

Family Roles in Engineering Undergraduates' Academic and Career Choices: Does Parental Educational Attainment Matter?*

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The purpose of this paper is to examine in detail the roles that families, particularly parents, play in the academic and career choices of students majoring in engineering at the undergraduate level, with a particular emphasis on how roles may differ when considering the parental level of education. Previous studies have reported the various influences on students' decisions to enter and persist in engineering at the undergraduate level. Though the role of the family has been identified as an important influence, there remains a limited understanding of specific family roles. In this large qualitative study design, the authors use constructivist epistemology, an emergent design, and a basic interpretive approach. Semi-structured interviews were conducted with a sample of 118 engineering undergraduates enrolled at two universities and representing diversity in parental educational attainment. Based upon interview transcripts, six distinct family roles were identified in participants' academic and career choices. Variations in certain family roles were found with parental educational attainment. This study is innovative in that it significantly contributes to the knowledge base of family, especially parental, influences on engineering students by including the previously under-explored factor of parental educational attainment. Findings are synthesized into recommendations for developing recruitment and retention interventions for engineering undergraduates, particularly students with little or no familial experience with higher education.

Keywords: parental education; family roles; first generation college students

1. Introduction

Educational professionals and scholars in a number of regions of the U.S., most notably in the state of Texas, have recognized that increasing participation by its many first generation college students in higher education is 'critical for the future social and economic well-being' [1, p. 5]. State-level data from the 2004 Postsecondary Student Aid Study conducted by the U.S. Department of Education revealed a vastly different demographic of first generation college students in Texas (identified as students whose parents did not pursue any post-secondary education) than their peers whose parents attended college [1]. Specifically, this study revealed that first generation students were more likely than their counterparts to be female, come from minority backgrounds, be financially independent and be non-native English speakers. Additionally, these students were likely to attend college closer to home, live off campus, work full time, and receive no family financial support for their

education [1]. Other researchers have reported that first generation college students have lower retention rates, particularly in their first year, and take longer to graduate [2–4]. Because the parents of first generation college students are often unfamiliar with the higher education process [2, 5], researchers have reported that these students may have less family support than students from families in which attending college was an absolute expectation for success [6].

In this study, we examined in detail the roles that families, particularly parents, play in the academic and career choices of engineering students. This study builds on our previous work with a sample of engineering students diverse in ethnicity, in which we found that families differed in the ways they influenced their children's choice of major and career. Furthermore, we observed that specific roles varied with parental educational level and occupation [7]. Though the family roles of the 37 participants were briefly described, further work was needed to better articulate a more thorough

understanding of these roles. Those initial preliminary results inspired the specific focus of this paper, which greatly expands on prior findings by identifying and describing in detail six major recurring roles. The current study expands our previous research to include a total of 118 (including the initial 37) engineering undergraduate participants enrolled at two public research intensive universities with different student body demographics. The sole focus of the current work is to conceptualize the specific roles of families/parents in engineering students' academic choices from a qualitative perspective.

1.1 Context

Engineering education scholars have reported many influences affecting student selection of engineering as a college major and their subsequent persistence or withdrawal from the major. In particular, perceived self-efficacy [8–10], peer influence [11, 12], faculty relations [11–13], attainment value in engineering and personal identity [14] and the engineering curriculum [15–17] have all been shown to influence students' decision to select engineering as their major. Additionally, engineering students, especially women and minorities, report that parents, mentors, role models, and teachers influence their choice of engineering as a college major [12, 18–20].

Most strikingly, but in a way unsurprisingly, researchers have found that parents employed in science, technology, engineering or math (STEM) related disciplines exert a positive influence on their children choosing a STEM major, with the greatest positive outcomes with Hispanic and African American males [21]. Similarly, in surveys of students who persisted in STEM at U.S. historically black colleges and universities, researchers found that both the educational level of their parents and their career choices in the sciences were accurate indicators of students' choice to pursue similar study [22]. Using the National Education Longitudinal Study of 1988 (NELS:88) dataset to model the probability of earning a STEM degree, other researchers have found that the variables used to gauge family support for academic achievement were among the most valuable predictors [23].

Given that 50% of U.S. college students have parents with either no or limited college experience [24], a number of scholars have been keenly interested in investigating the persistence and success of such students in college. Note that the term 'first generation college student' denotes different definitions in the literature. Some researchers have restricted the definition to include only students whose parents attained no more than a high school diploma, while others include students

whose parents completed some college (including an associate's degree) but did not earn a four-year degree. Given that the potential number of U.S. students currently engaged in STEM study contains a substantial number whose parents have limited education, student program diversity officers, admissions counselors and engineering education faculty at four-year institutions are greatly concerned with attracting and retaining a larger and more diverse group of students to engineering. They cannot assume, however, that the parents of these students will be conversant with the U.S. higher education system, or necessarily supportive of their children who wish to pursue such education. Indeed, many urban universities, rural universities and community colleges serve large numbers of students whose parents have limited or no experience with higher education.

Though prior studies have revealed the importance of both family and parents as a prime influence in the selection of engineering study, *there remains a lack of detailed knowledge about the role of the family in engineering selection and persistence, especially for students whose parents have a limited education.* Findings from this current study will greatly contribute to elucidating how these families, and most particularly, the parents, with either limited or no higher education, influence the academic and career decisions of their children.

