First Generation College Students in Engineering:  
A Qualitative Investigation of Barriers to  
Academic Plans

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Abstract – While understanding factors that relate to the recruitment and retention of engineering students has garnered much attention in recent literature, little is known about the educational experiences of first generation college (FGC) students majoring in engineering. This work employed a social cognitive theoretical framework to qualitatively investigate the educational experiences of FGC engineering students at an urban research university. Semi-structured interviews were conducted with eight participants in this pilot study. Interview data were coded and content analyzed using NVivo™ software. Nearly sixty emergent themes were identified, including six major barriers: 1) lack of understanding of the college admissions process, 2) financial constraints, 3) difficulty of coursework, 4) lack of engineering role models, 5) role conflicts and 6) lack of parental understanding about higher education and/or engineering. These barriers are discussed in terms of developing effective recruitment and retention interventions for first generation college students majoring in engineering, and recommendations for future work are offered.

Index Terms – First generation college students, Social Cognitive Career Theory, Recruitment, Retention

INTRODUCTION

The term “first generation college student” has been defined in various ways by different researchers: some consider students to have “first generation” status if their parents completed only a high school diploma or equivalent, some consider the definition to include students whose parents attended some college but did not complete a degree, others include students whose parents completed a two year degree but not a four year degree. Regardless of the exact definition used, it is clear that students with limited parental experience in higher education face significant disadvantages compared to their “continuing generation” counterparts. Furthermore, a significant number of students entering college are first generation students; Choy [1] reported that 53 percent of students entering a two year institution and 34 percent of students entering a four year institution in 1995-1996 had parents with no more than a high school education (a thorough search of the literature did not reveal more recent statistics).

The higher education literature is overwhelmingly consistent in its treatment of the disadvantages facing first generation college students compared to their continuing generation counterparts. While previous studies of FGC students did not specifically investigate students in undergraduate engineering majors, the existing body of research on FGC students can help engineering educators gain a better understanding of the barriers likely faced by FGC students majoring in engineering. While first generation students are less likely to pursue higher education [1], those that do are at higher risk for attrition during their first year and are less likely to be retained to degree completion compared to continuing generation college students [1-3]. In a study by Chen [4], 43 percent of first generation college students did not obtain a degree compared to 20 percent of continuing generation college students. FGC students often lack a basic knowledge about the college application and financial aid processes [3], have lower academic preparation [3], come from lower socio-economic backgrounds [3,4] and have fewer less support [3] for pursuing their college plans than continuing generation students. First generation college students are also more likely to be Black or Hispanic [4].

A recent study by Trenor and colleagues [5] which investigated the educational experiences of diverse female engineering undergraduates found that FGC students perceived lowered supports and increased barriers for their educational plans compared to their continuing generation counterparts. These findings, consistent with other literature in higher education, point to the need to better understand barriers faced by FGC students in pursuing engineering degrees. Such investigation is necessary to effectively recruit and retain more students from varied educational, socioeconomic, and ethnic backgrounds into the field of engineering. The current pilot study is unique in its focus on first generation college students majoring in engineering. In this work, we aim to identify and explore distinct barriers

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perceived by FGC students majoring in engineering at the undergraduate level. For the purposes of this study, “first generation college student” is defined as a student for whom neither parent earned a four year degree. We adopt this definition on the basis of Choy’s [1] work, which concluded that students whose parents attended some college but did not earn a bachelors degree had no advantage over students whose parents completed only a high school education or below.

THEORETICAL FRAMEWORK

This study utilized a social cognitive theoretical framework, specifically, Social Cognitive Career Theory (SCCT) [6]. While Betz and Hackett [7] initially applied social cognitive theory to academic and career development processes, the theory has its origins in Bandura’s [8] work. Later, Lent and colleagues [6] employed SCCT to students studying math, science [9] and engineering [10]. SCCT provides a useful framework for investigating factors that influence how an individual’s interests develop into goals, and how these goals become actions. Lent, Brown and Hackett [6] describe the factors that directly influence or moderate these choices and processes: environmental variables, cognitive person variables, and other person factors. Environmental factors may be distal (in the past) or proximal (contemporary) to the choice process, and may include access to role models, financial resources, social supports and family influences. Cognitive person factors include outcome expectations (what one expects to happen if a certain course of action is followed), self-efficacy (one’s confidence in achieving a certain task) and goals. Finally, other person characteristics such as gender and ethnicity may influence an individual’s career development decisions.

