ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #24988

Familial Influences Affecting Student Pathways to Engineering at Two-Year and Four-Year Institutions

Miss Julia Machele Brisbane, Clemson University

Julia Brisbane is a senior undergraduate student majoring in Bioengineering at Clemson University, and a full-time undergraduate research intern with the SC:SUPPORTED (Statewide Coalition: Supporting Underrepresented Populations in Precalculus through Organization Redesign Toward Engineering Diversity, NSF Award #1744497) project. She plans to obtain a master's degree in Biomedical Engineering and a Ph.D. in Engineering Education.

Dr. Eliza Gallagher, Clemson University

Dr. Gallagher is an Assistant Professor of Engineering and Science Education at Clemson University, with joint appointments to Mathematical Sciences and Education & Human Development. Her research interests include student cognition in mathematics, development of teacher identity among graduate teaching assistants, curricular reform to foster diversity and inclusion in STEM fields, and development of mathematical knowledge for teaching. She is co-PI on an NSF INCLUDES Design and Development Launch Pilot, "Statewide Coalition: Supporting Underrepresented Populations in Precalculus through Organizational Redesign Toward Engineering Diversity (SC:SUPPORTED)," Award #EEC-1744497.

Abigail E Hines, Clemson University

Abigail Hines is an Industrial Engineering student at Clemson University. She is involved in research aimed at increasing diversity and inclusivity in the STEM field as well as research regarding the mood improvement effects of virtual reality on humans.

Joseph Murphy, Clemson University

Joseph Murphy is a Fall 2018 graduate of Clemson University whose research interests include expanding access to higher education, combating stratification and sexuality studies. He is actively participating in SC INCLUDES, a research project aimed at improving engineering student retention in South Carolina via improving math education and inter-institutional coordination.

Ms. lesteria Armoni Dunwoody, Clemson University

I am a first generation college student at Clemson University. During my academic journey I have joined many clubs that center around advancing the minority community in the areas of economics, education, and health.

Khushi Patel, Clemson University

Khushi Patel is an Engineering and Science Education PhD candidate at Clemson University. Her research focus is on student conceptualization in chemistry. She received her undergraduate degree in Chemistry with a minor in secondary education from Millsaps College. She also holds a secondary license to teacher chemistry and general science for middle and high schools in the states of Mississippi and Tennessee. She received her master's degree in Inorganic chemistry from Tennessee State University.

Dr. Aubrie Lynn Pfirman, Clemson University

Aubrie L. Pfirman is a Teaching Consultant for the Office of Teaching Effectiveness and Innovation at Clemson University. Her research interests are chemical education, scholarship of teaching and learning, educational development, inclusive educational practices and reform, and STEM education. Dr. Pfirman received a B.S. in Chemistry and an Instructional I Certification in Secondary Education from Misericordia University, and both an M.S. in Chemistry and Ph.D. in Engineering and Science Education from Clemson University.

Ms. Shannon Roberson
Dr. Anand K. Gramopadhye, Clemson University

Dr. Anand K. Gramopadhye's research focuses on solving human-machine systems design problems and modeling human performance in technologically complex systems such as health care, aviation and manufacturing. He has more than 200 publications in these areas, and his research has been funded by NIH, NASA, NSF, FAA, DOE, and private companies. Currently, he and his students at the Advanced Technology Systems Laboratory are pursuing cutting-edge research on the role of visualization and virtual reality in aviation maintenance, hybrid inspection and job-aiding, technology to support STEM education and, more practically, to address information technology and process design issues related to delivering quality health care. As the Department Chair, he has been involved in the initiation of programmatic initiatives that have resulted in significant growth in the Industrial Engineering Program, situating it in the forefront both nationally and internationally. These include the Online Master of Engineering in Industrial Engineering Program, the Endowed Chairs Program in Industrial Engineering, Human Factors and Ergonomics Institute and the Clemson Institute for Supply Chain and Optimization and the Center for Excellence in Quality. For his success, he has been recognized by the NAE through the Frontiers in Engineering Program, and he has received the College's Collaboration Award and the McQueen Quattlebaum Award, which recognizes faculty for their outstanding research. In addition, Dr. Gramopadhye served as the Editor-in-Chief of the International Journal of Industrial Ergonomics and is on the editorial board for several other journals.

