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SHAPING AUTONOMOUS DECISION MAKERS: FAMILIAL INFLUENCE ON PERSISTING FIRST GENERATION COLLEGE ENGINEERING STUDENTS

Denise R. Simmons[1,*] *& Julie P. Martin*[2]

[1]Myers-Lawson School of Construction and Civil and Environmental Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

[2]Department of Engineering and Science Education, Clemson University, Clemson, South Carolina, USA

*Address all correspondence to: Denise R. Simmons, Myers-Lawson School of Construction and Civil and Environmental Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA, E-mail: Email: densimm@vt.edu

Researchers recognize generational status in college as a noteworthy factor in understanding the barriers, supports, resources, and decision-making processes of engineering undergraduates. Using a constructivist grounded theory methodology and critical incident technique, this study explores the influences that first generation college (FGC) students ascribe to their families as they decide to select and remain in an engineering major. These influences are distinct despite parental lack of specific "college knowledge." Findings yielded a description of relationships among concepts (theory) uncovered (grounded) in the data. Families served as sounding boards by posing questions and reflecting the importance of those answers. They inspired their children's motivational dialogue and instilled an overt expectation to seek fulfillment in their chosen path in engineering. Families provided significant emotional support and assistance with college admission and financial decisions necessary for completing participants' pursuit of an engineering degree. The authors present practical implications for families, engineering educators, and other educators that have the potential to impact retention of FGC engineering undergraduates.

KEY WORDS: *family influence, academic and career decisions, persistence, constructivist grounded theory, first generation college student, engineering undergraduate*

1. INTRODUCTION

The number and diversity of engineering college graduates has garnered increased attention from research, funding, and policy perspectives in recent years (National Academy of Engineering, 2012; President's Council of Advisors on Science and Technology [PCAST], 2012). Efforts to recruit and retain a large and diverse engineering student population occur at many levels: from grants awarded to single researchers, to local and regional programs hosted by school districts and universities, to national-scale Presidential mandates (deGrazia et al, 2000; PCAST, 2012). These efforts also cover all levels of the US educational system, from pre-kindergarten (Brophy et al., 2008; Richards et al., 2007) to post-graduate (e.g., National GEM Consortium, n.d.).

Of particular interest when looking to attract and retain undergraduates in engineering are

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first generation college (FGC) students. Estimates of the number of FGC students entering college vary widely depending on how FGC status is defined (Pappano, 2015; Smith, 2015); estimates suggest that somewhere between 20% and 80% of all undergraduates are FGC students (Pappano, 2015; Smith, 2015; Chen, 2005). FGC students face a multitude of distinct challenges not encountered by continuing generation college (CGC) students. From higher education studies, these challenges include possessing less knowledge about applying to college and obtaining financial assistance; experiencing increased difficulty in adjusting to the rigors of college coursework; and higher dropout rates (Chen, 2005; Pike and Kuh, 2005; Pascarella et al., 2004; Vargas, 2004; Choy, 2001; Thayer, 2000; Hsiao, 1992). Although a number of studies indicate that programs designed to help FGC students also help their peers, the reverse is frequently not the case (Gullat and Jan, 2003; Schmidt, 2003; Thayer, 2000).

The engineering education literature reveals that FGC students tend to choose engineering as a major less often than CGC students (Balemian and Feng, 2013). FGC students in engineering must contend with varying degrees of access to engineering-related social capital and the contrasting levels with which families support their children as they pursue engineering (Martin et al., 2014; Martin et al., 2013; Fernandez et al., 2008). Israel et al. (2001) suggest that the importance of social capital (e.g., family, teachers, counselors, and other students) cannot be ignored when preparing students to be successful in the workforce. Engineering students and professionals often come from families where at least one member is already an engineer, a process known as occupational inheritance (Mannon and Schreuders, 2007). This phenomenon exists in other fields (e.g., law, medicine, agriculture, the military; Dorie et al., 2014) and is a celebrated feature in engineering (ASCE Foundation, n.d.). Occupational inheritance, while offering strength and continuity to a field, may also serve as a barrier to attracting new recruits to engineering, making engineering seem like a field not open to other students. This study's importance lies in the potential to help bolster national efforts to recruit and retain more undergraduates, in the form of FGC students, who will then complete an engineering degree and choose an engineering career.

Research indicates that the college choice process occurs at the same time as the career decision-making process, both of which are strongly affected by the variables of family socioeconomic status and parental education levels (Fisher and Padmawidjaja, 1999; Stage and Hossler, 1989). The positive influence of significant individuals in a student's life is crucial for engineering student academic and career decision-making processes such as selection of college major, persistence in engineering, and career intention. For example, mentors, role models, teachers, and parents are all particularly effective influencers upon student selection of science, technology, engineering, and math (STEM) as a college major (Martin et al., 2013; Allendoerfer et al., 2012; Mannon and Schreuders, 2007; Goodman et al., 2002; Adelman, 1998; Seymour and Hewitt, 1997; and Astin and Astin, 1992). Educational outcomes are greatly affected by parental influence (McCarron and Inkelas, 2006; Hossler et al., 1999) and are strongest when the influence occurs before high school (Cabrera and La Nasa, 2001; Hossler et al., 1999; Attinasi, 1989). Despite a large number of studies examining the experiences of FGC students, the precise influence of the family on FGC student success remains as yet undetermined.