1.2 Terminology and explanation of categories

In our previous research [7], we classified our respondents as 'first generation college' students only if the highest level of education attained by either parent was a high school diploma or less. Using this conservative definition, we assumed that a student whose parent(s) had some college but did not complete a four-year degree (classified in our previous research as a 'continuing generation') might derive *some* advantage from the experience of their parents engaged in post-secondary study, if but only for a short while. In this current study, however, we used a less conservative definition that allowed us to probe for nuanced differences. In particular, we used the National Center for Educational Statistics' definitions [24] to categorize our respondents into three groups: 'first generation college (FGC)', 'some college (SC)', or 'continuing generation college (CGC)', based on the highest level of education achieved by either parent. In other words, if one parent had a higher level of education than the other, we used the parent with the greater level of post-secondary study to categorize our student participants accordingly. See Table 1 for the terminology used in the current study.

Utilizing these refined definitions allowed us to distinguish what roles, if any, may be distinct based

Table 1. Study terminology

Name	Acronym	Description
First generation college	FGC	Highest level of educational attainment for parents is a high school diploma or equivalent.
Some college	SC	One or both parent has some college experience but neither earned a four-year degree.
Continuing generation college	CGC	One or both parents attained at least a four-year college degree.

upon the *limited college* experience of the parents of our study participants. Specifically, whereas parents without any higher education may be unfamiliar with either the admissions requirements or the application process, parents with some post-secondary education, but lacking a four-year degree may offer assistance in helping their children to prepare college applications and apply for financial aid. Parents who completed a four-year degree, however, may have a different perspective on the benefits that a college degree can provide or can serve as a role model for either academic or career plans.

1.3 Epistemological view and research questions

Our goal was to understand the meanings our student participants constructed regarding the roles their families, and particularly their parents, played in their academic and career choices. We used a constructivist epistemological viewpoint [25–27] that values the realities expressed by participants. Furthermore, we assumed, based upon our own prior research and that of our peers, that students would perceive multiple influences from their families. To elucidate these roles and relations to parental education attainment, we pursued two questions in this study.

1. How do undergraduate engineering students perceive and describe the role(s) of their family, particularly their parents, in influencing their academic and career choices?
2. In describing the roles of their parents in this process, how do these perceptions and descriptions vary with the level of education of their parents?

2. Research design and method

This study is best described as a basic interpretive approach [28] with an emergent design [25–27]. We used the constant comparative method of coding to inductively determine patterns from the specific approaches that our participants used to describe their family's influence on their academic and career decisions [25]. Our research design was emergent in that we utilized datasets collected during three semesters over a three-year period at two universities. Building on an initial inductive analysis of the

first dataset, we included a larger and more heterogeneous sample, and then refined our analyses, results and conclusions (see Analysis section for details).

2.1 Recruitment of participants

A combination of purposive and convenience sampling was used to recruit participants from two U.S. universities: 1) an Urban University (UU), with an ethnically diverse student population consisting primarily of commuter students; and 2) a Rural University (RU), located in the southeastern U. S. with a predominantly white student body. These institutions were selected because of the differences in the student demographics. This project was approved by the Institutional Review Boards at both universities. Recruitment was conducted during three separate semesters (Fall 2006 at UU: 37 participants, Spring 2008 at UU: 43 participants, and Fall 2009 at RU: 38 participants). Consistent with the emergent design, the details of the recruitment varied somewhat during each round/semester. Students were recruited by emails sent to listservs for undergraduates majoring in engineering. In each round, participants were first invited to complete a web-based demographic questionnaire, the purpose of which was to gather demographic information from a relatively large number of participants in order to identify potential participants for individual semi-structured interviews. From this questionnaire, we employed purposeful sampling in selecting prospective participants for the interviews. All interview participants received a \$20 cash card.

2.2 Participant description

Our study sample was composed of participants representing each category of generational status (first generation college, some college and continuing generation college) from both participating institutions, as denoted in Table 2. The comparatively small percentage of FGC sample responses from RU compared to UU was expected in that approximately 30% of engineering students at UU were estimated as FGC, whereas only 7% at RU were FGC at the time of the study. We ensured that our sample was also quite ethnically diverse: 21 were Asian (18%), 23 were Hispanic (19%), 29 were African American (25%), 43 were White (36%),

Table 2. Participations by generation status in college from each university

	First Generation College (FGC)	Some College (SC)	Continuing Generation College (CGC)	Total
Urban University	26	16	38	80
Rural University	4	9	25	38
<i>N (%)</i>	30 (25%)	25 (21%)	63 (53%)	118

and two (2%) identified with more than one ethnic group. Eighty-four participants were female and 47 were male.

2.3 Analyses

The entire analysis process was guided by the lead author and occurred in two phases. Initially, two researchers analyzed transcripts from the initial dataset of 37 engineering students at UU. Each researcher identified emergent themes and constantly compared each new transcript to those themes, reviewing prior coded transcripts as necessary for coding these new themes [25]. Multiple rounds of inter-rater comparison verified that similar segments were coded in an identical manner. In this initial dataset, 11 family roles were determined and labeled, and memoing was used to describe the various roles and their ascribed meanings. We then examined the roles in terms of parental educational attainment and noted discernible patterns.

The complete dataset of 118 participants was then re-analyzed, with the assistance of two additional researchers designated for this task, using the initial 11 roles as *a priori* initial codes. Using these 11 roles as the initial point for a new round of constant comparative coding, we continually refined the categories in the large combined dataset. Many rounds of memoing and inter-rater discussions were held to determine which of the initial 11 roles emerged as the most salient in the complete dataset, which included a diverse group from both participating universities. Based upon the quality of their descriptions of their family's influence (i.e., sufficient evidence of thick description of each role), some of the original 11 were deleted, and others were combined to yield the final six roles. Another final round of memoing was then conducted to record differences in and nature of the roles based upon parental educational attainment.