Title: "*Familial Influences Affecting Student Pathways to Engineering at Two-Year and Four-Year Institutions"*

Abstract: Improving retention rates of engineering students in higher education has been a nationwide goal aimed at expanding and diversifying the engineering workforce. Initial mathematics placement in institutions is a major predictor for attrition, with 52% of students from two-year institutions starting below calculus as opposed to 14.4% of students from four-year institutions starting below calculus. Consequently, national data shows that the attrition rate for engineering students at two-year institutions is 69% while the attrition rate for engineering students at four-year institutions is 37%. As the prevalence of students taking an indirect path towards completing an engineering degree increases, the examination of those students' pathways towards an engineering degree is necessary.

In the SC:SUPPORTED project, we conducted focus groups with students from two-year and four-year institutions across the state of South Carolina. Themes related to academic influence, social influence and family influence emerged from analysis of the focus group data. Within family influences, which are *the ways family members affect a student's persistence in education, choice of major, and choice of institution*, there were differences between students attending two-year institutions and those attending four-year institutions. Family members include parents, siblings, other relatives, and also "fictive" family. The goal of this paper is to discuss the factors that influence why students choose engineering and choose to attend a two-year or four-year institution.

Introduction: The national need to expand and diversify the engineering workforce has led to multiple research initiatives to examine the cause of high attrition rates and to improve engineering programs [1, 2]. Multiple studies have reported that high attrition rates can be attributed to teaching and advising [3, 4], curriculum and coursework [5], and lack of feeling of belonging in these engineering programs [6, 7]. Despite efforts at the post-secondary level such as incorporating active learning [8], revamping the course curriculum [9], and stressing the importance of mentoring and advising [10], attrition rates remain high [11]. Underlying many of the observed issues at the post-secondary level is insufficient mathematical preparation in high school. Entering engineering students whose initial college math placement is below calculus complete their engineering degrees at half the rate of those who start in calculus or higher [12].

Past research indicates the importance of family in influencing different aspects of students' academics. For example, it was found that students taking an indirect path to a four-year institution are more likely to have their parents involved academically by monitoring schoolwork and influencing the student's academic plans [13]. Additionally, students at two-year institutions who subsequently transferred to a four-year institution had, on average, a higher socioeconomic status than those who did not transfer to a four-year institution [13]. Specifically related to parental influences, parental behaviors were found to be related to a student's career decision-making self-efficacy, or how strongly the student believes that they can complete the necessary

tasks to make career decisions, indicating that adolescents valued their parent's career-related opinions [14].

Parents were also found to play an important role in shaping the mathematical ability of young adolescents [15], which is important as mathematics courses serve as gatekeepers to engineering degrees. Unequal access to social capital, due in part to parental educational occupation and attainment, can impact how engineering students experience education [16]. Another study found that first year engineering students who leave their engineering programs in good academic standing had been influenced by their family to study engineering. These students were seen to have been influenced more by family than students who stayed in engineering [17].

The term *fictive family* refers to a person who is not a family member, but who acts in some ways as a family member to the person. Simmons and Martin emphasized the importance of "engineering fictive kin," referred to in this study as a *fictive family*, in influencing first-generation college students in engineering. Fictive kin guide the student and explain what engineering is; encourage, discuss, and/or aid the student in finding a job; suggest academic resources to help the student; aid in selecting courses to take; and provide other academic guidance [18]. Engineering fictive kin were able to increase feeling of belonging to engineering, instill confidence in major choice selection, impact persistence in engineering, and develop an engineering related network for students [18].

Previous work on family and fictive family influences, however, has not looked at differences in initial math course placement or persistence in major between students at two-year institutions and students at four-year institutions. This gap in the literature is particularly meaningful since national data shows that the attrition rate for engineering students at two-year institutions is 69% while the attrition rate for engineering students at four-year institutions is 37% [11]. Initial mathematics placement is a major predictor for attrition, with 52% of students from two-year institutions starting below calculus as opposed to 14.4% of students from four-year institutions starting below calculus [19, 20]. This presents a significant issue for diversity in engineering, since Black and Hispanic students nationally are overrepresented at two-year institutions and underrepresented at four-year institutions [11]. We see similar patterns of lack of representation in South Carolina as we do nationally. Specifically, 27.35% of the state population is Black and 5.34% is Hispanic. At two-year institutions in the state with ABET-accredited engineering programs, 29.7% of students are Black and 5.8% are Hispanic. Meanwhile, at four-year institutions in the state with ABET-accredited engineering programs, 18.8% of students are Black, and 4.2% are Hispanic (Figure 1) [21, 22, 23]. Thus, understanding the differences in factors affecting two-year students versus four-year students will provide insight into increasing diversity in engineering within the state.

