

## **2006-661: WHY STUDENTS LEAVE ENGINEERING: THE UNEXPECTED BOND**

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# Why Students Leave Engineering: The Unexpected Bond

## I. Introduction

This research study is part of an in-depth longitudinal study of engineering students, at four institutions, to gain significant insight into the learning of these students across diverse populations and environments. In this longitudinal study, researchers look carefully at the lives of engineering students (approximately 40 from each campus) during the first three years of their college experience with an emphasis on the challenges they face and how they handle those challenges. In this paper, we describe why, after only one year, students at one institution in our study chose to switch to non-engineering majors. We explored the underlying issues that led to their departure and used ethnographic exit interviews to collect data to better understand the intrinsic and extrinsic motivators that led to their leaving engineering.

Fifty percent of students who enter engineering programs as freshman do not earn an engineering degree<sup>1</sup>. Although many of these students may have been academically prepared and highly motivated to study engineering, something happens during the first year that results in their choosing to leave engineering. A change in motivation is perhaps the ultimate factor in their final decision.

## II. Theoretical Framework

In the context of classroom learning, psychologists describe student's motivation as "achievement motivation" with three unique learning goals<sup>2,3</sup>. Students may have a goal to master a new set of skills or knowledge (mastery goal), to do better than others (performance goal), or to be accepted by others (social goal)<sup>4,5,6</sup>. Researchers found that students with mastery goals outperform students with either performance or social goals.

We argue that engineering students must strive for all three goals to succeed. They must be motivated to adjust to college life (social goal), motivated to avoid failure of a course (performance goals), and ultimately motivated to achieve success in earning an engineering degree (mastery goals). The first year student trying to achieve these goals must deal with the complex interrelationship among the goals. In this paper we further argue that the motivation to study engineering can disappear or be greatly diminished when there is a break or potential break in this interrelationship. For example, if you fail a class you in turn are not making successful progress towards earning a degree. Students, who are unsuccessful in making progress towards these goals, simply leave engineering, and do not earn degrees in engineering.

## III. Background Literature

The literature cites a number of factors, often thought to be isolate and independent, for why students leave engineering. Performance in calculus courses, the most commonly cited, is believed to be the largest obstacle for first-year students in engineering programs. The design of most engineering curricula expects students to be calculus-ready when they arrive at college. Many are not. Thus, when students fail or withdraw from Calculus I, it greatly affects their

progress in engineering programs more so than any other courses<sup>7</sup>. As a result, many students abandoned engineering because of grade related issues<sup>8,9</sup>.

A study of science and engineering students by Seymour and Hewitt<sup>8</sup> reported that, 23% of students who switched majors indicated that a significant factor in their decision to leave the major was problems with their grades. Receiving grades in introductory courses that were far lower than their high school grades caused a shock to students' ego and resulted in switching decisions. Grades served as a representation that students understood the course material thus, grades were seen as more important than students' mastery of how well they understood the subject matter.

Students' attitudes also play a role in their persistence in mathematics and subsequent persistence in engineering. Research findings indicated that a student's persistence in mathematics courses correlated strongly with their liking mathematics and confidence in their mathematics skills<sup>10,11</sup>. However, other factors may influence a student's attitude and motivation to persist.

In our study, we will show that concern about financial issues, particularly maintaining financial aid, also has an impact on a student's persistence in engineering. Consider that today, many more students need financial assistance to attend college than they did 20 years ago. The growing need for financial assistance stems from the 80% increase in tuition over the past 20 years coupled with only a 40% increase in family earning power<sup>12</sup>. Students seek scholarships and grants to help defer tuition cost. Quantitative studies of college students found a direct relationship between financial aid and retention<sup>13,14</sup>. Students with sufficient financial assistance who did not have to work were more likely to persist towards a degree than those who did not have aid. The persisters spent more time and effort on academic activities. Studies<sup>8,15</sup> specifically on engineering and science students showed similar results. Seymour and Hewitt's<sup>8</sup> found that 29.5% of those students who switched their major had financial issues.

The results of this study will show evidence of how the connection between students' performance in mathematics courses and their need to maintain financial aid, in the form of merit (GPA dependent) scholarships, impacts their choice to leave an engineering program.

### **III. Methodology**

This paper focuses on the students in a longitudinal study who decided, after only one year, to switch to non-engineering majors. We present the case studies of three of those students from one institution. A total of five students participated in exit interviews but it was the data from three of those students that presented enlightening information that had not been suggested in previous studies. These case studies include data from structured interviews conducted during the students' second semester (before they decided to switch majors) coupled with ethnographic exit interviews data gathered once their decisions to leave were final. The data were analyzed and coded to identify clusters of student issues and reasons for leaving.

The structured interviews and ethnographic exit interviews differed in their format. The structured interviews consisted of specific predetermined questions designed to probe issues concerning student identity, their skills development and their current knowledge. The ethnographic exit interviews, on the other hand, were free flowing exchanges with the

interviewer asking follow-up questions on relevant topics and issues that were arbitrarily introduced by the student. Ethnographers use this type of interview to discover what people do and why before they assign meaning to the behaviors and beliefs<sup>16</sup>. Our interviews provided rich data on the variety of issues and motives that led to students switching to a non-engineering major. While the primary intent of this work, and most ethnographic work, is not to generalize across populations, we hope that the stories that we share will provide insight on the continued inquiry of factors leading to student attrition in engineering programs.

