Influences for Selecting Engineering: Insights on Access to Social Capital from Two Case Studies

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Abstract – This paper employs the theory of Social Capital to explore the educational experiences and academic career decisions of engineering undergraduates. Two case studies are presented from a larger mixed-methods project which investigated the experiences of ethnically and socio-economically diverse female engineering students at an urban research university. Participants completed an online survey, which included items about reasons for selecting engineering and information sources utilized in doing so. Additionally, semi-structured interviews explored participants’ perceived supports and barriers for college and career plans. Triangulation of survey and interview data yielded insights regarding the relations between social capital and students’ academic and career decision making processes. While both participants first became interested in engineering during middle school, their reasons for entering the field and access to information about engineering were very different. The social capital inequity apparent in these cases can be attributed in part to parental educational attainment and occupation.

Index Terms – Case study, Female engineering students, First generation college students, Social Capital Theory, Social Cognitive Career Theory

INTRODUCTION

Recruiting and retaining diverse students into the field of engineering has garnered much attention in recent years. In particular, significant resources have been devoted to the study of factors influencing women’s selection of engineering at the undergraduate level. A better understanding of female students’ reasons and influences for entering the field and access to information about engineering were very different. The social capital inequity apparent in these cases can be attributed in part to parental educational attainment and occupation.

While these studies underscore the importance of parents and/or engineering role models in many female students’ choice to major in engineering, less is known about why students without similar access to role models enter the field. In a recent study [4], we reported several factors that influenced female students’ entry into undergraduate engineering majors. Similar to the minority participants in the aforementioned Seymour and Hewitt study, our participants from diverse ethnic and family educational backgrounds reported unique purposes for pursuing engineering degrees. Distinct family roles related to academic and career plans were identified based on parental educational attainment [5]. Furthermore, first generation college students perceived lower social supports compared to multi-generation college students [4].

This study was conducted at the University of Houston (UH), an urban research university with an ethnically, culturally and socioeconomically diverse student body. In the 2006-2007 academic year, female students comprised 23% of the engineering student body; 59% of these female students reported belonging to an ethnic minority group. (The university classifies students studying on an international visa—13%—as a separate ethnic category, however, so the actual number of minority students is higher than this figure indicates). Over ninety percent of students commute to campus from the metro-Houston area. UH serves many first-generation college students; a recent poll of entering first year engineering students revealed that approximately 30% had parents who did not attend college. Unlike many of the
students previously studied in the engineering education literature, these first generation college students do not have engineer parents, and may not have access to any engineer role models. If we are to recruit and retain more students from diverse educational and socioeconomic backgrounds into engineering, a better understanding of the factors influencing their decisions to major in engineering is necessary. This paper presents two case studies; the participants were part of a larger (N=37) mixed-methods project conducted at the University of Houston [4] during the 2006-2007 academic year.

THEORETICAL FRAMEWORK

In this paper, we explore two students’ decisions to major in engineering through the lens of Social Capital Theory. Social capital can be defined as “a form of capital that resides in relationships among individuals that facilitates transaction and transmission of different resources” [6]. Portes [7] pointed out the intangible quality compared to other forms of capital by stating, “Whereas economic capital is in people’s bank accounts and human capital is inside their heads, social capital inheres in the structure of relationships.” Social capital has been shown to predict a number of academic and career outcomes, including academic performance, high school attrition and occupational attainment [7]. Pascarella described the social capital deficit of first generation college students as a “handicap” in obtaining and understanding necessary information about college [6]. Lin [8] described four main reasons that social capital is effective:

1. it enhances the flow of information
2. it may influence individuals with decision-making power (e.g. “putting in a good word”)
3. it may offer necessary or desirable social credentials
4. it offers reinforcement of an individual’s identity and recognition within a given social group

RESEARCH QUESTION

What people and experiences influence students from varied socioeconomic and parental educational backgrounds to select engineering as a college major?

PROCEDURE AND PARTICIPANTS

I. Procedure

This work was approved by the University of Houston Committee for the Protection of Human Subjects. The larger study consisted of quantitative (online survey) and qualitative (interview) portions. All female undergraduates (N=350) enrolled in engineering during the fall 2006 semester were invited to take an online survey instrument, which consisted of 81 items [4, 9] and demographic information. Participants were asked to indicate reasons they entered the field of engineering as well as information sources they used in the process (items are shown in Table 1).

A cash card lottery incentive was offered to survey participants. One hundred and sixty students (a 46% response rate) completed the online survey instrument, and they were subsequently invited to participate in one-on-one interviews with one of the researchers. Thirty seven survey participants volunteered to be interviewed. The semi-structured interviews lasted 30 minutes to one hour, and participants were compensated with a $20 cash card. Interviews were recorded with the participants’ permission, were transcribed, and checked by the project leader. Following content analysis, the qualitative data were triangulated with survey data.

