, 62% of those thinking about leaving engineering agreed it would compared to only 39% of those not thinking about leaving engineering. Five percent of students who belonged to engineering related student organizations and were thinking about leaving said their commitment did not distract them from their studies, while 16% of those not thinking about leaving engineering said they were distracted. There was a notable difference between those thinking about leaving vs. those not considering leaving engineering in their attitudes toward the core courses. The percentage of those who said they were struggling in their math course was 29% for those thinking about leaving vs. 15% for those that were not. Percentages for those struggling with chemistry were 41% for thinking about leaving vs. 32% for those not considering leaving. Finances may be a contributor to students selecting majors other than engineering after the first semester. It was found that 49% of those thinking about leaving engineering would change their major to keep a scholarship whereas only 12% of those not thinking about leaving engineering would change their major. Motivation certainly has a factor in whether students continue as engineering majors. It was found that only 37% of those thinking about leaving engineering were willing to devote the necessary time to be an engineer compared to 88% for those that were not considering leaving the major. Finally 68% of those considering leaving engineering said their motivation had decreased in their first fall semester compared to only 6% of those who were not thinking about leaving the engineering program.

It is interesting to examine the differences between the responses of the students indicating they were considering leaving their engineering programs from the two participating institutions. While most of the responses were similar, a few questions garnered significantly different responses. The following results are only for those students thinking about leaving their engineering programs. When asked if they felt overwhelmed in the math course they were currently in 21% of UF students agreed, while 35% of School 2's students agreed. When asked

about family pressuring them to major in engineering, 12% of UF students admitted family pressure compared to 25% of School 2's students. An increase in motivation was noted by 7% of UF students vs. 3% for School 2. Thirty percent of UF students agreed that they could complete their chemistry assignments compared to 50% of the students at School 2. When asked about high school preparation in chemistry, only 23% of the UF group felt prepared while 37% of School 2 did. Study time varied by school when there were no tests with 26% of the UF group studying more than 4 hours. School 2's group had 37% studying more than 4 hours. Enrollment in student organizations related to engineering was 9% at School 2 and there were no students in the UF group who indicated they were members. For non-engineering related organizations 62% of School 2 were members compared to 42% of the UF group. Thirty five percent of School 2 indicated they were struggling with their math class compared to 22% for the UF group. Suggesting that differences exist chemistry and math instruction at the two institutions, those struggling with chemistry had the opposite result with 52% of the UF group struggling in chemistry while only 43% struggled at School 2.

Conclusions

A significant problem facing engineering education today is the retention of freshmen engineering majors. This study intended to explore a set of factors that might contribute to freshmen attrition. As expected those students considering leaving engineering responded differently from those who were intent on staying. The differences in the responses of these two groups indicate that students considering leaving are having more difficulties with their core subjects and suspect their preparation is a factor. This suggests that placement in remedial courses may be a more suitable first semester experience. It is also clear that the students considering leaving engineering are not as excited about engineering as evidenced by their responses to the questions on motivation and interest change on becoming an engineer.

What may be just as interesting are those responses showing very little difference between those thinking about leaving and those determined on staying the course. For example both groups of students indicated that they studied the same amount for tests. Both groups indicated their social activities (student groups and Greek organizations) did not interfere with their studies. Students who worked rarely worked more than 10 hours per week and indicated that work was not a distraction from their studies. There was little difference with how effective the professors and TA's for chemistry helped them understand the material. Both groups of students had friends that were engineering majors. Not encouragingly, neither group studied with friends, sought help from professor or TA, or utilized tutor sessions. Roughly 60% of each group said they were confident they knew what engineers do in the workforce. There were only a small percentage of students who felt their family pressured them to choose engineering as a major (19% for those thinking about leaving vs. 10% for those not). There seems to be a correlation between thinking about leaving engineering and variables related to chemistry and math preparation and ability. This could be useful for freshmen advisors. Finances may also be a contributor to students choosing majors other than engineering after the first semester. Almost half of those thinking about leaving engineering would change their major to retain a scholarship. Motivation certainly has a role in whether students succeed as engineering majors. Only about one third of those thinking about leaving engineering were willing to devote the necessary time to be an engineer. Finally it is clear that many students' motivation decreases in their first fall semester. Future research should

examine these issues as well as others over time to see if there is a change.

References

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Table 1:

Questions where the response differs between those thinking about leaving and those who were not.	Students Thinking about Leaving Engineering	Students Not Thinking of Leaving Engineering
	Percentage agreeing with the statement. Unless otherwise stated	Percentage agreeing with the statement Unless otherwise stated
I am pleased with the quality of teaching that I have received.	65%	72%
Poor performance in college calculus, chemistry or physics would make you change engineering as your major.	62%	39%
I feel overwhelmed by the math course I am currently taking.	28%	15%
My family pressures me to pursue a degree in engineering.	19%	10%
I am feeling overwhelmed by my chemistry course.	41%	29%
My motivation for becoming an engineer has increased.	9%	45%
I had adequate high school preparation for the math course I am currently taking.	55%	73%
I am able to complete assignments in the chemistry course I am currently taking.	41%	54%
My family supports or encourages my choice of engineering as a major.	62%	91%
I am able to complete assignments in the math course I am currently taking.	59%	80%
My motivation for becoming an engineer has decreased this semester.	68%	6%
Of all my subjects I like math and science the most.	40%	67%
I am certain that I want to be an engineer.	4%	75%
I am willing to devote the necessary time to be an engineer.	37%	88%
My current math professor and/or TA is helpful in enabling you to understand material.	41%	60%
Introduction to engineering class has positively or negatively influenced your view of engineering as a career choice.	42% positive	76% positive
How many hours per week do you work.	13% work over 10 hours per week	9% work over 10 hours per week
Do you belong to one or more engineering related student organizations? Yes	5%	16%
If so, rate the degree to which your commitment to these organizations distracts you from your studies.	95% said no distraction	84% said no distraction
I feel overwhelmed in trying to balance my coursework with my social life.	31%	20%
I would rather participate in extracurricular activities than studying or doing homework.	69%	57%
I am struggling with material in my current math class.	29%	15%
I am struggling with material in my current chemistry class.	41%	32%
I would change my major to something other than engineering to keep a scholarship. Yes	49%	12%
I understand the relationship between pre-engineering classes (chemistry, physics, calculus etc.) and what I will take	48%	61%
I would choose courses to keep my scholarship.	79%	61%

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