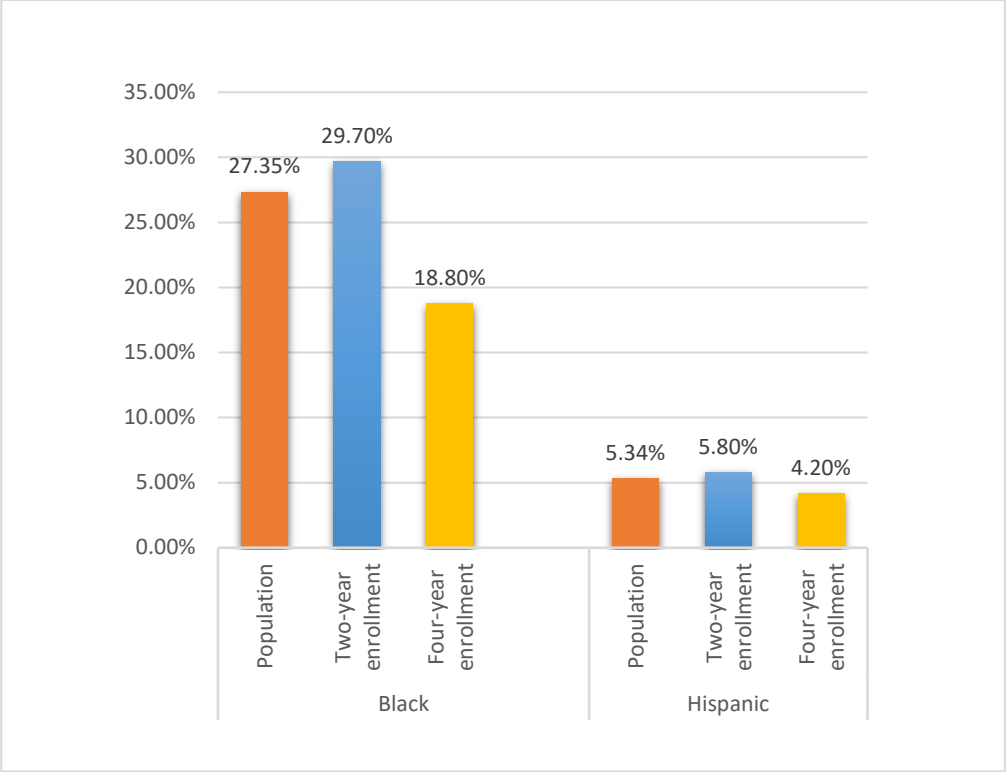

Figure 1: Bar graph of percentages for Blacks in the South Carolina population, at two-year institutions, and at four-year institutions. Bar graph of percentages for Hispanics in the South Carolina population, at two-year institutions, and at four-year institutions.

The SC:SUPPORTED project examined the factors associated with initial mathematics course placement at a statewide level using a sequential mixed methods approach. In this paper, we report qualitative results drawn from focus group data. Three types of influences affecting mathematics placement and major selection emerged: family influences, academic influences, and social influences. In this study, we define *family influence* as "the ways family members affect a student's persistence in education, choice of major, or choice of institution." Family members included parents, siblings, other relatives, and fictive family [18].

Within the three major themes emerging from the focus group data, family influences stood out because there were more transparent differences between students attending two-year institutions and four-year institutions. The goal of this paper is to discuss the differences in family influences affecting engineering degree paths between students attending two-year and four-year institutions.

Methods: The results from this paper are a part of a larger study that included 20 institutions with ABET-accredited engineering programs in South Carolina. The study utilized a sequential mixed methods design that is described in greater detail elsewhere [24]. The results we report here are from qualitative analysis of data from the first rounds of focus groups conducted at two-year and four-year institutions. Additional focus groups were conducted subsequent to this analysis and are not discussed in this paper.

Focus groups are small groups of people who participate in a guided discussion. Participants in the focus groups we conducted were students enrolled at either a two-year or four-year institution at the time of their study. Each focus group location was determined based on quantitative analysis of prevalent mathematical pathways within the state [24], while each location and target population (Table 1) was intended to explore anomalous results within the state patterns. At each site, all potential participants meeting the focus group parameters received an explanatory email and a link to a qualification survey. The qualification survey included questions to confirm the focus group parameters (major and initial math course placement) as well as prompts for the students to self-identify race/ethnicity and gender and to indicate schedule availability for the focus group. Specific participants were then invited to maximize racial/ethnic and gender variation within target parameters and target focus group size of 5-10 participants. Each focus group lasted approximately 90 minutes and was conducted by the same person to increase process reliability. The focus group leader was supported by a second research team member who recorded order of speakers and other observational notes.

