First Generation Students' Engineering Belongingness

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Abstract

This research paper investigates first generation (FG) upper level undergraduate engineering students' engineering experiences and how their experiences affect feelings of engineering belongingness. When compared to "traditional" continuing generation (CG) students, FG students have been shown to have difficulty meeting admission requirements, a need for external employment, and obligations to family. This body of research illuminates FG struggle, but little literature focuses on FG students' personal experiences and ways they are successful in attaining an engineering degree. This work strives to understand how FG engineering students develop belongingness to major, often at higher levels than their CG peers.

Five FG engineering students with high quantitative belongingness were selected for an interview. A semi-structured interview protocol based in interpretive phenomenological analysis was used to elucidate the students' experiences that fostered belongingness. Separate themes from each student were created from coding and then overarching themes unified a shared experience.

The following overarching themes were prevalent among the participants: similarity to classmates, recognition as an engineer by peers, limited questioning of belongingness, and belongingness is a state of mind. The results depict that elements of engineering identity play a part in making students feel they belong (e.g., recognition), but in some cases, belongingness is distinct from identity constructs (e.g., being similar to others). Past literature has shown that belongingness and identity may be related, and created by each other, while findings in this study show that identity and belongingness are interrelated and give the research community further insight for upper level FG engineering students.

Introduction

This research paper showcases first generation (FG) upper level undergraduate engineering students' engineering experiences and how their experiences affect feelings of engineering belongingness. The rigor of engineering is often what unites engineers from around the world[1–3], but the background of these individuals allows for diverse thinking and idea generation. Through diverse thinking, the engineering workforce can create new and innovative products that will improve the world and the living conditions of humankind. Although the engineering community values these diverse ideals, diverse individuals often report negative experiences within their engineering college experience[4–6]. Students that make up the majority of engineering are White heterosexual males that transition to college directly after high school following the footsteps of their parents[7–9]. To understand the experiences of students who do not fit this mold, this research paper seeks to understand first generation upper division engineering experiences and how these experiences influenced student belongingness to engineering.

Understanding the experiences of first generation students allows for greater diversity of thought in engineering. First generation status is not restricted to one measure of diversity and allows for variability in the following diversity measures: race, gender, and sexual orientation, because any

individual can come from parents who have not received a bachelor's degree. Although first generation students (FGS) can be diverse, studies have shown that FGS are often from lower socioeconomic households and minority groups[10].

Background

Literature shows that engineering experiences are described as more difficult than other majors, students exit with an entitled mindset for a high paying job upon graduation, use the potential pay to motivate them through the degree program, and are less inviting for diverse individuals[1,2,4,6]. Engineering challenges even high achieving, well prepared high school students who often have added avenues for success[3].

> My dad is a chemical engineer… I also had a really good engineering teacher [in high school who] used to work with my dad… I could tell he really wanted me to be an engineer[3].

This student has a sense of belongingness in engineering (both in grades and people in his life who are engineers) while also having a parent who had graduated from engineering. Although this student had added avenues for success, the student chose to drop out of engineering, even though the student had many more resources than a FGS. Delving into literature about FGS, these students take fewer college preparatory classes, choose engineering at a lower rate, and have fewer people to offer them guidance and help for entering into engineering[11,12].

Engineering is not only a difficult major, but also has a rigid culture[6,13]. Students from diverse backgrounds are accepted in engineering only if the students have engineering characteristics such as high math and science skills and a curiosity of how the world is put together[2]. In this case, if a diverse individual shares an engineering mindset, then students are able to connect with other students. Although Godfrey and Parker state that students from diverse backgrounds are accepted in engineering, their findings also suggest that the students who participated in the study were less accepting of individuals from different ethnic backgrounds when there is no shared mindset[2]. Additionally, diverse individuals in engineering are often exposed to stereotyping that leads to alienation, the need to prove oneself, and self-doubt[4].