#### **IV. Results**

In this study, researchers found four major issues that led to students leaving engineering majors. Students cited the following factors that led to their decision to change majors: (1) lack of faculty guidance/advisement; (2) lack of community engagement; (3) scholarship/financial dilemmas; and (4) course difficulty in the areas of calculus I and II. The latter two factors were particularly intriguing because of the unanticipated connection between them. The challenge of mathematics courses, particularly calculus, and a student's financial circumstances combined to sway students away from majoring in engineering. Although other researchers have shown that financial circumstances and course difficulty each independently contribute to student attrition, it is their unique link that led to students' departure and is presented in the form of three case studies in this paper.

Consider the case of George, a mechanical engineering major, who entered the university with a 4.0 high school grade point average and a very high SAT math score. The university awarded George one of its most competitive merit scholarships. During his first semester, George began having difficulty with calculus, which he tried to address by studying harder and by joining a study group. Nothing seemed to help. He eventually withdrew from the course. Yet, George stated that he was "very committed" to pursuing an engineering major in his structured interview during his second semester. He further added that he really wanted to be an engineer. However, George decided to leave engineering at the end of his second semester.

During the exit interview, George discussed the rocky academic transition from high school mathematics to college level mathematics. He stated:

[T]hroughout high school math [years], I got straight A's in all maths, then I come (sic) to calculus. I took calculus my senior year in high school, but I ended up auditing it which meant I just sat there and took notes but I didn't get [a] grade. So I figured ... that would help me 'cause I knew I had to take it in college, but I came here and I still didn't get it.

When George was asked why he decided to exit the engineering program he stated:

...I was just looking out for my GPA, because I didn't wanna lose my scholarship, and I figured that math was gonna kill me 'cause all the maths are 4 credits and ...everything else I was taking was ... 2 or 3 credits, so that would probably be ... a major part of my GPA, so I had to just leave.

George left the engineering program with a 3.46 grade point average.

Amber, a computer science major, presents a similar story about why she left the engineering program. Amber entered the university with a 3.8 high school grade point average and a very high score on the SAT in math for which she earned a very competitive university scholarship. At the time of the structured interview, Amber indicated that her commitment to engineering was only fair and that engineering was not a big passion in her life. Nonetheless, Amber felt since she started with engineering, it was the major she was going to complete. Although confident in her math ability, she had problems with calculus during her first semester. She eventually earned a “C” and decided to leave engineering at the end of her second semester. When asked, during the exit interview, what influenced her decision to leave the engineering program, she stated, “I am here on scholarship I couldn’t afford to fail a four credit class or even [earn] a C.” Amber left the engineering program with a 3.60 grade point average.

Betty, an electrical engineering major, also decided to switch to a non-engineering major after one year. Although she earned only average SAT scores, she secured a merit based university scholarship. At the time of the structured interview, Betty was not confident in her math ability and found calculus to be difficult because she believed that the professor’s teaching style was not congruent with her learning style. Nevertheless, she wanted to be an engineer because “engineers are creative”. She failed calculus, lost her scholarship and decided to leave. During the exit interview, Betty discussed her reasons for switching majors. She stated:

I had a scholarship and I lost my scholarship, ‘cause I failed the class and that means I’m paying for my education now, so I have to get a good grade, and if I’m paying for it, I wanna take a class that I know that I’m gonna pass.

Betty left the engineering program with a 2.46 grade point average.

What happened to Betty was George and Amber’s biggest fear. Would their difficulty in a core engineering course (calculus) affect their ability to maintain the required GPA and thus result in loss of their scholarship? Is the pursuit of an engineering degree worth the risk of not being able to finance the pursuit of any degree? Arguably, engineering is perceived as one of the most rigorous majors in undergraduate education. Even so, these students entered the university enthusiastic about becoming an engineer but left, prematurely, before they were exposed to the heart and soul of the discipline. They did not leave the university and abandon their dream of a college education; rather they switched to less risky majors in order to maintain their scholarships.

## **V. Summary**

We are left to believe that these students’ enrollment in college is contingent upon financial assistance through merit-based scholarships. Since they were awarded these scholarships, their academic potential and efforts to become an engineer were recognized. But students are abandoning the engineering major simply to maintain their scholarships. This finding is disturbing because students are choosing a major, not based on interest or aptitude, but based on minimizing the risk of losing their financial support. The fact that the engineering community may be losing some of its brightest workers is even more disturbing.

Ethnographic studies, like the one described in this paper, ultimately will allow researchers, faculty, and administrators to identify the specific reasons why students leave. In this study, we discovered that students' motivation to earn a degree remained strong although the motivation was not linked to earning an engineering degree specifically. If their ultimate goal is to earn a college degree, we saw that George, Amber and Betty did not want to jeopardize their enrollment in school, therefore they decided to switch to an academic program where earning a degree appeared to be more attainable.

In our study, the decision to exit the engineering program and change majors was made during the students' first year which strongly suggest, as other researchers<sup>17</sup> have found, that student support regarding retention should be the strongest in their freshman year. Since recognition precedes reaction, institutions can assume a proactive role by first identifying the reasons for students' departure from their engineering programs and then developing intervention programs to specifically address these reasons. To the extent that this research might contribute to the body of knowledge about engineering student retention, it will fulfill a useful purpose.

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