2.4 Trustworthiness

Adhering to the methodological advice of other researchers [29] who discuss the paramount importance of establishing trustworthiness of qualitative data in the developing field of engineering education, we particularly emphasized the trustworthiness of the work throughout the study. We addressed measures of internal validity (credibility), external validity (applicability), and dependability

(consistency) through a variety of strategies [30]. To address credibility, we explained our assumptions based upon our prior work and the literature, as well as our epistemological perspective at the outset of the study. We also used prolonged engagement [27], working with the data over a period of several years, going back and gathering more data to confirm and refine our initial analyses. We triangulated the perspectives of other researchers using peer debriefing, particularly including the often fresh insights on themes and codes from the researchers who joined the project at various stages, as well as results based upon the conclusions regarding parental education.

The transferability, or external validity, of qualitative data lies in 'the degree to which aspects of research findings can apply to contexts other than the study context from which the findings emerged' [31, p. 70]. We have aimed to present rich, thick description of the roles, their complexities, overlaps and even discrepancies. To this end, we have endeavored to facilitate the transferability of our work by offering research-based suggestions regarding potential implications for the recruitment and retention of engineering students.

2.5 Useful theoretical lenses

Researchers have discussed how the inductive nature of qualitative research means that 'the use of theory in qualitative research comes much later, if at all, as a lens through which the findings can be interpreted' [29, p. 57]. While our prior research and that of our contemporaries seem to intimate the importance of this analysis, in accordance with [29, p. 56] we prudently examined the data 'without preconceptions as to existing theory or pre-determined categories, allowing themes or categories to emerge from the data.' Through this process, we elucidated novel insights that would be otherwise impossible if an existing theory or concept were imposed upon the data [25, 29]. In this study, the various nuances of our data would be lost if subject to examination using a single theoretical lens. As such, we enhanced our analysis via conceptualization of our data through both Social Cognitive Career Theory [32] and Network Theory of Social Capital [34].

2.5.1 Social Cognitive Career Theory

Lent and colleagues' Social Cognitive Career Theory (SCCT) [32] posits that career choices are

not made in a social vacuum, but are instead directly influenced or moderated by environmental (contextual) variables, cognitive person variables, and other personal characteristics. Environmental variables that are contemporary or background in nature include social supports, actual or perceived barriers, access to role models and material resources. Previous research investigating undergraduate engineering students has shown that perceived social supports and barriers are indirectly linked, via self-efficacy, to intentions to persist in engineering [32].

2.5.2 *Network Theory of Social Capital*

Lin's Network Theory of Social Capital is most simply described as resources gained from relationships [34]. In particular, the concept of inequalities in social capital offers a different yet complimentary lens with which to examine our results. Lin defines the occurrence of inequality in social capital—the quantity or quality of available resources—as the result of differential access to social resources, a disadvantaged position in a network, differential activation, or homogenous network characteristics [34]. For example, students who are among the first generation in their family to attend college have been described as having a deficit of social capital [3]. When applied to the realm of education, scholars posit that education-related social capital comes from a variety of sources, or agents, including family (termed 'kin'), school/institution and peers [35–39].

3. Findings

Each of the six roles is described in detail here, using representative quotes from transcripts to support the description. Different participants are cited each time. A summary of each role identified in this study and the relationship to parental educational attainment is shown in Table 3 (Discussion).

3.1 *Role 1: Common supporter*

Nearly all participants (112 of the 118 interviewed) described their families as Common Supporters of their goals and achievements. All 30 FGC students, 20 of the 25 SC participants, and 61 of the 63 CGC students placed their families in this context. The FGC and SC students described their parents as quite enthusiastic about their choice to pursue post-secondary education to achieve a higher standard of living and engage in more meaningful life pursuits that they themselves did yet not possess, and unfortunately might not ever achieve. These participants believed that this support was not contingent upon majoring in engineering specifically, but in simply pursuing higher education. For example, one participant

stated that, 'They [my parents] really don't know anything about engineering, but they're just happy that I'm going to college. . . . My family is supportive of me going to school; they really would not mind what I study' (FGC) and 'They don't really mind—my parents, they don't know anything about school. I guess they don't pressure me too much, as long as I do good in my classes they are proud of me' (FGC). Participants described their parents as being pleased that they are on a path that will earn them a degree and eventually, a good job. Indeed, as one respondent told their interviewer, 'My dad, he's supportive . . . both of them are supportive about it as long as it really supports me and I have a job [when I graduate]!' (FGC). Similarly, another said 'they [my parents] were very supportive of it. They said whatever you want to do is fine with us, at least get a degree' (SC).

Students from the FGC, SC and CGC categories also described general emotional encouragement; in other words as feeling supported in whatever specific major the student wished to pursue. Some participants talked of how their parents showed their support when the student wanted to give up, by saying things like: 'You can do it! You're almost there! They always support me' (CGC).

Participants from all generational categories spoke of the obvious pride, pleasure and satisfaction among family members regarding their decisions to pursue the study of engineering specifically. For example, a FGC student stated: 'My mother really pushed me to go to college and continue school because she knew that education was very important,' he said, 'So she was very proud of me when I decided to go to college and study engineering' (FGC). Another respondent said that his 'dad was . . . supportive with the chemical engineering because he sees it as a practical field, something that's going to be there as opposed to some of my friends are going to English and music where unfortunately sometimes it's hard to get a job. . . .' (CGC).