Espinoza identified that these issues of racism exist for first generation Latino students in engineering. One student said:

> Where I'm from there ain't White people... it made me more mindful to perceptions that a lot of people that don't deal with Black or Hispanic people might have. I would be walking around campus and people would look at me kind of weird lots of times; some people would look at me all scared… other people looked at me like 'that's the guy that robbed me' –Hercules[6].

Another participant, Billy, talked about how racial and minority students were viewed on campus as "'probably someone from around the neighborhood', not 'Oh he's a college student'"[6]. Although these participants felt their peers were not accepting of diversity, they felt the

engineering department was a diverse place because of the number of other diverse faculty and Asian students[6].

Both studies show a mix of experiences from racial and ethnic minority students and reinforces the need for qualitative studies to investigate experiences at different universities and among groups, thus giving a reason for the following FGS qualitative study. FGS who pursue engineering are often linked with a minority status, are low income, and are at times part of programs that give them resources to succeed[14]. Interestingly, a national survey conducted across the United States had shown that first generation graduating seniors were 60% white and FGS seniors made up 41.2% of the population[15]. Despite these results, FGS literature often does not discuss the experiences of White FGS.

Additionally, FGS are often compared to their continuing generation students (CGS) counterparts. FGS saw helping their family financially after college and bringing honor to their family as more important factors to go to college than their CGS peers[16]. FGS also take fewer risks in college[11], are more afraid of failure[17], and are more likely to choose majors with high earning potential rather than majors that have traditionally lower earning potential[11]. A high percentage of FGS students do not have the necessary pre-requisites for engineering, which was linked to a higher percentage of FGS students choosing to major in business, vocational fields, social sciences, and health sciences rather than engineering[18]. The literature shows FGS have unique experiences in college and are more likely to be unprepared for the engineering rigor needed. Despite these claims, many FGS in engineering often succeed to graduation, yet little work has examined the experiences and attitudes that aided in their success. The research questions that are directing this study are the following:

RQ 1: How do first generation college students' experiences within engineering influence engineering belongingness?

RQ 2: How is engineering belongingness and engineering identity related for first generation college students?

Theoretical Frameworks

Belongingness

Belongingness for this study is defined as a student's perceived sense of belonging. Sense of belonging is conceptualized by an individual's self-measure of "fit" within a group or institution[19]. Many articles refer to difficulties of some groups striving to belong in engineering, namely Latinos, African Americans (previously outlined)[4,6], and women. All three groups make up a minority in engineering. The experiences of women in engineering attest to experiences of stereotyping and sexism that reduce belongingness. This is best illustrated in McLoughlin's work on spotlighting that describes overt sexism, use of un-inclusive pronouns such as "he" when referring to an engineer, and giving more resources to females[7]. Other work focused on a participant who was at the intersection of multiple demographic measures found that she felt like she did not belong because she did not have some of the preliminary math skills[20]. She talked about the students that could understand the material. "The others that do know things, they

really don't like to help you. I found"[20]. She was not given many of the same opportunities in high school as some of her peers. She came from a high school that did not have extensive college prep courses.

> Some people come into college with 10 credits or more already. And I am like, wait a minute. How do you even get this? My school didn't provide that, you know, because we don't have the money to provide those types of classes - Inez[20].

The previous examples illustrate that minority groups in engineering have difficulty belonging in engineering. FGS characteristics (lower math preparation, less help with getting into engineering and also knowledge of how to pursue college) often mirror the characteristics of underrepresented populations in engineering. Despite similarities, FGS students reside at the intersections of different diversity markers and may utilize different experiences to develop their belongingness.