This paper describes a grounded theory study that explores the role of family, specifically parents, as academic and career influencers of first generation college (FGC) students—that is, college students for whom neither parent has attained a bachelor's degree (Choy, 2001). The study focuses on undergraduates who persist in engineering. It does so by operationalizing persistence in engineering as obtaining junior level (completed 60-94 semester credit hours) or senior level (completed 95 or more semester credit hours) at the university while enrolled in an

engineering discipline. One semester unit of credit equals a minimum of three hours of work per week. Our study develops a theory that describes the specific ways that persisting FGC students perceive their families as influencing their academic and career decisions regarding engineering. A grounded theory methodology was employed because few or no theories of persisting FGC engineering students exist and grounded theory allows new properties of a phenomenon to appear (Charmaz, 2014; Corbin and Strauss, 2008).

This study use interview data to explore the familial influences on the academic and career decisions of FGC students who have persisted in an undergraduate engineering program at a large, public university. Coding and analysis of the data involved constructivist ground theory techniques to build theory concerning how family influences persisting FGC students in engineering. In contrast to much of the existing literature on FGC students that focuses on advice, support, and other specific influences that families are not able to provide (e.g., "college knowledge"), the results of this study point to specific and positive influences that students perceive to be significant when making academic and career decisions. These findings highlight four key practices: two-way conversations between parents and students, sharing of expectations, perceived unconditional support, and development of positive self-talk. From the data emerged a theory of constructs and contexts in support of these practices as well as the identification of outcomes of these practices.

2. METHODS

2.1 Study Design

A rigorous constructivist grounded theory methodology was used in collecting and analyzing the data for this study. Grounded theory methods consist of a systematic inquiry approach for the purpose of theory construction and include several key strategies for conducting data collection and analysis. These strategies include inductive, abductive (i.e., reasoning to the best explanation in response to findings where no explanations exist), comparative, interactive (with data and voices of the participants), and iterative strategies (Charmaz, 2012). All of these strategies were employed as a part of this constructivist grounded theory methodological framework.

This study was based on an interpretivist perspective and thus provided the framework for investigating the family influences from the perspective of the participants (Charmaz, 2014). This constructivist inquiry began through the eliciting of student experiences, specifically by asking how these students constructed their experience. The constructivist perspective is one in which the experience is recorded through the perspective of each participant to gain multiple (individual) views of a construct (Crotty, 2003). Another key principle we use from constructivist grounded theory is the co-construction of data and analysis when observing the interaction between the researcher and the participant (Charmaz, 2014).

Memos were used throughout data collection, data analysis, and the writing process. These memos helped guide the initial and subsequent focused coding and ensured a constant reflection process as we used data to build evolving theory. Data collection was ongoing through tools such as theoretical sampling, saturation, and sorting to clarify and enhance the study's coding and theory-building. From these steps, the theory described the initial causal, context, and intervening conditions that informed the strategies and led to the central phenomena – the description of relationships among concepts (theory) uncovered in the data (grounded) – and consequences (Charmaz, 2014; Corbin and Strauss, 2008; Clarke, 2005; Mertens, 2005). The resulting theory

is reported as a paradigm model (Corbin and Strauss, 2008). The use of these methods supported the participants' active construction or "meaning making" of their experience by allowing them to interpret what happened, evaluate it using their current perspectives, and draw conclusions about what the experiences meant to them.

Guided by the previously described interpretivist perspective, this study sought answers to an important but neglected question: how do undergraduate engineering FGC students who have persisted to junior or senior year describe the influence of their family on decisions related to (1) their initial selection of an engineering major, (2) their persistence in an engineering degree program, and (3) their commitment to an engineering career upon graduation?

The study investigated the family as a unit, each family member individually, and the changes in relationships over time in an effort to determine if students' perceptions of family influence differed by family member or time period. Students in the study described influences occurring during both high school and college. The data from this description supported the emergence of a theory and model of the conditions and consequences of family influence on undergraduate FGC students in engineering as they make academic and career decisions.

2.2 Study Population: Selection and Description

An online demographic questionnaire collected responses from a university-wide sample of 3,285 engineering undergraduate students at a Public Southeastern University (PSU). At the time of the study, PSU did not have an accurate count of enrolled first generation college students. The demographic composition of undergraduate engineering students at PSU included 81% White; 8.2% Black, Non-Hispanic; 5.5% unknown; 2.1% Asian; 1.4% Hispanic; 1.4% International; and 0.4% American Indian/Alaskan Native students with 81.3% men and 18.7% women. Calls for volunteer participants were sent to listserv managers of engineering departments, societies, and programs with a request to distribute the electronic invitation to members of their listserv. To comply with IRB age requirements for participants to be 18 years old or older, the online survey first asked students to indicate their birthdate. Of the 462 students that completed the demographic questionnaire, 91 were identified as undergraduate FGC students in engineering. Participants' self-reported parental education levels were used to determine their generational status in college. To purposefully select and invite participants, the study used the following selection strata:

1. Majoring in an engineering discipline;
2. First generation college students;
3. Junior (third year) or senior (fourth year) university classification at time of interview.

Forty-five students met the selection strata, with 16 of those invited to participate in the interviews. During theoretical sampling, the first author invited four participants to return for a second interview to better elucidate a particular aspect of the emerged grounded theory. Our theoretical sample consisted of students who had previously participated, who had indicated a willingness to return for a second interview, and who were deemed better suited for explaining certain aspects of the theory based on abilities to reflect deeply, as noted in the first interview.

At the time of the interview, all of the participants were FGC students enrolled at PSU who had persisted in an engineering discipline to their junior or senior year. PSU classified most of the participants as seniors (13 seniors, 2 juniors, and 1 participant interviewed a month after graduation).