Case study research methodology investigates a “phenomenon in its real-life context” [10]. Although each case is unique, the utility in case study research lies in its applicability to other cases or settings [10]. Stake [11] describes this by saying, “How we learn from the singular case is related to how the case is like or unlike other cases we do know, mostly by comparison.”

Purposeful sampling among the 37 interview participants resulted in the selection of two representative cases for in-depth analysis based on generational status in college and parental occupation: a third generation college student with an engineer parent and a first generation college student. While the details of these cases are unique, the constructs/themes are representative of what we found in the larger study and are consistent with the variation in social capital among the UH student body as observed from the research team’s collective teaching, administrative, advising, and recruiting experiences.

II. Participants

The first participant, Ava, is a third generation college student who was interviewed during her second semester as an electrical engineering major. The second, Maria, is a first
Her only transition issue, she said, dealt with the increased amount of personal responsibility she experienced once at the university.

“It’s just, you know, it’s just a lot of self discipline to go to classes. Because there’s no one saying, ‘Well, you have to go to class’ or, ‘Oh no, you’re going to be tardy to class.’ It’s just a personal gotta-do-it-yourself thing.”

When asked how soon she felt a sense of belonging at the university, she replied,

“…actually it was really that week before school started [in the fall] ‘cause I had gone to [the] Honors Retreat and then I got to know a lot of people... And they gave us packets of what other people’s majors were and I was like, ‘Oh well they’re electrical [engineering majors], they’re computer [engineering majors], I can go talk to them.”

Ava described her greatest challenge in pursuing an engineering degree in terms of the course load and rigor:

“The amount of work and the difficulty cause, like, it’s a lot of work to do. I mean it’s not a stroll in the park, and then you’re learning new programs.”

Her plans after graduation were influenced by her engineer father and his advice to do work that she would enjoy:

“I think that’s kind of an influence from my dad. I just want to work in an oil company or something... something that I will use my skills. Cause one of the things he told me to do is...He’s like, ‘pick a job you like to do because you’re going to be doing it for like the next 30 years or something, so do what you want to do.’ So I know what I want to do, so I gotta find a place that I want to do it. And I’ve gone to visit his office a lot and I see what they do and I was like, ‘That’s what I’m going to school for.’ ”

She was confident about her ability to get an internship and permanent job after graduation due to her father’s connections and support:

Interviewer: “Do you think it will be hard getting a job in your major?”

Ava: “No, probably not. Probably ‘cause I just have the resources like my father works at [Major Engineering Company]. And he’s like, ‘Well if you want an internship, go ahead and fill out the papers and I’ll turn them in for you.’ My dad has always been really supportive and if I wanted to do something, he’ll help me. So I want to do this [he says], ‘OK, I’ll talk to so and so and I’ll get forms for you and then fill it out.’ But he made it [so] that if you don’t fill it out, then that’s your loss. He’s like, ‘I can give you everything but you have to do it.’ ”

The interviewer then asked Ava about what she hoped to accomplish in her career. She replied,

“I hope to take the knowledge that I learned from schooling—like all of the schooling I ever did—and I hope to put it to good use. Because there are some times that I’m sitting in calculus [thinking] ‘When am I ever going to use this?’ And then you think about it, and it’s like, ‘maybe I would use this.’ So I just want to hopefully
use all of this education...You know I’m spending however many years in school and I hope to use all the education and put it to good use. And hopefully make someone else’s life a little easier …”

Case Two: Maria

Maria was a 26 year old transfer student who worked full-time to pay for her education and living expenses. Her mother (her only living parent) was born in Mexico, but she was born in the United States. She vividly remembered her first exposure to engineering, which also took place during middle school:

“Sixth grade Career Day. There was a petrochemical engineer who came into the school…I fell in love with it, and I knew I wanted to be a petrochemical engineer. And when I got to college they didn’t have it [the major], they only had chemical, so I went for the next closest thing.

And I think, later on in sixth grade, we had—I think it was female students who were interested in chemistry and engineering—and we actually came to UH and we did a tour here. And we got to see the different departments and got to go into some of the labs.”

When asked what the engineer said, Maria replied, “You know, I can’t remember it exactly… But I remember that was my turning point. That was when I knew what I wanted to be.”

Subsequent Career Days at her school reinforced her decision. When asked who else influenced her choice, Maria said, “…every year we had Career Day where somebody from the field came in, and there was somebody who came in that was [in] civil engineering who said that the U.S. was falling behind. You know, like we have five lawyers for every one engineer. But Japan or China have five engineers for one lawyer. [They said] you know, that we were backwards.”