Identity

Identity, is how one identifies his/herself as a person who engages in a particular role or group through interactions with others, relationships with family, and colleagues[21]. Identity can also be reinforced by doing well on tests and working on projects with other engineering majors[22]. Interest in a particular subject or in the field in which they are seeking a degree is also an important part of a subject-related role identity[23]. Engineering identity, as framed in prior work, consists of three constructs: performance/competence (how well a student feels they can do at engineering related tests, tasks, and projects), recognition (how recognized a student feels from their peers, parents, professors, and others), and interest (how much students want to learn more about engineering)[24]. Many studies have worked to understand the development of an engineering identity: equating engineering identity to belongingness, explaining a way of thinking and conversing in engineering often referred to as a community of practice, and understanding the culture of engineers[2,22,25,26]. Identity based motivation also defines identity as malleable and constantly being dynamically constructed[27]. Identity based motivation therefore looks at how experiences affect a student's emerging identity. This study strives to contribute to this literature by understanding students' experiences and better understand how identity and belongingness are related.

Methods

Participants

Participants consisted of FGS who had high levels of belongingness based off previous work[28]. In brief, FGS had significantly higher levels of belongingness when compared to CGS peers, but data did not elucidate why this difference existed. The original quantitative sample size consisted of upper level engineering students in a communications class for engineers at a western land grant institution (n = 162). FGS with belongingness scores in the upper 50th percentile were recruited for this study. Students were notified using Institutional Review Board (IRB) approved procedures. First, students were emailed on a weekly basis using the email provided in the previous quantitative survey. Then, further contact was conducted by personal messaging

utilizing a social media website. Messages were private and the study information was the only information sent to participants. A review session for a course that may have contained potential interview participants, and a senior project exhibition day where students were presenting their engineering projects were targeted to recruit participants. Research group members were utilized to encourage students to initiate contact if they wanted to participate. Five participants from the course accepted the invitation and each participated in a single interview. The small sample size was required for the qualitative analysis because our interpretative phenomenological analytic lens required the use of a small homogenous populations to elicit the essence of the experience and allows for an in-depth level of analysis[29]. Additionally, this sample allowed us to focus on the experiences of successful FGS. This focus allowed us to address the ways in which FGS develop belongingness in engineering environments, an area under served in current literature.

Each interview was about an hour long and were conducted over the phone, in person, or via skype whichever was the most convenient for the participant. The five participants expressed belongingness in a variety of ways. The participants were prompted with the following questions: "Do you feel like you belong in engineering? Why or why not?"; "Do you feel like you belong in your engineering classes? Why or why not?"; "Can you tell me an experience that made you feel like you belonged in engineering?"; and "Can you tell me an experience that made you feel like you did not belong in engineering?"

Pseudonyms were used to maintain anonymity for participants. The pseudonyms are Matt, Peter, Henry, Scott, and Tony *(n* = 5). Matt is a White third-year student who attended a technical high school. Matt went straight from high school to college. Matt is pursuing a mechanical engineering degree. Peter is a White/Hispanic third-year student who attended a western rural high school. Peter went to community college before attending the university and received an associate's degree. Peter is pursuing a mechanical engineering degree. Henry is a White fifth-year student who attended a nearby western high school. This high school was different from Peter's high school. Henry was near graduation at the time of his interview. All other participants had at least one more year before they graduated with their degree. Henry also attended a nearby community college before attending the university and received an associates. Henry is pursuing a mechanical engineering degree. Scott is a White third-year student who attended a high school out of state. He had recently entered the university after receiving his associate's degree at a community college near his high school the previous semester. Scott is pursuing a chemical engineering degree. Tony is a White fourth-year student who attended an in-state high school that was located far from the university. Tony attended a community college near his high school and received an associate's degree before attending the university. Tony is pursuing a mechanical engineering degree. The participants' demographics mirrored the sample population's demographics that indicated a high representation of FGS who identified as White. The following table summarizes the participants who were interviewed for this study.