The participants' self-reported race and ethnicity included Hispanic (2), African American (1), and White (13). The gender balance of the participants was nine males and seven females.

The participants reported their engineering majors as follows: electrical (4), civil (3), bioengineering (2), chemical and biomolecular (2), computer (2), biosystems (1), industrial (1), and mechanical (1). To protect the identities of the participants, we do not disclose combinations of major, gender, and race/ethnicity.

2.3 Data Collection and Analysis

In order to increase the "likelihood that the full array of multiple realities would be uncovered" (p. 40) a stratified, purposive sampling strategy and a series of in-depth, semi-structured interviews were used to collect and analyze data using grounded theory methods (Lincoln and Guba, 1985). The first author conducted 70- to 105-minute, in-depth, semi-structured interviews with 16 students using the critical incident technique (Simmons and Martin, 2014; Simmons, 2012; Walther et al., 2011; Corbin and Strauss, 2008; Woolsey, 1986; Flanagan, 1954). Data collection and analysis involved memo writing and reviewing, emergent coding, diagramming, and verification techniques.

The critical incident technique—a qualitative research method used to explore significant experiences to better understand resulting behaviors—substantially influenced how each question was crafted and the approach taken with each interview (Walther et al., 2011; Grant and Trenor, 2010; Woolsey, 1986; Flanagan, 1954). The critical incident technique was used as a structural method to guide the development of interview questions that focused participants on specific interactions and aided discovery of the nuances of these interactions with the family influencers they identified.

Each interview consisted of two phases. During the first part of the interview, the first author encouraged the participant to reflect on how he/she first learned about engineering as a college major, chose engineering as a major, and made present-day engineering-related academic and career intention decisions. From these narratives, it was possible to learn various triggering factors, critical steps taken to enable each participant to make engineering-related academic decisions, and the outcomes and perceived significance of the decisions reported by the participant. The second phase of the interview involved follow-up questions that explored the critical incidents described in the first part of the interview. Given that all participants mentioned family members as critical, family influences were the focus of these follow-up questions. Table 1 shows each object of the critical incident technique investigation along with example statements or questions that guided the exploration of each critical incident.

To counteract the tendency to recall only recent memories and help participants to explore interactions over all previous time periods, the first author questioned each participant about when and how he or she reached a decision to attend college, heard for the first time words such as "engineer" and "engineering," and selected engineering as a college major and career. These questions prompted participants to reflect on the interactions critical to selecting engineering as a college major that occurred in the years preceding enrollment in an engineering degree program. All participants described the influence of several family members. Once the participants explained the influence of family upon their engineering-related academic decision making, they were asked about specific interactions with each family member that were critical to their engineering-related academic decision making. To ensure that the shared incidents were salient to the participants' engineering-related academic choices, participants were asked to provide a link between the incident and decision(s) about engineering. From the critical incident technique perspective, it was found that certain interactions and thoughts critical in understanding the subsequent actions and behaviors of the study participants.

TABLE 1: Example interview questions used to probe family influence

Object of Investigation	Example Statements or Questions
Triggering factors for engineering selection and persistence [causal conditions and context]	Related to making academic decisions, please tell me about specific family members you speak with. What specifically do you speak with [first named family] about? How did you decide to speak with him/her about that topic?
Critical steps toward pursuit of engineering degree [strategies]	As a result of your conversations with a family member you previously named, please explain what action did you take?
Final outcomes of decision(s) and follow up, if any [consequences]	Did that action impact your academic decision-making? If yes, tell me more.
Exploration of the impact of influencers on participant's decisions and actions related to engineering [intervening conditions]	Was one particular family member most influential to your academic decision making? What academic-related things do you depend on this most influential family member for?

The first author interviewed all participants, noting each significant behavior and interaction mentioned by the participants, and then engaged in a fact-finding approach to further explore the behaviors, programs, and individuals deemed as critical to the selection and persistence in their college, choice of engineering major, and career intentions. Initiating these forays with the broadest possible themes, the initial critical incidents explored in the interviews related to (1) choosing a major; (2) learning about engineering; (3) choosing a college and engineering major; (4) making past, current, and future academic decisions in engineering; (5) interacting with specific family members; and (6) planning for a career after completing a Bachelor of Science degree in engineering. Open questions (e.g., tell me how you selected your major) helped participants to recall specific incidents and steps related to each theme. When the interviewer asked questions such as, 'tell me with whom you discussed choosing a college major', the participants' responses aided the development of a list of influencers that included family members. The interviewer next expanded the list of critical incidents by inquiring about those family members specifically mentioned by the participants, using such prompts as 'tell me about specific conversations you had with your mother about choosing a college major'. If mother was mentioned, the interviewer inquired about the father's presence and role.

Twenty recorded, transcribed verbatim interviews resulted. Analysis began, using NVivo 8, after the first interview. The data corpus consisted of nearly 23 hours of interviews and over 600 pages of transcribed interviews with field notes and memos. The first author listened to each recorded interview many times throughout the study to understand and check the meanings each participant conveyed in his or her interview and to connect and differentiate meanings across all the interviews.

In line with constant comparative analysis of grounded theory, the first author wrote memos throughout the data collection and analysis period (Charmaz, 2014), using initial, focused, and theoretical coding during the study's emergent coding process. During initial coding, important data segments were grouped into concise categories. Throughout the study, the coding was re-

visited for comparison and updating, which allowed for constant comparisons and development of new hypotheses to explore as the data collection progressed. After coding each interview, the interview guide was updated accordingly to further refine the probing questions. The study's emphasis on focused coding allowed us to synthesize larger, significant data segments, which in turn resulted in major categories of amassed data. During theoretical coding, the relationships among categories that led us to construct the initial theory were specified (Charmaz, 2014).