Since Maria was majoring in industrial engineering and chemistry, not chemical engineering as she previously indicated as her initial interest, she explained more about the academic path that led her to industrial engineering. She graduated near the top of her class in high school and was accepted into two very prestigious universities. She left home to attend one of them, but had to return when her mother became ill. From there, she attended a local open enrollment university, and then later entered the University of Houston as a transfer student majoring in chemical engineering. She explained that her chemistry grade point average was very low when she transferred. When she did not meet the requirements of her probation, she explained her decision to choose industrial engineering instead:

“I knew it was going to be some kind of engineering. That’s why when I didn’t make it for chemical engineering, I knew whatever I wanted to do had to be in the engineering field…Well, to be honest I just looked at the prerequisites and it [industrial engineering] was the one that I had the closest pre-requisites to get in.”

She explained her double major in Chemistry by saying, “And I had so many chemistry [course credits] that I didn’t want it to go to waste.”

Even though her mother was not able to help her with her college choice process, Maria enthusiastically responded when asked about her mother’s support in her choice of major: “Oh yes! My mom has always supported me with everything.” She also explained that her mother taught her that education was a way to improve her status in life:

“But my mom always said is that education is what’s going to get me ahead. Like, I don’t have the ties. My mom went to third grade. My dad passed away when I was six months old. So it’s just been me and my mom. I certainly don’t have money. I mean I’ve paid—I put myself through college, you know—I paid. I took out loans. So she always told me that my education is what’s going to get me ahead. And so that’s what I’ve done.”

She also described her struggle to work and go to school at the same time:

“For me it’s very difficult because I work full-time and I go to school full-time...It’s hard to know…to realize…you can’t go and tell them [the professor], ‘I’m sorry I didn’t go to class because I got off of work at two o’clock in the morning and I slept through my alarm clock.’ And then, like, I still try my best…and still try to do what I can. It’s just hard, you know…all of this emphasis on grades.”

When asked if she felt a sense of belonging in the College of Engineering, she replied, “Sometimes, not always. When you’re in the classroom and your teacher is asking you something and you’re participating...absolutely.” However, she described sometimes feeling disconnected with the rest of the students because her work schedule prevented her from participating in student organizations, “I really don’t know who I belong with. I’m kind of a roamer.” Maria talked at length about her purpose for getting an engineering degree, which involved stable employment that would provide a good income to support her mother.

“I want to make a difference in my community... I want to help my mom...like I said, my mom only went to the third grade. She’s made a lot of accomplishments. She learned English. She’s an order taker at...a five star hotel. It’s good and all, but I’d rather take her out of there and put her through maybe computing school or something and get her some type of office job, you know, something easier.”

She viewed her engineering degree as a means to that end, but did not necessarily believe that the work she would do as an engineer would help her advance her goal of helping people, although she described the safety aspect of engineering as a possible way to make that contribution. She had also thought about eventually going into law, but maintains a focus on getting a job right after college to secure a better lifestyle for her mother and herself.

“Well, if I did industrial engineering, honestly, I don’t think that I could help other people but I could definitely help my mom because they make okay money.”

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She reiterated that her main focus was to financially support her mother, who had sacrificed for her.

“But right now my main focus is to graduate, start paying my loans and my bills off, and try to get that house… I live in a home with my mom—we’ve been living in that house since 1985 and we’re renting. So x number of years that we’ve been living in a house that’s not even our own. I mean, like, it took us 12 years to put a nail in one of the walls ‘cause the day we move out we don’t want them to tell us something… We painted the walls, put in new carpet, redid the bathroom and at the end none of that’s ours. We’re going to move out one day and what do we have to show for it? And so that’s my thing. I need to have that financial stability where I can get the house for my mom. At least something I can say, ‘This is yours… You want to put a nail in the wall, put a nail in the wall!’”

The interviewer then asked Maria about her biggest challenge in achieving her career plans; she said, “Graduating and getting a job.” She went on to elaborate, “Right now it’s not so easy because right now I’m just trying to get my foot in the door. But once…I honestly think, that once I get my foot in the door, I can make it happen.”

When asked about potential measures the College of Engineering could take to assist in the success of its students, Maria responded with suggestions for increasing networking opportunities with faculty and local companies:

“…have more social events with actual companies. To try to offer us more events where we can go work either school projects or interning at companies. The faculty…you know, have more situations where we can meet with the faculty socially. You know, like, I wouldn’t say all the faculty needs to know my life story, but you know just have an environment where you get to see that they’re real people.”

Survey Results

Ava and Maria’s responses to the survey items about reasons for selecting engineering as a college major and the sources of information they used in making that decision are summarized in Table 2. Commonalities between the two participants are shown in italics.