RESEARCH QUESTION

This paper addresses the research question: What barriers do first generation college students perceive for their engineering academic and career plans?

METHODOLOGY

I. Procedure and Participants

This study was conducted at the University of Houston (UH), an ethnically diverse urban research institution [11]. During the fall 2007 semester, the UH student body consisted of 16% African American, 20% Hispanic, 36% White, 6% Asian, and 6% Native American students. Over 90 percent of UH students commute to campus daily, and many, if not most, hold outside employment. Approximately 30% of incoming first year students in engineering have parents who did not complete a four year college degree. The diverse ethnic, educational, and socioeconomic background of the UH student body makes it an ideal setting for this study of first generation students pursuing degrees in engineering.

This work was approved by the University of Houston Committee for the Protection of Human Subjects. First generation college students enrolled in the Cullen College of Engineering’s Program for the Mastery of Engineering Studies (PROMES) during the fall 2007 semester were invited to participate in the study via email. Eligibility of volunteers was confirmed, and a purposeful sampling of volunteers resulted in a sample of eight participants from various engineering majors and academic levels. Freshman through junior level students were chosen to represent a range of academic progress. The sample included two women and six men, from African-American (n=1), Asian (n=1), Hispanic (n=3) and White (n=3) ethnic backgrounds. Four participants were majoring in chemical engineering, two in electrical engineering, one in mechanical engineering and one in computer engineering. Four participants worked 11 to 20 hours per week, three worked one to ten hours, and one was not employed. Family financial support for college expenses was varied: five participants reported no financial support from their families, two participants reported a family contribution of less than half of their college costs, and one participant received family financial support that covered half or more of college expenses.

II. Interview Method

At the start of the interview session, participants completed a brief paper survey to provide background and demographic information. One-on-one interviews lasting one half-hour to one hour were conducted; interviews were recorded with the permission of the participants and were subsequently transcribed. A semi-structured interview guide was followed, and when appropriate, probing questions were used to gain more detailed information about a particular response. Participants were compensated for their time with a $20 cash card. One participant took part in a recent related study on female engineering students [5] and with her permission, previous interview data was combined with a shortened supplementary interview collected for this study.

III. Analysis Method

Interview transcripts were read by two researchers, who each developed a list of recurring themes from the participant responses. Following the initial round of theme identification, the researchers compared their lists of emergent themes, negotiated and formed a common list consisting of 29 initial themes. Each transcript was imported into NVivo™ qualitative research analysis software for analysis.

Utilizing the initial 29 themes, both researchers individually coded two interviews at the paragraph level. The discrepancies present after this initial round of coding were discussed, negotiated to consensus, and the remaining interviews were coded by one researcher. During the iterative coding process, a number of additional themes emerged, and were added to the list of themes for a total of 59 themes. After the first round of coding was completed on all eight interviews, one researcher re-coded the interviews again to identify any parts consistent with newly defined themes. A typical interview had approximately 20 different themes associated with approximately 30 paragraphs of interview

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response. Of the 59 final themes, 12 were identified as barriers; six barriers were chosen for discussion in this paper based on the frequency of occurrence and perceived relevance to the engineering education community.

Following the identification of the six barriers included in this paper, each transcript was coded for these six themes by the second researcher. The coding by the two researchers was compared, and all discrepancies were negotiated to consensus. Therefore, the final inter-rater agreement for the themes discussed in this paper was 100%.