To ensure trustworthiness of the data, the authors employed techniques such as prolonged engagement with the data, investigator triangulation (i.e., discussion among multiple researchers), reflexivity, member checking, use of low inference descriptors or direct quotes, peer debriefing, and theoretical sampling (Charmaz, 2014; Borrego et al., 2009; Johnson, 1997).

3. RESULTS

The paradigm model (Corbin and Strauss, 2008) provides an effective conceptual vehicle for showing how concepts are causally or contextually related to each other and the phenomenon of interest. In this study, the actions of family and interaction strategies of the participants can be shown as they relate to the emerged theory of the role of family in the academic and career decision making of first generation college students in engineering. Causal conditions are the events that lead to the development of family as engineering influences. Context and intervening conditions refer to the particular set of conditions in which the theory is couched. Actions and interaction strategies refer to the reported actions of family and the resulting responses of their children, the study participants. Finally, the outcomes, both intended and unintended, of these actions and responses are the engineering decisions made by the participants.

Figure 1 illustrates the actions of family and interaction strategies of the participants in relationship to the emerged theory of the role of family in the academic and career decision making of FGC students in engineering. This section presents and discusses the results of the study using quotes from participants that support the parts of the theoretical model in Fig. 1.

3.1 Causal Conditions and Context for Engineering Influences

Participants described their lived experiences related to family influences and personal responsibility with respect to their decisions to pursue undergraduate degrees in engineering, persist to graduation, and obtain a job in the engineering field. Participants reported causal conditions that led to the development of family as engineering influences: recognition of family norms for financial, educational, and career behaviors; acceptance of personal responsibility to make decisions that aligned with family norms; and a blend of these family influences. The initial coding of the data provided a description of the context for engineering influences and revealed the causal conditions—family norms and personal responsibility exhibited by participants – through several actions, activities, and discussions with family and observations of family.

Participants acknowledged that prior to them attending college, their parents helped them make decisions about financing college, illustrating *family financial behavior norms*. During high school, mothers offered participants help with completing financial aid forms and fathers helped with decisions about financing college. During college, financial discussions with mothers and fathers were limited to the future salary earned by engineers.

Parents, especially mothers, were the biggest influence on their children's choice of engineering as a course of study, even though parents offered no engineering-specific academic