Table 1: *Participants' demographic summary*		
Pseudonym	Race/Ethnicity	Degree before entering university
Henry	White	Associates
Peter	White/Hispanic	Associates
Tony	White	Associates
Matt	White	High School Diploma
Scott	White	Associates

Qualitative Data Analysis

Thematic analysis that borrowed from an interpretative phenomenological analytical (IPA) lens was used to elicit themes from the data collected. An IPA lens was utilized because it is a "research approach committed to the examination of how people make sense of their major life experiences"[29]. IPA therefore allows researchers to interpret experiences from the participant's perspective. IPA consists of multiple passes through the data. First, we familiarized ourselves with the participant's voice by listening to the audio recording, and reading through the transcript. We sought to become so familiar with the participant's voice that we started speaking in the participant's voice by using their speech patterns while reading the transcript. After becoming familiarized with the data, we then analyzed the data using three different passes.

First, we conducted a descriptive pass to understand what the participant was saying. We sought to capture what the participant was trying to convey. We captured the essence by writing notes about the experience and summarized the statements using the participant's words. Then, we utilized a linguistic pass to understand how the participant answered the questions and what might be their opinions on their experiences. We looked for pauses, specific words or phrases that were unique and often linked with emotional connotation, and any inflection in the participant's voice that better explained what the participant was trying to convey. Lastly, we did an interpretive pass where we connected their descriptive and linguistic codes with the data to create my interpretations of what the participant said.

After the three coding passes were completed for each interview, we created overarching themes for each participant by connecting the codes created. Themes based on belongingness were created when participants were asked about their belongingness in engineering. Memoing was also done so our own experiences in engineering and being an FGS would not cause misrepresentation of the participant's data.

Themes for each participant were created separately, superordinate themes were generated by connecting themes from each participant to understand the experiences that led to the development of FGS belongingness. An outside reviewer was used to look over coding passes and themes that were created to ensure interpretive quality[30]. The reviewer confirmed if the themes were supported by the coding passes and that interpretations were viable explanations. I also utilized individuals in my research group to work through themes and how excerpts for the interviews supported the themes that were created.

Results

Belongingness is expressed by similarities to their peers.

First, similar academic characteristics and interests drove belongingness among students. Peter presented this idea in the following statement:

> All my classmates, they're, a lot like me, and it's just easy to sync with them… [they are] a bit more, intellectual, (pause) more nerdy, and hardworking. – Peter

Peter immediately made a comparison to his classmates when asked if he belonged in engineering. He described both himself and his classmates as a bit more intellectual, more nerdy, and hardworking. He felt accepted for his characteristics and also found that his other classmates pursuing engineering also had these characteristics. Peter's similarities allowed him to be himself around other engineers because he was similar to them and the similarity also made him feel a connection with his peers. Tony shared a similar feeling:

> I see [my roommate] as a very intelligent individual. We have fairly similar interests. We usually do nerdy debates. So it's really fun to get ideas out, even if they're not practical in real life. We met during Physics for engineers. We decided to live together because we had similar interests – Tony

Both Peter and Tony express classmates having similar personalities and interests and that made them feel they belong. Matt took a different approach to expressing his similarity to his peers than Peter and Tony. Matt had a less defined engineering identity but still expressed a similarity to his peers. Matt shared one personal aspect that he had with his peers:

> I think I belong in the major. Um, (pause) I guess I just feel, yeah, I think I belong. I think that I'm just awkward enough that everyone else is around the same level of awkwardness, and so we all get along. – Matt

Matt expresses that he thinks he belongs in engineering which may be related to his developing engineering identity. He is different from Tony and Peter because they were confident in answering that they belonged in engineering. He also linked his definition with how engineers often are colloquially defined: being awkward. The following excerpt is after Matt was prompted with the following question: Do you feel like an engineer?

> No I [I don't feel like an engineer] (exhales). As I learn more, I realize how much I don't know… I just feel like someone who's waiting to learn that they're an engineer. I'm in the halfway zone. – Matt

Matt, at the time of the interview, does not feel like an engineer yet. He is developing his engineering identity by collecting knowledge based on needing or wanting to learn, and realizing how much he doesn't know about engineering. He discussed that he belongs to engineering but still feels like he cannot fully belong until he gains the knowledge and feels like an engineer. He

also described engineering in a way that removes him from the description in the following excerpt.