Another participant said, 'Yes, they [my parents] are very supportive. They are very interested in what I am doing and where I plan on taking it. They are always looking up different occupations and different salaries in chemical engineering. They are just seeing what I might be doing later on' (CGC).

3.2 *Role 2: Unsupportive/Hinderer*

In contrast, another major role identified was that of either being unsupportive in specific behaviors or hindering participants' progress in their chosen major. This role was prevalently described by 62 participants—over half our sample—and notably even by those participants who *also described feeling generally supported* by their family/parents.

Twenty-three of the 30 FGC participants, and 10 of 25 SC participants described instances or situations when they did feel that their family *did not offer support for their choice* of degrees or careers. The nature of the descriptions from FGC and SC participants was markedly more complex than that of CGC participants. The FGC and SC participants described the hindrance role in terms of their families forcing them to choose between school and other obligations. While these participants described their parents as wishing them well in successfully pursuing post-secondary study (General Supporter role), these parents either simultaneously put pressure on them or unwittingly hindered the specific things that the students needed to do to succeed. Many FGCs described how their families could not appreciate what college life entailed, particularly in regards to the tremendous academic rigor that is requisite for obtaining an engineering degree. 'I live really close to home so they always want me to come home on the weekends,' one young man said, 'I want to go see them but I'm in college, you know, I want to be alone and into the college life. So I go like probably one weekend every month. [I] especially [feel pressured by] my dad because he's really close to me because I'm the youngest. . . . They used to be with me all the time so they're always asking me, 'when are you coming home, when are you coming home . . . ' (FGC). Similarly, another said that:

They [my parents] probably think it [school] is insane. My dad dropped out of high school when he was 16 . . . then he went back and got his high school diploma later and so he's never been a school oriented person . . . school just wasn't his thing . . . So he thinks I'm insane. He probably thinks I could take over the family business and be perfectly fine, but I have other plans for myself so. And my mom, she doesn't understand what I do . . . she would just look over my shoulder [while I was doing homework] and see what I was doing and she would just walk away. I mean they honestly have no idea what I'm doing and I'm okay with it (SC).

While 29 of the 63 CGC participants described their parents as assuming a similar role, the nature of the participant perceptions was markedly different compared to the FGC and SC students. Some CGC described this unsupportive role in terms of perceived pressure from their families to pursue a career in a discipline other than engineering, at least in their initial choice of a college major. One CGC participant stated, 'My parents were pushing more for a political law degree.' He was nonetheless resolute in his response, telling them, 'I am a math/science person.'

Another described her father's unsupportive role as an 'I-told-you-so' attitude. '[My dad] hasn't really talked to me about [engineering]' the student said, 'If I complain about calculus he just says, 'I

told you to do pharmacy.' And I'm like, 'No, I am not going to do pharmacy, I am majoring in engineering!' (CGC).

Participants in all categories discussed conflicts between school and feeling pressure to place family obligations above their studies. '[My family] didn't like it for a while. I mean my third year, my junior year, was the hardest one for us. I barely saw them and they didn't like it at all. They would complain. I would get home like at 1:30 in the morning and I would get out like at 7:00, so I would never see them during the week. And then the weekend I would be eating breakfast with them and I'd leave to study, and then come back at night and sometimes stay at school. They didn't like it.' (CGC). Another student stated, 'My brother just had twins and I'm a godfather to them and I don't see them often enough' (CGC).

3.3 Role 3: Legacy

Ninety-one of the 118 participants described either family expectations or a tradition to pursue post-secondary study in either engineering or another discipline, which in turn influenced their choice of major. Specifically, 22 of the 30 FGC participants, 15 of the 25 SC students, and 54 of the 63 CGC students spoke of their families as instilling a 'Legacy', although such a role assumed a different meaning according to parental level of education. In the strictest sense of the word, CGC participants spoke of parents, siblings, grandparents, or other family members that are engineers, and described feeling a sense of family tradition, or even occasionally, a pressure to succeed in the field of engineering. Such traditions are perhaps best expressed in the response of one participant, who stated, 'My dad's an engineer. My uncle's an engineer. My grandpa's an engineer. It kind of follows—both sides of my family' (CGC). Another facet of the Legacy role for CGC students entailed pursuing study in what they viewed as a highly respected profession (which could either be an engineering discipline or a similar field of study). One student described his choices in following a different career path from either of his parents:

They want me to choose whatever I like and because I don't want to follow the footsteps of my mom or my dad—he's a doctor she's a judge/lawyer—so I knew I wasn't going to go with any aspect close to that. I already told them that from the beginning I would never become a doctor because I would not want to be known as Dr. X's son, so I just wanted to do something completely different (CGC).

Within the FGC and SC categories, participants repeatedly expressed a perspective of 'inheriting' a legacy of diligent labor and an inherent value for education from their families. These participants

felt that their family's value of education—even though the education of their parents was limited—was their primary motivation for undertaking study to acquire a four-year degree. Students also stated that while their parents may be unfamiliar with the discipline of engineering or what the job of an engineer involves, their families viewed it as a respected profession which would lead to gainful employment, and a lifetime of security.

One participant said:

Because my father and mother they always [said] 'if you want to do something, you have to get an education, you have to work hard because things are not just going to fall in your lap' so it's very much [expected that] you're going to college, you have to get a job, a good job. They definitely taught me at a very young age that education is one of the most powerful tools you can have . . . so it was already ingrained in me to go to college (SC).