Table 1: Institution type, target demographics for each focus group, and the number of participants in focus groups

Institution Type	**Target Demographics**	**Number of Participants**
Four-year	Engineering majors, placed below Calculus I	6
Four-year	Placed in Calculus I or above	5
Two-year	Engineering or tech certification, took upper level math courses in high school	6
Two-year	Placed below Calculus I	3

At the beginning of each focus group, participants were asked to place stickers to represent responses to answer several focused prompts on posters placed around the room (Table 2). The stickers were color-coded and linked to participant-selected pseudonyms to preserve anonymity while allowing the researchers to see the distribution of responses and guide the group discussion more effectively to points of interest [25].

Table 2: A sample of questions depicted on the walls during the focus group discussion

Sample Question on Poster	**Answer Choices**
When you were in high school, where did you MOSTLY seek advice about academics (classes, scheduling, college applications, etc.)?	Parent/guardian, guidance counselor, teacher, school website, friends, siblings, other family members, internet search, other
What struggles, barriers, or hardships did you encounter that had an impact on your academic performance in high school?	Transportation issues, financial issues, working a job after school or on weekends, family duties or responsibilities, extracurricular activities (sports, band, etc.), societal expectations, legal issues, lack of stable home situation, lack of access to technology, other

What helped you achieve success in high school?	siblings, friends, peers, extracurricular activities (sports, band, etc.), parents/guardians, other family members, role model or mentor, religion/faith/spirituality, job or workplace/co-workers, academic club or group, access to tutoring, access to technology, good advising, other

Each focus group was audio recorded and sent to a third-party transcription service to be transcribed. Transcripts were verified by a member of the research team for accuracy and speaker names were coded with a combination of the self-selected race/ethnicity, gender, and pseudonym. In this paper, excerpts from the transcript are referenced by the self-selected pseudonym, and the pronouns correspond to the gender identified by the participant in the qualification survey.

The analysis team included faculty members and graduate students in engineering and science education, as well as a multi-disciplinary team of undergraduate students divided into six-person sub-teams exploring themes related to academic influences, social influences, and familial influences. The focus of this paper is on data analyzed by the familial influences sub-team.

Each transcript was unitized prior to distribution to the undergraduate analysis team, so that team members would be coding the same meaningful units of text [26]. Individual team members read the interview transcripts and created open codes related to themes they found. The analysis team then discussed the open codes, negotiated differences in interpretation, and reached consensus on the assigned codes. These open codes were organized to create categories and subcategories using axial coding. The process of open coding and axial coding was iterative until an agreement was reached across all sub-teams. Following the axial coding, the teams then used selective coding to define the major themes and carry out further analysis on the section of text associated with those selective codes.

Results: The following excerpts have been edited to delete pauses and hesitations when it does not affect the meaning of the quote. In some cases, words or phrases have been altered to improve clarity, such as replacing a pronoun with the relevant noun; such alterations are indicated by brackets around the replaced phrase. Bracketed ellipses indicate removal of a non-relevant intermediary passage of text that separates two relevant passages of text. Ellipses in the text not enclosed in brackets indicate a meaningful or revealing pause by the speaker.

The three main questions on the posters that led to themes related to family influence are shown in Table 2. Three subthemes emerged within the focus group data related to family influences: family responsibilities, fictive family influence, and family guidance. Parental, relative, and sibling guidance were grouped separately under family guidance due to observed differences in prevalence between participants from two-year institutions and participants from four-year

institutions. We did not see specific, direct or overt guidance from fictive family so the theme of family guidance excludes fictive family.

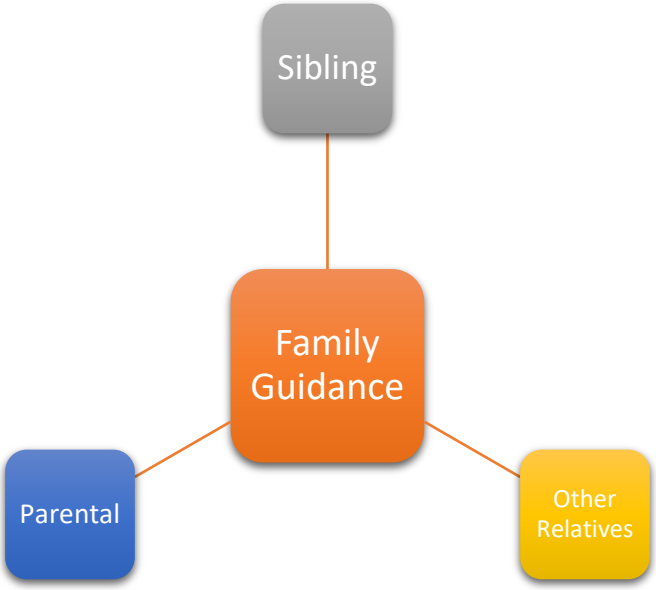

Figure 2: Breakdown of family guidance sub-theme into parental, sibling, and other relative guidance