> A lot of engineers made the decision to be engineers because they wanted to be able to try really hard in something they knew they were already good at. Instead of branching out to being more social. – Matt

Matt described engineers as a group of individuals, describing them as "they." In both this excerpt and the one above where he described his peers as awkward, it appears he is speaking about an engineering group where he is not included. He reinforced why he thinks he belongs while describing himself, and then the group. Matt is forcing himself to feel like he does not belong because he believes he needs to know more. He is forcing himself to feel like he does not belong, but the engineering group is not causing his lack of belongingness. In other words, Matt's level of belongingness is self-imposed. Although Matt described his peers in a nuanced way, Matt, Peter, and Tony described their belongingness by comparing themselves to classmates.

Belongingness is developed when someone is recognized as an engineer.

Another way students described their belongingness to engineering was when they were recognized as an engineer by their peers. Tony referred to his peers and how they discuss ideas when discussing why he felt that he belonged to engineering,

> We can discuss ideas, and are intrigued with each other's ideas… I don't feel like the other people who are in engineering think that I'm just sort of a novice. If that makes sense. I think that a lot of the people I know respect my ideas, and I respect theirs. - Tony

Tony feels that his ideas are respected by his peers and that he is not a novice. He brought forward experiences where he was recognized as an engineer. The following excerpt from Tony unpacks an example of Tony's perceived recognition from peers:

> [My roommate and I] came up with the idea of how cool would it be to make a simulation of a Rubik's cube in MATLAB… once I finished it and I was telling people about it, because that was when I was pledging with [engineering fraternity], a lot of people were amazed with it. They're like, "Wow, I can't believe you did that. That's, that's crazy." And I like getting those reactions from people who I respect as engineers. It really made me feel like an engineer. - Tony

The older members of the fraternity, who Tony perceives as engineers and respects, were amazed by Tony's project, thus recognizing Tony as an engineer. Tony described this particular experience as being very important in making him feel like an engineer. His engineering skills and knowledge was validated by individuals he sees as engineers. The above excerpt was when Tony was prompted by describing an experience that made him feel like he belonged.

Another measure of recognition is by oneself. Matt does not see himself as an engineer and wants to have an experience where he can recognize his engineering self.

> I think maybe the one reason I don't feel like I'm an engineer yet is because I haven't done anything engineering. Like I haven't designed, I haven't built something to completion that I felt [could have] a stamp saying, "This is an engineering thing that I've done." - Matt

Matt recognizes that he must build something to completion to be an engineer. Then, he could show this something to others and himself that he is capable of being an engineer.

Belongingness is expressed when a student has interest in engineering.

Matt expressed feeling like he belonged in engineering when he first was gaining interest in pursuing engineering.

> I always thought it'd be cool to be an inventor. One of my teachers in 5th grade assigned us a project where we had to build a simple machine that makes our lives easier… It was probably the worst thing I've ever built, but it really got me interested in engineering. I didn't know what engineering was [in 5th grade], but it got me more interested in making things, building, science, and math. – Matt

Matt describes his project as the worst thing he had ever built. He did not feel recognized as an engineer and he makes that clear by saying it drove his interest. Matt felt belonging in engineering when he became interested in the field. Although Matt is the only participant to have exclusively cited interest when he felt like he belonged in engineering, others expressed varying levels of interest.

One model of interest defines four increasing levels of interest: triggered situational interest (students become interested in a subject), maintained situational interest (students find they are still interested after first being exposed to the material), emerging individual interest (students start to seek out material and more subject material on their own), and well-developed individual interest (when students are committed to learning more material)[31]. Matt expressed his triggered situational interest because the project had gotten him interested in engineering in the beginning. The following excerpt shows the Tony's interest in engineering. "I felt like I was learning a lot… I feel like at that point it was not only fun, but I felt like I was actually doing something." Tony saw that he was learning a lot and having fun which means he was able to learn a subject with little perceived effort which is a characteristic of well-developed individual interest.