Another said, '[My family is] very supportive . . . especially my mom. [She is always] focusing on education. Her not finishing college plays a role in her pushing me' (SC).

One student, speaking of his grandfather, stated that he would have become a great engineer if given the opportunity.

I was always hanging around my grandfather and he's always been a man who's been able to fix anything and work on anything just about. And so growing up with him, being around his garage and seeing the things that he's been able to do, and he didn't go to college and he barely finished high school, so it was, I was always interested in the things he did and the ways he fixed things and the ways that he found how things work. And so I guess growing up that was a natural tendency. And then I realized that he would have made a great engineer if he would have had the chance to be, you know, be one, have the education, so I thought I'm interested in that, that's what I want to do (SC).

For FGC students, the Legacy role overlaps somewhat with the Common Supporter role; participants felt that their parents had instilled in them the importance of obtaining a college degree and were subsequently encouraged by their parents to pursue a degree in whatever field they chose. However, the interaction of these Legacy and Common Supporter roles with the Hinderer role illuminates the tension felt by those participants who described both Common Supporter and Unsupportive/Hinderer roles. While the participants felt that obtaining an education was a value impressed upon them by their families, the families also did not necessarily understand the realities of the 'sacrifices' required of these students to succeed in an engineering curriculum.

3.4 Role 4: Future financial provider

Thirty-one participants expressed motivations for becoming engineers to achieve financial stability for themselves, for their own future families, and for

their parents in their old age, all goals they thought otherwise impossible without an advanced degree, particularly a degree in engineering. FGC and SC participants discussed their concerns in terms of the struggles of their parents with limited education, and expressed the desire to help their families of origin financially through employment as an engineer. Specifically, these students discussed using their earnings as an engineer to financially provide for their parents or younger siblings. 'I think I have to work by then because my parents will retire and come here probably. I don't think they are going to work in a McDonald's or something like that, most likely they [will] rely on me by then and I have to get some income' (FGC). Another said, 'I just want to help my dad out. That's the major thing right now . . . get a job . . . and just help my dad' (FGC).

Additionally FGC and SC expressed a desire to avoid the hardships their parents had endured. 'My mom would tell me stories back in the day when my brother was a little kid, how they were struggling and stuff,' one participant said. 'And then I just thought about it; when I have a family I want to be able to, you know, give my kids a good life, so that's probably the reason I picked engineering, too' (FGC). Others professed similar beliefs. 'My family had a lot of things happen in high school and money issues . . . money isn't everything but . . . I want to not have to worry. I want to be able to provide for my kids and pay for college for them, because I didn't have that opportunity' (SC).

While CGC participants talked about earning an engineering degree as a means to provide for family, they spoke solely of future spouse and children, not their family of origin. For example, one representative student stated, 'I just want to be happy. I just want a job that I can see myself doing for the rest of my life, and as an engineer, you are most likely going to get a pretty good paycheck . . . I could support myself and support my family' (CGC).

3.5 Role 5: Knowledge source

Fifty-nine participants cited their families as direct sources of knowledge or information regarding their academic or career plans: 16 of the 30 FGC students, 10 of the 25 SC students, and 33 of the 63 CGC students. Responses from participants whose parents did and did not have four-year degrees were similar in that they mention speaking with family members either studying to become engineers or who had already done so. One notable difference, however, was that when participants in the FGC and SC groups referenced family, it was not their parents, but rather their extended family (e.g., uncle, cousins) who most influenced their educational decisions and aspirations. Some expressed a desire to assist younger siblings through the college/

application process. One respondent, mentioning one of these extended family members, stated:

[My cousin who is a civil engineer] calls once in a while and asks me how I am doing and stuff. And it feels good because he wants to know if I am doing good or if I have gotten a job. . . . Right now he is working for a geotechnical company. So he told me a little bit about the stuff that they do (FGC).

Another SC student learned of engineering from reading magazines to which his grandfather subscribed. 'I'd read articles on science and technology in *Popular Science*, *Popular Mechanics*,' he said. 'My grandpa would always have those lying around the house' (SC).

Many continuing generation participants mentioned their parents or siblings as knowledge sources and described listening to personal anecdotes from these relatives. One participant, who came from a family of engineers, talked of the self-satisfaction of contributing to family discussions about engineering. 'I can put [provide] input into those conversations now, [when] my uncle and my dad are speaking,' she said. 'I can talk about his business and that's good for me, I like that.' (CGC)

Another CGC participant said:

Ever since I was younger [my dad]—he's a forensic engineer—he's been telling me cases, and I actually get to go on site with him sometimes. I'll do diagrams for him or I'll work in the office and I'll help him do subpoenas or read through cases. It's just; I really like that kind of forensic type of engineering. [My uncle] he's a mechanical engineer and, my, my grandfather is a chemist and he's allowed me to work in the lab with him sometimes over the summer as well and I really love chemistry much more than I like physics so I decided on chemical engineering (CGC).

3.6 Role 6: Facilitator

Thirty-nine participants considered their families as facilitators of their academic and career plans, but not as direct sources of either knowledge or information. Participants in all categories described their parents as assisting in either acquiring the necessary information to better understand the subject of engineering, locating engineering-related opportunities or researching schools with engineering programs. Some FGC and SC participants had parents who worked with or knew engineers:

One of my dad's co-workers—his friend—actually is going for [a] chemical engineering [degree]. Then my dad started asking [him] all of the questions, you know from father to father, and then my dad's like, 'Oh that sounds like a good idea! Try to do your best, and try this.' Then he started looking up stuff, too (SC).