RESULTS

I. Identification of Barriers

This paper discusses six of the most prevalent barriers discussed by participants during the interviews:

1. Lack of understanding of the admissions process
2. Financial constraints
3. Difficulty of engineering coursework
4. Lack of engineering role models
5. Role conflicts between the demands of school, home, and/or work
6. Parents who do not understand the demands of an engineering degree and/or higher education

II. Overview of Barriers

The most prominent barriers discovered in this study fall primarily under one of two major categories which we have labeled as “institutional” barriers and “personal” barriers. Institutional barriers are obstacles related to the student's experience with, or perception of, university or faculty processes and policies. Personal barriers are those concerning family and personal background.

Institutional Barriers

1. Lack of Understanding of Admissions Process

Half (n=4) of the participants described difficulty with the admissions and financial aid processes that resulted from a lack of awareness of necessary procedures and timelines. One participant suggested that workshops be created to help parents better understand the Free Application for Federal Student Aid (FAFSA), and reflected on a conversation he had with his mother about paperwork needed for financial aid processing:

Participant: “Mom, I need the income tax [return].”
Mother: “Why [do you] need that?”
Participant: “Because the government asks for it.”
Mother: “You don’t need that.”

As the first person in his immediate family to enroll in a university, one participant described the experience of applying for admission to colleges and for scholarships late due to lack of information about necessary timelines. He was, however, able to subsequently provide guidance to his younger brother:

“I was the pioneer for my little brother. Because I was a senior, he was a junior, so [he] got the opportunity to learn from my mistakes.”

2. Financial Constraints

The theme of financial constraints surfaced in five of the eight interviews. One student said the decision to attend the University of Houston came down to scholarship opportunities. Another student expressed anxiety about graduating $40,000 in debt. Additionally, a married, working student expressed frustration with finances:

"The fact that I have to work is a huge problem… I might have to take out a student loan…just because I can't afford to work 10, 15 hours a week because [working] takes away [time from] studying."

3. Difficulty of Engineering Coursework

Four participants indicated that the difficulty of their engineering coursework was a notable barrier. In one case, the student described the difficulty of the curriculum as the primary reason for his policy against working and taking classes simultaneously, preferring instead to postpone graduation in the interest of gaining work experience.

One student described struggles with the coursework by distinguishing between the types of problems encountered in engineering versus other subjects:

“Studying history and English requires memory, synthesizing of ideas, composition, deducting, [and] logic, whereas [engineering] requires problem solving skills, [and] analytical skills…”

Two participants thought that the engineering bachelor’s degree should officially to be a five year degree plan, rather than the advertised four year one, as illustrated by these comments:

“In one semester you would have to take 18 hours of all these tough classes… it’s not do-able. I don’t know anybody that follows that degree plan.”

“It’s a five year degree instead of a four year, even though the degree plan says four.”

Personal Barriers

4. Lack of Role Models

Participants were asked if they had any role models in the engineering field when they were growing up. Five out of eight students responded that they had no engineer role models. One student talked about not understanding what engineering entailed until a university representative came to
his high school to distribute information. He subsequently performed independent research to make his decision:

“I didn't really know any engineers back then in high school. It was more just the university coming out [to the school] and giving pamphlets for the [college of engineering].”

One participant cited Socrates as his main role model, further indicating he had no engineers—or even present day role models—to whom he looked for guidance. Another participant described engineering role models that he met only after he joined the military after high school. Despite the fact that he met these engineers as an adult, they served as sources of information about the field and encouraged him to pursue an engineering degree.

5. Role Conflicts: Balance of School, Home, and Work

Four participants expressed having difficulty balancing their roles as students, family members, and/or employees. This theme was often intertwined with Barrier 2 (financial constraints) presented in the Institutional Barriers section. The rigor of the engineering curriculum compounded these concerns for participants.

In addition to difficulty balancing work and studies, several participants shared that they felt conflicted about meeting family expectations while in school. This was generally connected to Barrier 6 (lack of parental understanding of academic demands). One participant said:

“I’m more productive [on campus] doing my homework and working with my friends than I would be at the house, and [my parents] are like, ‘Well we don’t see you, we miss you, why can’t you come home?’”

Another shared:

“Sometimes friends and family don’t understand that you can’t do the things you would normally do.”