Peter expressed another aspect of a developed interest. "When I [had] taken system analysis. I don't want to just do that kind of engineering, where you're processing signals or something." Peter expresses a dislike for a certain discipline of engineering which means he enjoys some disciplines more than others. Students who have a developed interest begin to dislike different subjects because the material does not interest them. Henry expressed yet another aspect of developed interest. "When they say it for the first time on the board it's like, you don't really understand but you have to go home and practice it and do the homework before you really learn

it". Henry expresses internal motivation to learn the material. A well-developed interest causes students to self-regulate their learning [31], which Henry expresses in the quote above.

Scott also expressed a characteristic of a developed interest. Scott explains how a sub-Reddit post (AskScience) was a resource he used to understand how to become a researcher and also learn more about chemistry. "They mentioned a bunch of things when they were talking about chemistry and I knew that they would probably be a valuable asset when I started doing research." Scott shows that he is seeking answers to his own generated questions by using Reddit which is yet another characteristic of a well-developed individual interest.

Students feel belongingness in class through instances of performance/competence.

Two participants describe how they feel about belonging in their engineering classes.

> I feel like I belong in my engineering classes. I can, listen to the teacher and most of the time understand what they're trying to teach us. Sometimes it's like, "What?" I feel like I belong there. – Henry

> I do, because I understand them (my engineering classes). I never feel like I'm out of my league. I get through [my classes] – Scott

Henry says most of the time he can understand the teacher, and Scott says he can understand his engineering classes. Both base their belongingness in the classroom on understanding, or what is referred to in literature as performance/competence. Henry describes being confused at first with the material, but he eventually understands what is being taught. Tony shows a more nuanced example of performance/competence that shows he belongs less in classes where he is unable to understand the material.

> I'd say there are some classes I don't really like due to the material. There are some materials I'm not great at. Stuff that involves Fluids… is not intuitive so I don't really feel like in those classes that I fit in super well. - Tony

Tony expresses low performance/competence toward Fluids by saying it is not intuitive and he belongs less in those classes because he is not great at the material. The participants felt they belonged to their engineering classes based on their performance/competence of the course material. Henry and Scott appeared to have a high performance/competence while Tony expressed a lower sense of performance/competence towards certain courses.

Participants rarely question their belongingness in engineering.

All five participants had a quantitatively high survey score for belongingness to engineering. The following excerpts were elicited from the participants by asking the following question: "Can you tell me an experience where you questioned if you belonged in engineering?" Peter shared, "I don't know, it's kinda hard. Not really." Peter has a hard time thinking about ever questioning that he belonged in engineering. He could not come up with an instance. Tony has not questioned engineering, but has at times questioned certain classes and skills.

> I don't think there have been specific instances where I feel like I don't belong in engineering. It's overall things like feeling I don't necessarily have the skills... the classes that I haven't done well in are classes that I just struggled to understand the material… I just felt like this subject didn't really agree with me, but a lot of the other ones do. - Tony

Tony sees these subjects as minor setbacks but that does not make him question belonging. Lastly, Matt, who does not see himself as an engineer, has barely questioned belonging to engineering. He feels he cannot say he belongs in engineering because he believes he must first be an engineer.

> I don't think so [in regards to belonging in engineering]. I see those two questions [being an engineer and belonging in engineering] as being very similar. I've a hard time distinguishing the difference between them because one of them is becoming an engineer and one is being an engineer. I don't think that I feel like I don't belong in engineering. – Matt

Matt did not perceive an experience where he did not belong because he is trying to enter into being an engineer and the engineering community. If Matt felt he was an engineer, he may be able to confirm he belonged in engineering. All the participants hardly questioned their belonging in engineering when pursuing their degree.