Parental Guidance: Parental guidance is defined by any parent or guardian guiding a participant in an overt, direct way. This theme was stronger and more positive, by ways of being encouraging and supportive, in the four-year institution focus groups as compared to the two-year institution focus groups. An example of strong, positive parental guidance from the four-year institution focus group occurs when a participant is talking about her good relationship with her father who went to an engineering school, inspired her, and gave her helpful advice to pursue engineering. In response to the interviewer asking the participants if they sought academic advice from parents or guardians, one participant said:

> *Um, I think I did too. I think the main thing was that, well like I got a lot of advice from my father because he had also like gone through engineering school, so, like I have a good relationship with my parents so I, you know, it was just like I trust what they say, and they want what's best for me.* – Claire

In another four-year institution focus group, one participant talked about having several family members, including parents, siblings, and relatives, who were able to help him when he sought advice. When talking about his parents specifically, Caleb discussed that since they went to college, they were able to give him good advice overall. From this quote, we can see how parental support and encouragement influenced him to choose which institution he attended.

> *So my parents are just, like I would talk to them to see, cause obviously they've been to college before so I was just wondering what they thought would be best for me. And they would just say, you know, just do what you want to do and honestly, they'll say stuff like "We'll support you, whatever you wanna do," so, I just. They helped me to decide on [Four-Year Institution], I guess.* – Caleb

It is important to note that four-year institutions participants whose parents held advanced degrees gave more specific advice than most of the parents of two-year institution participants. Parents of participants from the four-year institutions were more supportive of their choices regarding academics or career. In the quote below, Aram asked his stepfather for advice. The participant mentions earlier in the interview that his stepfather is on the board of directors for a private liberal arts university and holds a doctorate from seminary:

> *Um, and up until my sophomore year of high school I had always wanted to do music and theater or something along those lines. Those are, also a very big part of life was like, writing songs and singing and learning instruments, etc. Uh, and I had a talk with my mom and my stepdad about what I wanted to do, where I was gonna go to college, etc., because sophomore year is about when they wanted all their kids to start, you know, really thinking about that kind of stuff. And, for me, it was just like a, they made me realize that, that wasn't a viable career choice. It certainly could be but it's not going to be a first choice kind of thing. It's not going to work for me necessarily and I need to have something else that I could do that was still going to be a good job that I would enjoy. And so we went through, you know, what I liked in school.* – Aram

In contrast, we saw less parental guidance in the two-year institution focus groups. Where parental guidance was present, it took the form of less degree-specific advice and more general degree completion encouragement. In the following example, Amy talks about how her mother pushed her to pursue her college degree while also having to take care of her own child.

> *[My mother] pushed us, and pushed me because I had a child, I thought I'd have to drop out. She was not gonna let that happen because she cleans condos and houses for a living because she has no education, she can't do much else, so she has like pushed me to, I didn't even wanna go to school like college, she said, "Oh, you're going, mm-hmm (affirmative). You're going one way or another." ... I would have dropped out of school, and I wouldn't have went to college if it weren't for her, 'cause I thought that's what a teen mom had to do, give it all up. And like the, um, she wanted to help with schooling ... You know it was so cute 'cause she would try to help me, and she would ex- I would explain something to me and it would be completely off but she was determined to help.* – Amy

Sibling Guidance: Sibling guidance comprises instances in which the participant was guided directly and overtly by a sibling of theirs. In the four-year institution focus groups we observed mostly relative and parental guidance. However, in the two-year institution focus groups, the

theme of sibling guidance emerged. For example, although Amy received general support and encouragement from her mother, as seen in the previous excerpt, for specific guidance on navigating high school, she turned to her siblings.

> *That's who basically helped me schedule 'cause my brother he's been to every school in I think [County], so he's knows what I should have done, when I should take it. I have, uh, seven brothers and two [sisters], so they knew what to do, and had to tell me how to do it.* – Amy

Other Relative Guidance: Other relative guidance was guidance by a legal relative who is not a parent or sibling and not in a guardianship role, such as cousins and non-custodial aunts or grandparents, who influenced the participant directly. This guidance was primarily seen in the four-year institution focus groups, and not in the two-year institution focus groups. It often took the form of discussing familiarity with college in general, or with a particular institution. An example of this from the four-year institution focus groups comes from Caleb who mentioned several family members he sought advice from. In the case of Caleb, multiple family members who had close ties with the university contributed to his decision to attend a four-year institution.