**SUMMARY OF PARTICIPANTS’ REASONS FOR SELECTING ENGINEERING AND SOURCES OF INFORMATION USED.**

<table>
<thead>
<tr>
<th>Reasons for Selecting Engineering as a College Major</th>
<th>Ava</th>
<th>Maria</th>
</tr>
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<tbody>
<tr>
<td>Good at math or science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Like to build and/or fix things</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Like to solve problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents/relative is an engineer</td>
<td></td>
<td></td>
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<tr>
<td>Enjoys challenge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scholarship</td>
<td></td>
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<tr>
<td>High school advisor or teacher</td>
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<tr>
<td>Participated in engineering camp or workshop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College visit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attracted to challenge of difficult curriculum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents recommended it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents or other relatives are engineers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking the work that engineers do</td>
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</table>

<table>
<thead>
<tr>
<th>Sources of Information about Engineering</th>
<th>Ava</th>
<th>Maria</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school teacher</td>
<td></td>
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<tr>
<td>College visit</td>
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<tr>
<td>Engineering camp</td>
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<tr>
<td>Family friend</td>
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<tr>
<td>UH College of Engineering</td>
<td></td>
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<tr>
<td>Other: [participant wrote in] Career Day</td>
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</table>

| Age of first interest in engineering                | Middle School | Middle School |

In other publications [4, 9] related to this work, we reported statistically significant differences in perceived social supports for first vs. third generation college students. Additionally, we found role conflicts related to employment and academic demands to be a major barrier for Hispanic students, who had statistically lower levels of parental educational attainment. In an upcoming publication [5], we describe different roles that families of female engineering students played in their career development choices based on parental educational attainment. These previous findings are echoed in these case studies viewed from the lens of social capital.

Our previous work [4, 9] utilizes Social Cognitive Career Theory as a theoretical framework for understanding the academic and career decision processes of diverse female engineering undergraduates. While SCCT does not include social capital per se, Social Capital Theory may inform our understanding of the contextual influences described by Social Cognitive Career Theory for these cases.

Social capital is evident from the quantity and nature of the sources of information each participant used in selecting her major: whereas Ava named six sources, including her parents, family friend(s) and teachers, Maria named only one (Career Day). Furthermore, it is interesting to note that Maria did not indicate a teacher as an information source. Their reasons for selecting engineering also differed in some respects; while they both were good at math and science and
liked to build/fix things and solve problems, Ava mentioned other reasons, including the camps her mother found for her, recommendations by parents, and engineer relatives. She does not mention that she is interested in engineering because it will provide a well-paying job, as does Maria.

Ava possessed and utilized consistent social capital through her family ties. Her engineering father and supportive mother served as sources of information about the field of engineering (Table 2) and helped her access resources such as summer camps. Her engineer father had the connections (influence) to help her get a job. When asked about perceived difficulty in getting a job, Ava linked her father’s connections to her confidence in gaining employment. Her father offered her access to his colleagues on her behalf, which she perceived as useful social credentials. Furthermore, these family connections, along with visits to her father’s workplace, helped her to first recognize and then reinforce her identity as an engineer. Finally, the familiarity she gained with the field and the university campus as a result of her family’s encouragement in attending two engineering camps gave her confidence and eased the transition to college. These factors contributed to following in her father’s footsteps.

Maria, on the other hand, described a social capital deficit when she stated, “I don’t have the ties” (influence, social credentials). In gaining employment, she perceived “getting her foot in the door” to be a major barrier. When making her decision to study engineering, the only resource she used was visiting speakers at school (information); she had no continuous social capital other than subsequent yearly career day events. Maria’s reasons for selecting engineering (Table 2) did not reflect utilization of social capital, although she evidently gained enough information from the contact with visiting speakers to connect her talents and interests to a career in engineering. She was also keenly aware of the ability of the field of engineering to help improve her socioeconomic status, although it is unclear from her interview where this notion originated. As a college student, Maria’s full time employment prevented her from cultivating or mobilizing additional sources of social capital such as student organizations, leaving her sometimes feeling like an outsider in the College of Engineering. Aware of her social capital deficit, she desired more institutionalized opportunities to cultivate and reinforce social capital among faculty and prospective employers. Nonetheless, the driving factor of economic security motivated Maria to persist to graduation despite her social capital deficit.

CONCLUSIONS

These case studies illustrate the underlying importance of developing recruitment and retention efforts which provide sustained opportunities for students to access and cultivate social capital related to engineering. The development of persistent social capital is likely to be especially important in the educational development of first generation college students and others who may lack close engineer role models in their personal lives. Pre-college access to engineering role models and exposure to the campus and workplace environments are likely to be more effective recruiting tools when they not isolated events. Pascarella [6] identified social involvement with peers and extracurricular activities as important in helping first generation college students to access social capital; however, employment, living off campus, and part time enrollment often limit their involvement in extracurricular activities. By tailoring engineering networking and social interaction opportunities with peers, faculty, and professionals to the distinct needs (and often, schedules) of first generation college students, institutions could provide additional access to social capital, thereby potentially retaining more first generation college students in engineering.

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REFERENCES