A shared engineering mindset makes students feel they belong in engineering.

Unlike Matt, who explained his belongingness by feeling that he was like his peers, there were two participants (Henry and Scott) that expressed belongingness in a more nuanced way.

> I feel it's cool to talk to other engineers because we know the same stuff. I have friends who aren't engineers and I try to talk to them about some things and, they don't really know but when I talk with other engineering students it's cool to be on the same level. [To be] able to have engineering discussions with them. I fit in, in that aspect… If there's some new technology out there and we're like, "Oh they, they did this, they built that." We're like, "Oh wow! That's, I wonder how they did that."… Or if it was a non-engineer they'd be like, "Oh, Okay?" – Henry.

> Yes, definitely [I feel I belong in engineering]… Because I don't fit into the other careers or majors. Often times if I'm speaking to an arts or a biology or anything like that, there's a disconnect. Just the way they see the world, and they don't seem very interested in [the world around them]... They almost seem like they're just kind of there, whereas an engineer is often kind of excited about little things that normal people wouldn't get excited about (chuckles) –Scott

Both Henry and Scott describe a bond with their peers that is connected to a curiosity about the world around them, but also a feeling that they cannot converse with other non-engineers because they feel like the non-engineers do not understand this curiosity. Henry describes a non-

engineers' feeling with the word "Okay" followed by a question mark. His description means the non-engineer would find engineers' curiosity to be strange and foreign. Henry's comment may also signify that the non-engineer may also have not considered how things are built. Scott describes this uninterested view of the world around them by saying other majors are "just kind of there" while engineers get excited about "little things", such as the way objects around him are built. Henry described his lack of communication with non-engineers by saying he has tried, while Scott says he feels he fits in engineering because he did not fit into the other careers or majors due to his interest and curiosity.

Both Scott and Henry are describing an engineering mindset that is constantly wondering about "how things work". They are united with their engineering peers based on an upper level curiosity that they cannot find in other majors. They try to bring up their mindset with other majors, but cannot connect on the same level they can with other engineers. The description seems to be describing a deeper and richer definition of belongingness than the three participants who had stated they belonged to engineering. Matt Peter and Tony felt they belonged because they had similar personalities or had similar interests to their peers. Both Scott and Henry appear to feel out of place in other environments without an engineering influence and might be feeling this because they feel they fit in with other engineers so strongly.

Summary of belongingness themes.

Participants communicate their belongingness to engineering in a multitude of ways. Participants perceived similar personalities to their peers; ability to understand the concepts in their classes; being recognized for their ideas to create projects; having interest in the engineering major and the subject material; and lastly some participants (Henry and Scott) exhibited a further understanding of engineering and perceived a unifying mindset that engineers have. Four of the participants also had such high belongingness that when prompted about if they have ever felt like they did not belong in engineering they could not think of an experience, while Matt did not feel like an engineer and could not say that he belonged to engineering. Belongingness appears to be multi-faceted and is not just based off of one unifying idea. Participants feel belongingness based on affective domain traits and also competence toward the major. Participants also cited all of the engineering identity constructs used by Godwin's (2016) model to describe belongingness: interest, performance/competence, and recognition. Godwin's study confirmed that engineering identity is represented through the three constructs, but this study showed that belongingness is interrelated to a participant's engineering identity.