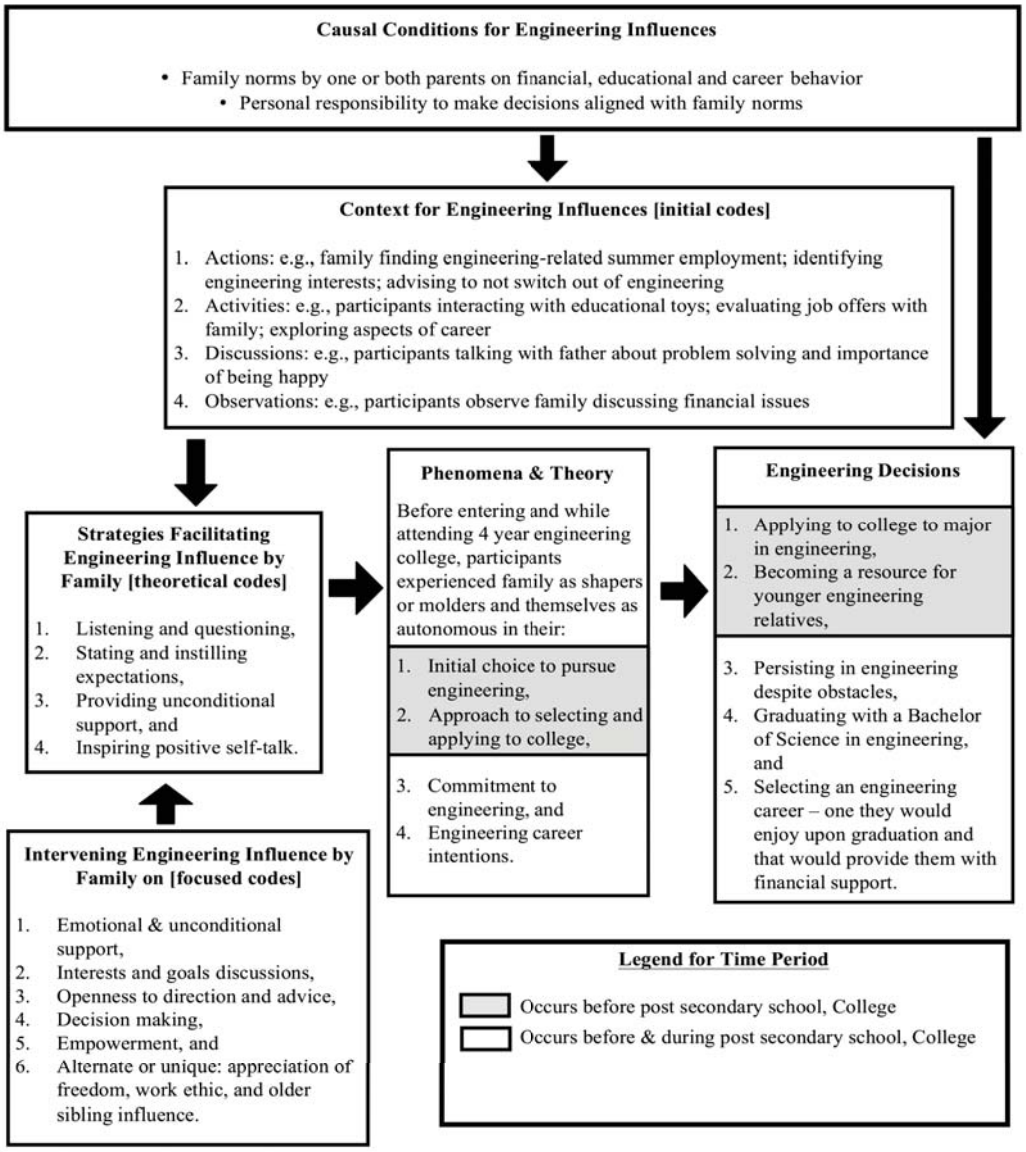

FIG. 1: Theoretical model of family influences on FGC engineering undergraduates resulting in academic and career decisions

advice to their children during college. As an example of *family educational behavior norms,* mothers in the study were attributed with locating and completing college admission and financial aid forms. Participants described their mothers' influence as providing emotional support that greatly encouraged and comforted them and supported their persistence in engineering. Participants shared with their mothers why they wanted to pursue a degree in engineering. Whenever the participant was facing a barrier, their mothers would remind them of these reasons. In all

interviews, participants repeatedly expressed the ability of their mother to listen, advise, and provide room for autonomous thought and action. Indeed, the participants most often ascribed the statement of "Mom had my best interests in mind" to mothers. With that foundation established, participants spoke openly with their mother about academic decisions and believed that their interests were paramount to their mother.

Participants also described situations reflecting *family career behavior norms*. Parents, especially mothers, involved themselves in helping participants search the want ads for engineering jobs. Parents also infused norms with nonverbal and verbal expressions such as "having fun in your career is important" and thereby instilled attentive, career-related encouragement. Adopting these norms as their own, participants were directly encouraged to pursue an engineering degree and subsequent career because it was an area of genuine interest that they believed would lead to a fulfilling career. Participants believed that their parents would support any genuine career interest.

Participants took *personal responsibility* for making decisions after listening to advice or answering questions posed by family. While parents conveyed general support and advice, participants saw themselves as the arbiters of their academic careers. One participant said simply that her parents expected that she would be able to make her own decisions: "… I've always had a really good relationship with my parents in that I could talk to them about stuff like academics and get advice up to a point and then they'd say, 'you're 21 years old, you have to make your own decisions at some point.'"

At times, parental advice included a complete picture of financial, educational, and career behavior norms and personal responsibility, creating a *blend of family influences*. After one participant had already changed from one engineering discipline to another and was considering changing to a non-engineering major, her parents encouraged her to remain in engineering and to consider the financial aspects of an engineering career. This advice resulted in the participant considering her future salary when thinking about changing majors. She decided to remain in her current engineering discipline.

Parents, especially fathers, however, particularly perceived engineering as being aligned with personal desires for their child to be financially stable, gain an improved social status by being a member of an "elite" profession, and have a career that would offer their child the ability to pursue opportunities that had been unavailable to them as adults because they lacked the requisite education. One participant mentioned, "Every time I get an offer I give [my stepfather] a call, yeah, we talk about it." This participant clearly accepted his stepfather's knowledge, gained from repairing machinery and earning an associate's degree, to helping him evaluate job offers. However, the participant delineated his knowledge from that of his stepfather: "[my stepfather] didn't have a degree in electrical engineering either, so now I'm in a different type of level than he is." When evaluating job offers, another participant considered balancing her salary with her expenses based on many conversations she heard her family having about not making enough money to cover household expenses.

3.2 Intervening Engineering Influences

Broad, general intervening conditions facilitated or constrained influences. Intervening engineering influences resulted from focused coding and included: emotional support, interests and goals, openness to direction and advice, basis of decisions, and empowerment. Focused coding revealed two alternate cases of influences that, while unique in this study, may point to the need for additional research.

In describing *emotional support* from family, one participant's comments represented well the sentiments of many of the participants: "… I mean family acts as the emotional, the drive, the ambition, they're a home base for us all."

The participants described various *interests and goals* including wanting to be financially independent from parents, completing and graduating from their current undergraduate engineering program, participating in undergraduate engineering research, and earning a master's degree and doctorate.

In various ways, all the participants expressed their *openness to direction and advice* regarding academics and their career. One participant described being advised by his parents not to make "spontaneous" decisions, especially financial decisions, and told how he applied that advice to his engineering academic decisions.

When it came to *basis of decisions* about a career, most participants described how their parents advised them not to make decisions based only on salary. Yet, a small number of participants received advice to remain in engineering for the eventual salary. Both groups of participants added that "enjoy your job" was key advice they received and applied to their engineering career intentions.

Many participants conveyed a sense of *empowerment* in making their own academic and career decisions. A typical response to how academic and career decisions were made was: "I just decided on my own."

Two alternate cases presented intervening influences that are different from those influences described above. Even when other participants were probed about these influences, no other participant believed it was a part of their lived experience. The influences related to the alternate cases were: appreciation of freedom and older sibling influence.

In the first alternate case, one participant expressed an *appreciation of the freedom* her parents had given her to choose engineering as a major and the fact that she did not feel pressured to remain in a major if she no longer enjoyed it. This description of the participant's freedom was motivated by her observation of the stress placed on a college friend by the friend's engineer parent to remain in engineering, and the perception that the engineering major was being forced on the friend. This participant perceived her friend's mother as "very, very controlling."