> *I have a cousin that's went to, uh. She, she's just been older than me and I was asking her like what was gonna be required of me in college and stuff and like, s-s-simple things like that. But then I would also ask my aunts and uncles because they have close ties to [Four-Year Institution] so I was […] already sure that I was going to [Four-Year Institution].*
> – Caleb

Another example of this shown when Robin, a participant from a four-year institution focus group, is discussing her great-aunt. Robin mentions how this relative influenced her to go to college and encouraged her to do well in school.

> *My great-aunt [is] amazing. Uh, she um, was a really big influence on me coming to [public university] because this is her dream school. She encouraged me to like retake the SAT and the ACT my senior year of high school, like, even though I didn't want to do it. Um, but she was just like, always encouraging me to do better in like my studies throughout high school so that I could get into a really good school.* – Robin

Fictive Family Influence: Unlike in family guidance, where we saw direct and overt guidance from family members, in fictive family influence, participants were influenced indirectly. Fictive family influence is considered influence from a person who was not a family member but is influencing the student to persist in their education, influencing their choice of major, or influencing their choice of institution. This theme emerged in both two-year institution data and four-year institution data. However, in two-year institution focus groups the fictive family influence emerged when the participant did not have a positive parental, sibling or relative figure while in the four-year institution focus group the theme emerged when the student did not have a

family member who majored in the participant's choice of major. One particular two-year participant discussed having to move frequently due to her parents being in and out of jail. This participant did not have a positive parental, sibling, or other relative figure in their life, so a high school statistics teacher became her fictive kin, taking on roles beyond school-based instructional duties to support her. This is important because she mentions in the interview that she was raising herself. The teacher who went beyond his role not only to bring her homework, but also to help her pass math, helped her persist in her education despite not having a positive familial role in her life. Overall, this led to this quote being coded as fictive family influence.

> *Um, I left home when I was 16 years old, my parents were both in and out of jail my whole life, so I kinda raised myself, and got myself through school. So it was a lot of just making sure that I was taking care of what needed to be taken care of, getting myself up and ready on time and to school, and then trying to take it seriously… Um, I got really sick my senior year, like in the hospital for weeks- um, actually resulted in me not graduating. After all that hard work. I was one credit short, geometry credit... I thought hmm! Um, but he [Probability and Statistics Teacher], uh, he would come to the hospital with prob/stat stuff and help me get through it. And I missed so much work that at the end he said, "Listen, if you could come in, and you can take this test, whatever grade you get on this test I will give you for the, for the course." I think I got like an 86 on it so I ended up passing. Um, but he was phenomenal, willing to go the extra distance to make sure that I was where I was.* – Gwen

When asked at what point they realized they wanted to be an engineer, a participant from one of the four-year institution focus groups responded by saying that she had a family friend who was an engineer.

> *Ironically, I have family friend as well who is a computer engineer. And during the summers, I would work with him. Because like, he would build my Dad's computers. So I thought that was super cool, so during the summers I would work with him and, uh, decided that's what I want to do.* – Robin

In response to the same question asked of Robin, another participant said he started thinking about this in middle school, again referencing a family friend. This is important as some people do not have actual family members who are in engineering or who know about engineering to guide them in the career path.

> *I have a family friend, who's also an engineer and asked him what did he do.* – Pancakes

Family Responsibilities: Family responsibilities are defined as any obligation towards their family that a participant referenced as an influence on their academic decisions. This emerged as a strong theme within the two-year institution data. While participants from the four-year institutions talked about family members who supported them, most did not discuss obligations

they had to their family that affected their academic performance. The sole exception was Robin, who discussed having to care for her father during her final year of high school due to his health.

> *Well, like my dad [had health problems] real bad my senior year of high school so that had an impact on me, like, as well, 'cause I had to take care of my dad and working practically full time.* – Robin

The theme of family responsibilities is more prevalent in the two-year institution focus groups, with many participants having to support their family. An example of having family responsibilities comes from John, who discussed how after he was done with classes, he had to work no matter how tired he was, in order to make more money to help his family. However, this work interfered with his academics, preventing him from graduating on time.