Discussion

The participants all exhibited high belongingness as indicated by their quantitative survey results and also expressed their belongingness to engineering in a variety of ways. The participants described their "relational connections that people develop with others in the communities in which they live, work, and play"[26]. Specifically, participants described their belongingness based on their similarities with other engineering students and through different experiences (e.g., recognized, feeling they can perform engineering tasks, are interested in engineering, etc.) that aid in engineering identity development. Previous work in engineering identity has shown that students are more engaged in their studies if they have a well-defined engineering identity[32]. This

work extends these findings through participants' explicit connections between their belongingness and engineering identity constructs (interest, recognition, and performance/competence beliefs). Literature on understanding fit of engineering students has shown that students feel they fit in when they develop an identity from the engineering program like application of specific knowledge and introversion[25] and see a similarity to their peers[22]. Results demonstrated that belongingness and engineering identity creation are intertwined. One study had shown belongingness is related to engineering identity[25], but this research study demonstrated that students feel belongingness either by being similar to their peers (separate from engineering identity) or having experiences that made engineering identity constructs salient thus allowing them to feel like they belonged.

Two participants, Henry and Scott, talked about a unifying engineering mindset that made them feel they belonged. Previous work examining this "engineering way of thinking"[2] indicated that this mindset is often perceived as a fundamental component of engineering. Both Henry and Scott express a fascination about the world around them and the way that other majors are not interested in their fascination illustrates how engineers are interested in not just things that work but how those things work.

Many articles in literature show that FGS often times have difficulty persisting in college[10,12], but this study shows that FGS are able to be successful in college and highly belong in engineering. Most studies refer to FGS higher attrition, but these same studies do not address the FGS who persist in their majors. This study suggests that FGS that persist to their upper division courses through receiving their associate's or starting at a university develop higher belongingness than CGS.

One way that institutions could decrease attrition of FGS is to create a mentorship program that connects younger FGS to older FGS who are both pursuing engineering. Since older FGS may have gained high belongingness to engineering, they could influence younger FGS to feel a further connection that may have not been felt otherwise. Specifically, by providing explicit connections to other students with shared experiences, younger students have the opportunities to be recognized by their peers within engineering. Peer recognition and similarities allowed students to increase their belongingness. For the students of this study, recognition by faculty was not mentioned as an experience that increased their belongingness in engineering. Finally, the ability to connect engineering to real-world problems (event if not realistic) gave students the opportunity to explore the use of engineering mindsets and practices. This exploration generated opportunities for students to see themselves as engineers. By opening up the engineering curriculum to allow for increased student choice in the problems solved, faculty may be able to further develop FGS belongingness to engineering.

Conclusions

FGS in engineering who exhibit high belongingness in this study connected their belongingness with their engineering identity. This research furthers FGS studies to understand how FGS are successful in engineering and integrate into the culture of engineering. This integration or belongingness is seen through the development of the engineering identity constructs of interest, recognition, and performance/competence. Additionally, FGS find belongingness through the

possession of engineering mindsets and ways of thinking. These results indicate that developing belongingness in engineering, while complex, is often generated through a series of smaller experiences. Given the often cited concerns of limited time presenting a barrier for evidence-based practices, this work suggests that small interventions could help build FGSs' belongingness in engineering.

Future Work

Further studies for each individual student will be done. Matt was the only student who was from a technical high school and may have a different perspective of his college experiences compared to the other participants who attended a community college prior to attending the western land grant institution. Tony also appeared to have deeper opinions and ideas of the engineering program and culture than his peers. Both Tony and Matt's opinions and answers to the protocol questions will shed light on the culture of engineering.

The demographics of the FGS interviewed properly represented the sample size surveyed for the study, but is often not represented in FGS literature. The sample size surveyed showed that upper level FGS were 50% White. Looking at literature, FGS are statistically more likely to be from minority groups[10,33]. Some possible explanations for the high percentage of White students is White FGS pick engineering at a higher percentage than non-White FGS, White FGS persist at a higher rate than non-White FGS, or the western land grant institution services a statistically high White FGS population when compared to nation-wide studies on FGS. To confirm any of the explanations, more studies must be run on the FGS population at the institution. A freshmen class could be analyzed for FGS demographics to see if a majority of FGS are White. A longitudinal study would need to be conducted to see students' persistence rates. Lastly, an institutional survey would need to be taken to characterize students' FGS status and demographic data.

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