The second alternate case involved *older sibling influence.* One participant discussed the actions of older siblings who started college, but did not finish. He explained that his older brother and older sister went to college, but they both dropped out. As a result, this participant said, "[my] dad doesn't believe in college and is probably expecting me to drop out sooner or later. But once I told him that I'm doing research [and] I'm working with the college doing something for my major, [his attitude changed]." The participant believed he had to convince his father that he was successful in college with the implication that he would eventually graduate from college—unlike his older siblings. Another participant spoke of his older sister who enrolled in college and later dropped out after becoming pregnant. Both participants described experiences of older siblings that resulted in their parents lacking confidence that their children would finish college. However, these two participants still perceived they had parental support to complete college and, therefore, adopted a commitment to completing an engineering degree.

3.3 Strategies Facilitating Engineering Influences

With the context and intervening conditions described above, this study presents four parallel core strategies that families used to influence FGC engineering undergraduates that resulted from theoretical coding: listening and questioning, stating and instilling expectations, providing

unconditional support, and inspiring positive self-talk.

Family members were valued for their *listening and questioning*; participants noted that family served as a sounding board for making academic decisions several times before and during college. These decisions often led to a specific course of action, particularly about financing college and selecting a field of study; however, participants ultimately viewed themselves as being in control and entirely responsible for making academic decisions and were encouraged by parents to do so.

One participant exemplified this shared, lived experience as she made decisions necessary for pursuing engineering study. In discussing the financial impact of remaining in college beyond the normal 4-year course of study, this participant first related how her mother asked her: 'how much is [college] going to cost you to stay extra [semesters]?' And then [her mom would ask] 'do you feel like you can do that? How easy is that transition going to be? If that is what you want to do, then okay.' As long as it wasn't going to cost like a ton of money that [she] had to come out [of pocket] with or [take out] a ton of loans, she was okay [with me] making the best decision.

The participant's decision-making process included explaining the situation, answering questions posed by her mother, and then making the decision. Using the same process, other participants related similar narratives of their parents, who served as their audience as these students related the difficulties of resolving issues in a particular course, deciding whether to remain in engineering, and in selecting a career.

To further reinforce the specific role of family influence in settling upon a specific course of action, another participant said: "[my parents have] the most impact [on my academic decisions]. [Ultimately,] I decide on my own and then just reach out to them to confirm that I was doing the right thing, or I had the right ideas."

One participant felt little pressure from his parents to pursue engineering study merely for the earning potential and described his experience as "my parents saw the listings [of many careers and associated] salaries of [these careers including] engineering. [Engineering careers] are one of the highest [salaries] and [my major in] engineering is one of the [highest among all] engineering majors. They told me don't [major in engineering] for the money. I already knew not to do it for the money." This participant represented well the freedom experienced by other participants to trust their own instincts and not base their college major decision on salary alone. While most of the participants enjoyed this freedom, two participants reported different experiences related to basing decisions on salary. One participant was asked by a parent to weigh the salary of engineers versus other professions when she was considering switching out of engineering. A parent of another participant noted that a good reason to stay in an engineering major was the salary of engineers. In each case, the participant felt comfortable making a decision after speaking with their parents.

Participants stated that they experienced the distinctive influence of family explicitly *stating and instilling expectations* through interactions that conveyed specific expectations to choose a major, attend and succeed in college, and to enjoy their engineering career. One participant described how one influencer, an uncle, provided advice and expectations based on his own academic and career regrets:

> *Well, I have one uncle in particular that he's the type [of person] that says 'go as far as you can go because I didn't'. I [tell him] okay, but I think I want to go into the work [force] for a little while. I don't want to give up on grad school because I still want more than my Bachelor's [degree]. [He says], 'well if you're going to go [to graduate school], go straight through'. [I told him], I want industry experience*

> *because part of my [current] regret is not allowing myself [to take time for a] co-op experience. So, I want to get a feel for the industry and then maybe go back to grad school. And he [told me], 'no, because I took time off from college to work and I never went back [to complete the undergraduate degree] and you're going to get used to the idea of making money. You're not going to want to go back [to school] just like I didn't'. So, I said okay. But he's definitely the one that pushes me and it's okay. [He said], 'it's not like I know your field, but if you recognize a good opportunity [for a job], [accept the job, even] if it is located [across the] country.'*

Many participants stated that their family urged them to enjoy their college years and to obtain a degree, which would propel them towards a career they relished. Participants explained that their parents were both happy and proud of their choice to go to college and this, in turn, set the expectation for the participants that they needed to be successful while enrolled. One participant summarized this sentiment well:

> *[My parents were] happy for me that I was doing something that I love and they were really proud of me that I was moving forward especially my dad. … he had a big smile on his face and he [said], 'you gotta keep moving forward, you gotta make us all proud, you're the first one to go to college here.' You know, he kept saying things like that which I could tell that he was really happy about it. That I wasn't just going to end up like my brother and my sister – just dropping out of college.*

One participant described being motivated by a wish to avoid disappointing her family and a desire to fulfill her expectations, as she explained:

> *I do want to say this. I feel like if I were to stop now, that I would feel kind of like I failed. Like I've made it this far and [failed]. I would feel like a failure because I didn't finish [and] I didn't live up to expectations that I set for myself and that [my family would] know. And that's not something I want to do. … I have to finish because I don't want to fail. I do enjoy doing it. … I can see myself as an engineer but I would just feel like a failure if I didn't finish and I want to say that.*

The participants often were grateful for their parents *providing unconditional support*.