Another FGC participant said, 'One of them [my dad's friends] is a civil engineer and the other one is an agriculture engineer. And my mom has a friend

and he's a petroleum engineer, so they were telling me about what they do and stuff like that.' (FGC)

Some FGC and SC participants stated that they chose a particular field of study because their parents provided them with information about that particular discipline. Typical is the story of one such student:

I chose Biomedical Engineering [because] my mom brought all these books home from the library. She brought [books about] . . . Dr. Benjamin Carson. I didn't know who that was. My mom [said] just read it, give it a try. And he's been my idol since third grade. He was a pediatric nurse and I've read all his books. He's been absolutely he's my inspiration (SC).

The Facilitator role also included numerous participants from the CGC group who spoke of how their parents provided them with information related to their interests. For example, one participant interested in Biomedical Engineering spoke about how her mother related such information to her, relating that 'When she (my mother) found something cool or whatever, she came across something like a new prosthetic or something she would like show me that' (CGC). Additionally, participants described their parents as providers of opportunity, whether either in locating camps for their children or connecting them with practicing engineers. One student described the efforts of his parents:

They found the camp for me for high school 'cause they knew I was interested in engineering. . . . They really got me into doing that major, so they supported [me] and stuff and helped me find more things to learn about it (CGC).

Another characterized the efforts of his parents to find a robotics contest for him to enter:

When I was in high school, I did attend a FIRST robotics which was huge and it gave me a chance to look at what they did and they built, you know, robots that completed functions and that really interested me a lot and that's where I saw a lot of the engineers, I met a lot of engineers for the first time there and it was unique (CGC).

4. Discussion

Our work extends the literature on how various factors influence the selection and persistence of engineering students to include differences related to parental educational attainment. Indeed, the identification and description of family roles experienced by students with limited parental educational attainment (FGC or SC) is the distinctly novel contribution of our research. A summary of our findings related to the research questions describing each perceived role and its relation to parental educational attainment is shown in Table 3. The description of the roles primarily differed between students with at least one parent possessing a four-

Table 3. Summary of roles and relation to generational status in college

Role name	Summary	FGC	SC	CGC
General Supporter	Nearly all participants described this family role, but how it unfolded varied based upon the parental level of education.	FGC and SC participants stated that their families were pleased that they were pursuing a college degree, regardless of the field of study.		CGC students often discussed the expectation of attending to college and the support of their parents in pursuing engineering study.
Unsupportive/Hinderer	Participants described situations in which family failed to offer emotional support or even exhibited behaviors hindering their engineering study.	FGC and SC felt that their families did not understand the college experience, the engineering field, and/or the demands of the curriculum. As a result, FGC and SC participants often felt pressure from families to place family obligations over schoolwork.		CGC participants tended to describe this role as familial pressure to study disciplines other than engineering, although some reported feeling conflicted between family obligations and school work.
Legacy	Expressed as either 'inheriting' a general expectation to go to college (regardless of their parents' education) or the specific goal of continuing the family engineering 'tradition'.	FGC and SC participants described this role through a perceived expectation for educational attainment that their parents had not achieved, and a strong family work ethic.		CGC participants cited family members who are engineers as influencing their decision to study engineering, thus instilling a family 'legacy' for the profession itself.
Future Financial Provider	Participants pursued engineering because of the promise of a future income and financial stability.	Some FGC and SC participants gave examples of pursuing an engineering degree to assist their family of origin financially, particularly to take care of their parents in old age.		CGC students spoke of becoming a financial provider and providing a comfortable life for themselves, a future spouse, and perhaps children.
Knowledge Source	Participants gained direct knowledge of engineering and careers through family members.	FGC and SC participants generally did not use family to acquire such information, although some used extended family such as cousins.		Many CGC participants perceived their families, particularly their parents, to be sources of specific knowledge about college and career options.
Facilitator	Participants provided examples of parents willing to help obtain college/engineering information/opportunities.	Even though parents lacked a formal education in engineering or any post-secondary education, participants described their willingness to help them find information about engineering, often through friends.		CGC students described parents as seeking out engineering-related opportunities (e.g. contests or camps) and conducting Internet searches on engineering-related topics.

year degree (CGC). First generation college (FGC) and some college (SC) participants generally described the roles similarly, indicating that the pivotal characteristic was whether or not the participant had a parent with a four-year degree.

4.1 Relation to prior literature

Our findings regarding the roles of *General Supporter*, *Hinderer*, *Knowledge Source*, *Legacy*, *Future Financial Provider* and *Knowledge Source Facilitator* bear some similarity to that found elsewhere [19, 39, 40]. Our study also reveals some commonalities to previous descriptions of the 'occupational inheritance' phenomenon for engineering students [19]. Whereas the previous researchers' discussion of occupational inheritance is limited only to students with parent(s) that are engineers (and therefore considered as a subset of our 'continuing generation college' students), our *Legacy* role also includes first generation college students who 'inherited' non-engineering specific characteristics, such as a

strong work ethic and who also placed great value on pursuing post-secondary study.

The *Future Financial Provider* role we describe is consistent with a previous quantitative study, in which the authors determined that first generation college students at a four-year university were more likely to report assisting their families financially as a reason for pursuing a four-year degree than were those whose parents had either some college education or a college degree [40].