> *We moved from California in 2012, like, at the end of the year. That was November. And, it was like about three months that my mom couldn't find a job. And you know, you have bills to pay and all that. I was 17, but right after like, whenever I turned 18, I applied. And then I got a factory job. In that time I was in, during summer vacation. But then after that I started high school, and it was the same thing. Like, I needed to help my mom. So, I found a job in a restaurant, fast-paced, like, they will yell at you and all that.* – John

Family responsibilities were also significant for Amy, who had to get a job during her senior year of high school so she could help her mother with money, and later had to take care of her own autistic and epileptic son. It is important to note that Amy mentions in the interview that she has had to switch her major multiple times because she found math intimidating, and assumed she would fail a math course. It is also important to note that she eventually selected nursing as a major because it didn't require any higher level math and because the availability of online courses to complete the degree allowed her to take care of her son. Amy's family responsibilities, coupled with fear of math, ruled out a traditional pathway to engineering and led her to a non-engineering career.

> *Well, I became a mother my senior year, and, so I had to get a job after school, and all my money went there and we were struggling ... My momma said if we didn't need cable and Wi-Fi we didn't, we didn't have to have it. That's [why] we took home a laptop every day for our school work to be done on, so I had to go to the library when it was opened 'cause in my town it was opened three days a week. So you had to go to a friend's house maybe to do school work, or something along that lines, and then, um, with my mother struggled, so she would watch him while I went to school and then I would take over while she worked. So school work was done like late at night because I also had to have m- money to bring in .... I had to choose a major where I could do most of it online because being a single mom he's with me 24/7 … I have missed assignments because, um, my son has autism and epilepsy. Well, he has like partial autism, not full blown ... And we go to Charleston a lot to take him to doctors, and I can't always meet the thing,*

meet this test, or I think I'm gonna be able to do it, but he has a seizure, so they're just like okay, jump on remote proctor, and take it real quick, I'm willing to do it right now. – Amy

Another participant from the two-year institution focus groups, Gwen, discussed her father's view that completing high school was not important because of family responsibilities. He wanted her to contribute to paying the bills by getting a job, which indicated a family responsibility as well as a parental influence against pursuing education.

My, my dad's big thing was drop out of high school, you're old enough, and get a job, and help pay bills. That was where his mentality was, so school wasn't important to him whatsoever, it was this is what I did, so this is what you need to do. – Gwen

In this study, three sub-themes were found related to familial influences: family responsibilities, fictive family influence, and family guidance. From these sub-themes, there were differences based on whether the student attended a two-year institution or a four-year institution

Table 3: Differences that emerged in family influences from two-year and four-year institution focus groups. The dominant theme for each institutional category is indicated in italics and set off by asterisks.

Two-Year Institutions	**Four-Year Institutions**
Parental and sibling guidance	**Parental and other relative guidance**
Fictive family influence in the absence of positive family influence	Fictive family influence specific to major choice in the absence of a family member with experience in that major
Extensive family responsibilities	Limited family responsibilities

As shown in Table 3, not only do we see differences in how the themes emerged, but also in which themes were dominant based on type of institution. The issue of family responsibilities, in particular, had broad ramifications for how students at two-year institutions engaged in academics and selected their field of study.

Conclusion: In this paper we defined familial influences as ways family members affect a student's persistence in education, choice of institution, and choice of major. Family members include parents, siblings, other relatives, and also "fictive" family. From these influences we found differences in the type and source of influence between students attending two-year institutions and those attending four-year institutions. The qualitative data from this paper is the basis for a survey to be distributed at public two- and four-year institutions statewide. The survey data will help us determine to what extent these familial differences hold at scale, as well as to what extent they are correlated with persistence and performance in an engineering degree, setting the stage for development of targeted interventions to broaden participation in engineering within South Carolina.

Funding Acknowledgement: This work was supported by the National Science Foundation under grant #1744497

References

[1] "Broadening Participation in Engineering (BPE)," 2 December 2018. [Online]. Available: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504870.

[2] "Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science," National Science Foundation, [Online]. Available: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505289. [Accessed 2 December 2018].

[3] B. N. Geisinger and D. R. Raman, "Why They Leave: Understanding Student Attrition from Engineering Majors," *International Journal of Engineering Education,* vol. 29, no. 4, pp. 914-925, 2013.

[4] P. A. Daempfle, "An Analysis of the High Attrition Rates Among First Year College Science, Math, and Engineering Majors," *Journal College Student Retention,* vol. 5, no. 1, pp. 37-52, 2003.

[5] R. M. Marra, K. A. Rodgers, D. Shen and B. Bogue, "Leaving Engineering: A Multi-Year Single Institution Study," *Journal of Engineering Education ,* vol. 101, no. 1, pp. 6-27, 2012.