They perceived that their parents supported them in all their decisions and not just those affecting their course of study or careers—an influence that was unique to parents. One participant described this unconditional support as follows: "Emotional support seems like the biggest area that maybe my parents are providing instead of specific advice or content knowledge related to college."

Many of the participants stated that they would say certain phrases to themselves, or create their own *inspiring, positive self-talk*. The participants frequently repeated the self-talk throughout the interview, which included, "I want to do well and not let my friends and family down; I grin and bear it and make myself do [whatever needs to be done]; hard work and discipline would pay off in the long run and [I'll] be able to have fun [eventually]; [the] key to success [is] never give up, push through, and get it done." When asked to convey how they developed the self-talk, the participants often credited their parent(s), especially fathers, for instilling the seeds of positive affirmations.

Through the accounts of the participants, it was clear that many of these examples of self-talk were an articulation of an inner dialogue related to persisting in engineering, grit, tenacity, and perseverance. Other participants emphasized a tenacious work ethic and dedication inculcated by a parent. One participant recalled his father's advice to succeed and explained his father's

rationale for wishing a better life for his son. In describing the resulting influence, the participant reflected that: "[my father was] definitely an example to follow … [and] hard work and dedication is the main thing you need to be successful. I've definitely used [hard work and dedication] while going through [college]. [My father's influence has] helped me to get through it."

3.4 Phenomena and Theory

The research question that guided this study is: how do undergraduate engineering FGC students who have persisted to junior or senior year describe the influence of their family on decisions related to their initial selection of an engineering major, their persistence in an engineering degree program, and their commitment to an engineering career upon graduation? The answer to the question is also the narrative description of the emergent theory: Before entering and while attending college, undergraduate FGC students in engineering experienced family as shapers and molders of and themselves as autonomous in their initial choice to pursue engineering, approach to selecting and applying to college, decision to persist in an engineering degree program, and intention to commit to an engineering career. Table 2 notes the time period during which the influence occurred, summarizes the casual conditions and context for family as engineering influences and connections to resulting strategies, and the four phenomena. Where "father and/or mother" are noted as the influence, the finding applies to both parents, stepparents, and to mothers or fathers, when only one parent was involved in the life of the participant.

3.5 Engineering Decisions

In every case in this study, participants' decisions helped them persist in engineering and plan their engineering careers. The participants in this study experienced positive outcomes that included support for applying to college to major in engineering, becoming a resource for younger engineering relatives, persisting in engineering despite obstacles, graduating with a Bachelor of Science in engineering, and intending to pursue an engineering career they would enjoy upon graduation and that would provide them with financial support.

Several participants, for example, credited their mother with helping them understand PSU's admission criteria. After her mother helped her with PSU's admission procedures, one participant described being more knowledgeable about where to find admission criteria and began tracking and looking at PSU's website independently. Participants described becoming a "college-knowledge" source for siblings and other relatives by, for example, sharing their academic experiences. In many ways, participants expressed their desire to complete an engineering degree and be successful in a subsequent career. Participants linked their family influence to their selection of an engineering career that could provide financial support and personal enjoyment.

4. DISCUSSION

This study represents a critical "snapshot" of participants' perceptions at the point in time when they were interviewed. It contributes to the body of knowledge regarding how families influence the post-secondary experiences of FGC students persisting in engineering study. Previous researchers have concluded that students' motivation for studying engineering develops before they enter a postsecondary institution and parents can be important influences in the pre-college lives and academic engagement of students (Cabrera and LaNasa, 2001; Hossler et al., 1999;

TABLE 2: Inputs into the four phenomena

At the Time Period:	**The Family Member With Particular Influence On Study Participant Is [Key Influence From]:**	**As It Relates To:**	**What Emerged Were Four Strategies Through Which Influence Was Conveyed:**	**Which Support Four Phenomena:**
Before College	Mother	Discussing college major esp. an engineering major	*Listening and Questioning*, examples include: Serve as sounding board on several decisions, particularly in issues related to financing and selecting a field of study Promote autonomous thought and decisions which caused study participants to view themselves as being in control and entirely responsible for making academic decisions Advise not to rush or make spontaneous decisions *Stating and Instilling Expectations*, examples include: State specific expectations to make decisions: choose a major, attend and succeed in college and to enjoy their engineering career *Providing Unconditional Support*, examples include: Support participants in all of their decisions and not just those affecting their course of study or careers; provided encouragement *Inspiring Positive Self-talk*, examples include: Cause study participants to repeat certain maxims; an articulation of an inner dialogue related to persisting in engineering, grit, tenacity and perseverance	Initial Choice to Pursue Engineering
Before College	Father and/ or Mother	Attending college and setting educational and career goals		
Before College	Mother	Locating and completing college admission forms		Approach to Selecting and Applying to College
Before College	Father and/ or Mother	Making decisions about financing college		
Before and During College	Father and/ or Mother	Making future educational and career plans to include linking degree completion to a fulfilling, enjoyable engineering career in the future		Commitment to Engineering
During College	Mother	Reminding of educational and career goals set by participant to include goals related to obtaining an engineering major		
During College	Father and/ or Mother	Considering financial/salary ramifications of switching out of engineering. No consensus on advice: consider loss of high salary career and do not consider salary loss		
Before and During College	Father	Perceiving career. Advice provided: be financially stable, gain an improved social status by being a member of an "elite" profession and have a career that would offer the ability to purse opportunities that had been unavailable to father because he lacked the requisite education		Engineering Career Intention