While it has been reported that family perspectives and actions could hinder their children in pursuing an engineering education [40], our results offer a much more nuanced and complex description regarding what this hindrance actually involves. In our study, interview participants described some family behaviors as making their pursuit of an engineering degree more difficult, or failing to support their efforts entirely, *even as those same participants described feeling generally supported*. Bui [39] also identified participants (13 of

89 surveyed) who reported hindering family factors. However, those survey results differed from our interview characteristics in that the three most reported hindering factors preventing the completion of an engineering degree were lack of family involvement, support, and encouragement; lack of financial support; and no family nearby. The focus groups of that study did, however, reveal one finding analogous to our own: a lack of familial understanding regarding the engineering profession, which resulted in no assistance in locating and securing either internships or co-operative jobs. While that sample consisted of a variety of parental levels of education, the results were not delineated by the level of parental education. *The qualitative nature of our work allows for a deeper understanding of the specific roles that are similar in both studies.*

Our findings are also comparable with that of Wentling et al. who studied females graduating with an engineering degree from the perspective of Social Cognitive Career Theory (SCCT) [41]. They surveyed students and conducted focus groups, querying participants about school, family, personal and societal factors that either hindered or helped their decision to study and complete their engineering degrees. To place their results related to 'parents' support of my personal career choice' and 'parents' encouragement to pursue an engineering degree' in context [41, p. 96], we assign the role of *General Supporter* here. For their definition of support, which they term as 'parents provid(ing) advice and information about careers in engineering' [41, p. 96] and 'family members assist(ing) in engineering homework' [41, p. 105], we assign the role of *Knowledge Source*. For their definition of 'Family helped financially' and 'family helped me getting an internship' [41, p. 105] we assign the role of *Facilitator*.

4.2 Application of theoretical lenses

The lens of SCCT offers a useful perspective for elucidating the influence of families, particularly the background of their student and proximal contextual influence of parents, on the academic and career decisions of children. Our research has shown that the roles of families in their students' career choice processes (the process of developing interests and goals, which manifest as actions) may be present as supports or barriers, which influences the students' self-efficacy or their outcome expectations. While the temporal nature of a given role (background, proximal or both) often differed depending upon the participant (one participant describing a specific role as a background influence and another as a current one), many of our roles can be understood in terms of social cognitive constructs. When described as background influences, these roles

sometimes either influenced students' self-efficacy or their outcome expectations via early learning experiences. Students also describe the effects of the roles they described on their interest-choice-action academic/career decision-making process. The differences in the roles based on parental level of education have been described in Table 3. We further describe each role below using the lenses of SCCT.

- **General Supporter:** Participants describing this role did so as support in general for obtaining a college degree and/or as particular support for majoring in engineering. When described as emotional support and encouragement, some participants articulated that it gave them a needed emotional boost, which was likely to enhance their self-efficacy.
- **Hinderer:** Participants described this role as a barrier to their engineering studies. As previously discussed, the perceived barriers or unsupportive role was not necessarily intentional but often existed as a tension (explicit or implied) between family expectations for family time and school obligations.
- **Legacy:** The nature of this role varied with parental education along the range of an expectation for educational attainment to continuing a family tradition of engineering, which was a background influence that affected participant outcome expectations, either for college education or specific to engineering study. For CGC students especially, it often manifested in terms of access to role models.
- **Future Financial Provider:** Participants generally described the outcome expectation that a degree in engineering would help them to achieve financial stability. In particular, students who did not have a parent with a four-year degree described the expectation that getting a degree in engineering would help to increase their lot in life, allow them to have an easier life than their parents and contribute to the financial status of their family of origin (e.g., take care of their parents). CGC participants described similar expectations for providing stability to both themselves and potential families of their own.
- **The roles of Knowledge Source and Facilitator** can be viewed from a social cognitive perspective in a few ways. First, direct or indirect knowledge from background or proximal influences made a difference in their college major choice process (the process of interests-goals-actions), either from gaining direct or indirect knowledge. This knowledge, experience and resources (either in the form of information or materials resources) that were provided or facilitated by the family perhaps

also influenced their outcome expectations for a degree program and career in engineering.

In terms of the theory of social capital, we have described several ways in which families (especially parents) contribute to academic and career social capital. Namely, this occurred via three identified roles: 1) the Knowledge Source, in which parents or family members directly provided information or resources for students from their own experience; 2) the Facilitator, in which parents used connections in their own social networks to help connect their student-children to resources and information and 3) the Legacy role, in which family capital is also represented in some cases, and in which students used family experiences in engineering in a very similar way to the Knowledge Source role. The degree to which family social capital was present and how these roles served as social capital varied with parental level of education. The Knowledge Source role and the nuance of the Legacy role that involved continuing the tradition of engineering were specific to CGC participants. Participants with parents of all educational levels described the Facilitator role, and even parents without direct knowledge of engineering were often able to use their own social networks to gain social capital for their children. CGC students, however, described more specific things that their parents sought for them.

The concept of strength-of-ties [34], and whether the relationship between the individual seeking information and resources and the one providing it is considered to be 'strong' or 'weak' is important when considering family social capital. This is because family ties tend to be strong, but the resources within the network tend to be homogeneous in nature. Our findings show that students with college-educated parents described these strong ties that provide specific information and resources related to engineering more in all three roles. The Facilitator role is nuanced based on parental education. While the strength of the ties with family members was strong and family members in all three educational categories were described as willing to help, the Facilitator role also involved parents connecting their students with individuals with whom either the parent or the student had weaker ties. This connection is known as the 'strength of weak ties' [34, p. 67]. The findings in this paper are consistent with our prior work [7] in which we determined that when the necessary engineering-related social capital does not reside within a student's kin relationships, students often turn to others with whom they have weaker ties (such as school personnel) but who possess more heterogeneous resources.