Yet another commented:

“[Because] I live close to my parents, a lot of times that’s a bit demanding, [like when they say] ‘Oh why don’t you come over for dinner?’ Well I don’t have time, you know. I don’t know [...] if there is something that could be done to open up their minds to it, to understanding it.”

6. Parents Do Not Understand Engineering Curriculum and/or Higher Education

Five of eight participants indicated that their parents did not understand the demands of an engineering curriculum.

“They probably have no idea what I have to go through in these classes, because it’s really technical.”

The same participant also explained,

“At first, they didn’t really know what an engineer was, so I explained it to them, and after [I did] these internships and co-ops, they have a better understanding.”

Another participant said:

“[My parents] wanted me to go to college; they just don’t understand what it takes.”

**DISCUSSION**

Our findings show that FGC students studying engineering face significant and multiple obstacles to enrollment and persistence in the curriculum. Many of the findings of this study echo the results of previous research not specifically focused on engineering students. Some FGC students pursue a college education with little support from family members [12]. Ishitani [13] stated that FGC students face “profound challenges at each level” of the educational system due to lack of parental experience with the process [1, 14]. Participants spoke of problems and hardships stemming from their unfamiliarity with enrollment and the scholarship application process. Many of these students did not get the help they needed from high school or community college personnel. Participants described how their unfamiliarity with the admissions process caused them to miss out on scholarship money and financial aid. Consequently, some participants expressed difficulty affording their education costs, and five of the eight participants received no financial help from their families. For some participants, conflicts between employment and school obligations were described in the interviews.

Our data suggest that the lack of parental experience identified by other researchers also plagues students majoring in engineering; in fact, this barrier may be compounded for engineering students because of the stringent demands of the engineering curriculum. The majority of participants (n=6) lived with their parents. The lack of parental understanding of the engineering curriculum’s rigor and necessary time commitment caused some participants to frequently feel conflicted about school and family obligations.

Lack of engineering role models also proved to be a salient barrier for the majority of these FGC students. Participants without early role models in the field of engineering did not learn of the field until late in their secondary education (or in one case, as an adult). In fact, one student decided to major in engineering on a whim while filling out the college application. Bandura [8] discusses the effectiveness of “coping” role models in developing self-efficacy—that is, models who have struggled and overcome obstacles to succeed. Given the high attrition rates [1, 3, 15] of FGC students compared to their continuing generation counterparts, the presence of coping models not only prior to entering college but during undergraduate studies may be particularly effective for FGC students studying engineering.

The difficulty of engineering coursework was another common barrier discussed during the interviews. The crowded undergraduate degree plan, which often requires students to
take 18 credit hours in a semester to stay on track to graduate, can be a significant burden for students who are working to pay for their education. Previous research [1, 3, 15] shows that FCG students take longer to graduate than their peers. While it is common to see engineering students take longer than four years to earn an undergraduate degree, participants spoke of difficulty being properly advised when they departed from the standard four year degree plan due to academic struggles or work obligations.

Several courses of action are recommended on the basis of this preliminary work. In the common case that students are not receiving necessary or accurate information about the field of engineering or university procedures from their high school or community college, the responsibility shifts to university personnel to provide it. Future work will offer specific research-based intervention suggestions based on a larger scale study which is in progress. Initial suggested interventions include:

- Providing additional and proactive mentoring at the high school, community college and undergraduate level by successful FGC engineering students (i.e. coping models).
- Increasing outreach to high school and community college students, counselors, and teachers to equip FGC students with information they need about college and encourage students to take appropriate preparatory courses.
- Improving parental education regarding the requirements for university admission, financial aid, expected engineering course load, and long-term benefits of earning an engineering degree. If language barriers exist, provide materials in relevant languages spoken by family members. If parental illiteracy exists, verbal communication may be necessary.
- Providing additional undergraduate advising for students with significant employment obligations.

This pilot study points to the need for further investigation of barriers and supports perceived by FGC students for their engineering educational plans. Such work has the potential to contribute to programmatic and pedagogical mechanisms to recruit and retain more FGC students in the field. At a time when our country is seeking to tap into every available talent pool to expand and diversify its engineering workforce, such research is particularly timely.

REFERENCES