TABLE 2: *(continued)*

During College	Father and/ or Mother	Expecting enjoyment from your job and having fun		
During College	Mother	Finding job after college. Example: searching want ads for engineering jobs		

Levine and Nidiffer, 1996; Sheppard, et al., 2010). In this study, when FGC students' academic decisions to enter and persist in engineering required so-called "college knowledge," family—most notably parents—were not necessarily able to provide specific academic advice related to engineering. This study clearly demonstrated that this does not mean such parents have nothing to offer to their children wishing to attend college. Indeed, even though no academic help was forthcoming, they could offer other types of support, such as providing focused, attentive, and direct encouragement. In exemplifying focused encouragement, parents asked questions, listened, and later reflected back to participants what the parents believed most important. These family influences appeared to create long-lasting impressions on participants that became a foundation upon which their academic and career decisions about engineering were made.

Parents should be made aware of their potential influential role and be provided support and resources from high schools and colleges. To promote the future success of FGC engineering undergraduates while still in high school, parents should be encouraged to talk about their job, why they support college attendance, the benefits they perceive, and the importance of talking with high school teachers about college and careers. Since much of the parental influence in our study was conveyed through conversations, parents can be advised on the typical college stressors and the type of messages that may best encourage their son or daughter to succeed.

Resources such as these can be shared through publications targeted at parents and in special sessions often held with parents during college recruitment visits and orientation. While FGC engineering undergraduates are enrolled in college, parents can encourage their children to put forth their best effort, to choose and successfully complete an engineering major, and find an enjoyable career based upon that major, which will result in financial stability and a comfortable life for the ultimate purpose of providing their own children with similar opportunities in college.

On the basis of the analysis described here, the authors advocate for acknowledgement by outreach, recruitment, and retention practitioners of the importance of family influence as a necessary adjunct for FGC engineering undergraduate persistence and success. Easy access to accurate information about financial aid, duration and challenges of degree completion, job prospects, and exposure to FGC role models who are content in their respective engineering disciplines are all candidates for integration into existing programs and services.

4.1 Future Work

In a 1994 study by Terenzini et al. (as cited in Engle, 2007), FGC and CGC students at four institutions were interviewed, and results showed that virtually all CGC students were surprised by questions concerning what had gone into their decision to attend college. The CGC students simply viewed college as a continuation of their academic and social experiences in high school, for them going to college was an unspoken, definitive assumption (Engle, 2007). However, FGC students in the same study tended to describe going to college as breaking family tradition. Ad-

ditionally, FGC students in other studies were less likely to receive positive support from parents and family members than continuing generation students (Terenzini et al., 1996; Hsiao, 1992). The family norms finding for FGC engineering students in this study is more indicative of the experiences of CGC students in other studies, suggesting a possible difference between FGC engineering students and FGC non-engineering students. Future research should explore these differences and try to disentangle why engineering FGC students may be more like CGC students when it comes to family influences and what other, perhaps more important barriers, are engineering FGC students facing.

This study analyzed student participants at advanced stages of their undergraduate careers, mostly seniors. Performing a longitudinal study would enhance our ability to make conclusions about how participants' perceptions might change during their undergraduate tenure. Future work should also include an exploratory investigation of those students that did not persist in engineering(students at the university who changed their major from engineering to another discipline).

These students can then describe their lived experience with that which influences their academic and career decisions, experiences that may relate a different and valuable experience of importance to the refining of theories, and the implications of that refinement. Future studies must also include engineering and non-engineering students to better understand both the consistent and inconsistent elements between the lived experiences of both groups. Also, this emerged theory should be analyzed in other settings for comparison against any theories not yet established.

Two compelling, alternate influences of note within the data emerged, that of appreciation of freedom in decision-making and influences of older siblings. This study provides but a glimpse of these influences and future study is necessary. Related to the finding of sibling influence, future research could involve determining the influence of FGC engineering undergraduates on their family, especially on siblings. Exploring the perspective of participants' family members would be a useful perspective. Additionally, previous research has suggested that other forms of social capital beyond the immediate family, such as community and peers, are also important in creating a diverse and successful workforce and these areas represent additional avenues to explore (e.g., Brown et al., 2009; Gonzales et al., 1996).

Finally, this study raises questions for future endeavors related to determining if participants with different demographics (i.e., gender, race, ethnicity, socioeconomic status) undergo different experiences. The delimitation of participants to a single university that was classified as a predominantly white, residential, selective research institution prevented the consideration of a wider range of experiences that may exist with FGC undergraduate engineering students attending different types of institutions. Our prior work suggests that a more ethnically, culturally, geographically, or socioeconomically diverse sample could help refine the theory.

5. CONCLUSION

In the interviews, participants were asked to first describe their academic and career decision-making processes, and then name and discuss each information source and influence on their processes. Over and over again, participants introduced and described key family influences. The multiple realities articulated by participants provided us with unique findings for mothers, fathers, and siblings, among others.

These findings offer insights into the nuanced ways families influence their children and help them make academic and career decisions in engineering and inform practical implications for

families and engineering and other educators. With shifts in the US demographics and with the most underrepresented populations experiencing the most rapid increases, FGC student attendance is predicted to rise significantly. The need to recruit and retain underrepresented students in engineering to strengthen the STEM workforce in the US is crucial. FGC students represent a potential untapped source of expertise, which can mitigate this coming shortage of skilled engineering professionals, by both diversifying and increasing the numbers of undergraduates who choose and persist in engineering.

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