[6] M. Rose, B. Bogue, D. Shen and K. A. Rogers, "Those that Leave: Assessing Why Students Leave Engineering," in *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference*, Honolulu, 2007.

[7] S. Haag, N. Hubele, A. Garcia and K. McBeath, "Engineering Undergraduate Attrition and Contributing Factors," *International Journal of Engineering Education,* vol. 23, no. 5, pp. 929-940, 2007.

[8] M. Prince, "Does Active Learning Work? A Review of the Research," *Journal of Engineering Education,* vol. 93, no. 3, pp. 223-231, 2004.

[9] C. Baillie, "Addressing First-Year Issues in Engineering Education," *European Journal of Engineering Education,* vol. 23, no. 4, pp. 453-465, 1998.

[10] R. M. Felder, J. E. Stice and A. Rugarcia, "The Future of Engineering Education. VI. Making Reform Happen," *Chemical Engineering Education,* vol. 34, no. 3, pp. 208-215, 2000.

[11] National Academy of Sciences, "Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads," in *The National Academy Press*, Washington, D.C., 2011.

[12] J. A. Middleton, S. Krause, S. Maass, K. Beeley, J. Collofello and R. Culbertson, "Early Course and Grade Predictors of Persistence in Undergraduate Engineering Majors," in *Frontiers in Education Conference*, 2014.

[13] V. E. Lee and K. A. Frank, "Students' Characteristics that Facilitate the Transfer from Two-Year to Four-Year Colleges," *Sociology of Education,* vol. 63, no. 3, pp. 178-193, 1990.

[14] B. K. Keller and S. C. Whiston, "The Role of Parental Influences on Young Adolescents' Career Development," *Journal of Career Assessment,* vol. 16, no. 2, pp. 198-217, 2008.

[15] M. N. Dickens and D. G. Cornell, "Parent Influences on the Mathematics Self-Concept of High Ability Adolescent Girls," *Journal for the Education of the Gifted,* vol. 17, no. 1, pp. 53-73, 1993.

[16] J. M. Trenor, S. L. Yu, C. L. Waight and K. S. Zerda, "Influences for Selecting Engineering: Insights on Access to Social Capital from Two Case Studies," in *Frontiers in Education Conference*, Saratoga, 2008.

[17] M. Besterfield-Sacre, C. J. Atman and L. J. Shuman, "Characteristics of Freshman Engineering Students: Models for Determining Student Attrition in Engineering," *Journal of Engineering Education,* vol. 86, no. 2, pp. 139-149, 1997.

[18] D. R. Simmons and J. P. Martin, "Developing Effective Engineering Fictive Kin to Support Undergraduate First-Generation College Students," *Journal of Women and Minorities in Science and Engineering,* vol. 20, no. 3, pp. 279-292, 2014.

[19] R. Landis, "Retention by Design: Achieving Excellence in Minority Engineering Education., Los Angeles," in *National Action Council for Minorities in Engineering*, Los Angeles, 2005.

[20] W. Velez, J. Maxwell and C. Rose, "2013 Annual Survey of the Mathematical Sciences in the U.S.," American Mathematical Society, 2015.

[21] IPEDS, "Integrated Postsecondary Education Data System," [Online]. Available: https://nces.ed.gov/ipeds/use-the-data. [Accessed 3 December 2018].

[22] PolicyMap, "Estimated Black population 2012-2016, by state," [Online]. Available: http://www.policymap.com/our-data-directory.html#Census:%20Decennial%20Census%20and%20American%20Community%20Survey%20(ACS). [Accessed 3 December 2018].

[23] PolicyMap, "Estimated Hispanic population 2012-2016, by state," [Online]. Available: http://www.policymap.com/our-data-directory.html#Census:%20Decennial%20Census%20and%20American%20Community%20Survey%20(ACS). [Accessed 3 12 2018].

[24] E. Gallagher, C. Brown, A. Brown, K. K. Frady and P. Bass, "Identifying Prevalent Mathematical Pathways to Engineering in South Carolina," in *Proceedings of the 2018 American Society of Engineering Education Annual Conference and Exhibition*, Salt Lake City, 2018.

[25] R. A. Krueger and M. A. Casey, Focus groups: A practical guide for applied research, Thousand Oaks: Sage Publications, 2000.

[26] J. L. Campbell, C. Quincy and J. Osserman, "Coding in-depth semistructured interviews: Problems of unitization and intercoder reliability and agreement," *Sociological Methods & Research,* vol. 42, no. 3, pp. 294-320, 2013.