4.3 Limitations

Like all research, this study has limitations. First, these data represent a 'snapshot' of participants' perceptions, rather than a longitudinal view of how family influences might evolve over time. Additionally, we also included only students who persisted in their engineering studies, not those who dropped out of the program. Other family roles may emerge if interviews were conducted with students who initially selected, but then left, undergraduate engineering majors. Finally, our adoption of a constructivist perspective to determine the students' frame of reference and perceptions (rather than their families') does not provide a totally balanced narrative that could be possible through actual interviews of the families of our student respondents. In particular, we did not determine if the parents of these students self-identified with these roles. Including students who considered engineering but ultimately majored in another field, students who left engineering at some point in their undergraduate studies, as well as their parents offer a rich area for future research that would deepen our understanding of these roles.

4.3.1 Significance of findings: Implications for recruitment and retention

From these new, specific results related to family roles and our prior work, we determined that in the absence of family capital, students often relied on either pre-college or college level personnel to either learn about or specifically pursue engineering as a college major. Engineering outreach, recruitment, and retention programs and personnel were the salient sources of information and support [7, 42, 43] that our participants used in this process. Therefore, to enhance the recruitment and retention practices among students with limited parental education attainment, we make the following recommendations.

4.3.2 Involving families

Our results show that while many FGC and SC students perceived emotional support from their families, such support did not necessarily correspond to the selection of engineering as a major, but rather a more general approval for pursuing a four-year degree. Also, because educating parents on the advantages of pursuing engineering as a college major and career may enhance their support for the specific plans of their student-children, they should be included in institution-wide recruiting events and in sessions describing engineering careers. Recruitment and retention personnel should understand these common misconceptions (which may be regionally or culturally linked) and

directly address them. Many FGC students in this study were motivated to pursue engineering as a means to provide for their family financially. As others have identified similar influences [12, 39], we recommend developing interventions that include information on paying for college, internship opportunities, and potential future earnings.

4.3.3 Institutional support

It is unrealistic, however, to assume that parents or families acting as either *Unsupportive* or as *Hinderers* will necessarily change their attitudes and behavior merely from such educational interventions. In these cases, the presence of strong institutionalized student support systems, peer groups, and non-curricular activities at the undergraduate level may be even more vital for student retention in engineering majors, as they may serve as alternate forms of emotional support and encouragement as well as engineering specific resources and information [7].

The participants in our study who reported a *Legacy* for engineering and/or higher education did so in the sense of a positive influence. An unanticipated consequence of this family role, however, could be pressure to follow in their parents' footsteps [12] or a decision to enter engineering (or a specific discipline) that is not informed by adequate knowledge of available options, but rather by 'blindly' following a parental example. Therefore, for purposes of retaining students in engineering study, it may indeed be important to offer *Legacy* students support in the form of advising or coursework to help them make an informed decision prior to undertaking engineering studies. Those students in our study who made academic and career decisions with no perceived influence from family, also need adequate pre-college guidance, resources and additional support during the early years of engineering study.

The roles that a family member may assume—*Common Supporter*, *Knowledge Source* and *Facilitator*—must also be nurtured and expanded to help them better support their children. Guidance counselors, for example, can foster these roles by providing families with specific, timely and periodic information on college and ways in which families can provide active, positive support to their children at various ages or stages of their life.

4.3.4 Equipping students to educate their families

Many students may well be uncertain regarding their future opportunities, work environment, and the actual work of engineering. By providing accurate information and role models for success early in their college experience, students will not only be able to make informed decisions, but will

be better equipped to explain their options to their families. Providing students with 'scripts' or role playing about how to talk to their families about the rigors of the coursework, the job opportunities and the ultimate return on investment of an engineering degree may help students communicate with family members who lack an understanding of the higher education system and who are unfamiliar with the demands of an engineering curriculum.

5. Conclusions

Using a constructivist perspective focused on the perceptions of engineering undergraduate students, we have demonstrated that the attitudes and expectations that parents communicate about engineering, their ability to provide guidance, and their ability to serve as role models can be dependent on the parents' own educational and professional experiences, or lack thereof. We have significantly enhanced the knowledge base of family influences on engineering students by including the previously under-explored factor of generational status in college, which in turn greatly expanded the variability in previously reported family roles. Specifically, we provided an in-depth investigation of the roles that families, and especially parents, play in the college and career choice processes of engineering students.

We conclude that some parents may be unable or even unwilling to positively influence and support their students in engineering due to a lack of knowledge or experience about higher education and/or the field of engineering. However, our research illustrates that even when parents and families cannot serve as *Knowledge Sources* for their students, they can help *Facilitate* their goals, but only if there is buy-in for the students' college and career plans. Although they may not serve as engineering specific social capital or professional role models, their work ethic or value for education (*Legacy*) may inspire their student-children to overcome obstacles in pursuing a degree in engineering. In order to attract and retain students into engineering majors whose parents have a limited education, university personnel must design effective programs and interventions that specifically recognize and address the roles that families may play in their academic and career choice processes. Our work has offered specific implications for such interventions based on these results. In the future, the inclusion of how parents/families may self-identify with these roles would provide an additional richness with which to view the influence of the roles on students' educational experiences.

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