



First year engineering experience from the rural student's perspective

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First-year engineering experience from the rural student's perspective

Introduction

This complete research paper will explore the experiences of first year engineering students from rural communities. According to the United States Department of Education, 31.3% of public elementary and secondary schools are in rural communities, serving 21.3% of students in the United States [1]. Of these students, only 27.1% will continue their education by enrolling in a college or university by the time they turn 24 (national average for all 18-24 year olds is 34.7%) [1]. While it is unknown how many of these rural students will pursue degrees in engineering, case studies suggest that rural populations are underrepresented in engineering programs at institutions throughout the nation [2]. Regardless, these numbers do not tell the whole story about rural students' experiences in the engineering field.

Educators have come to realize there are unique challenges rural students face when transitioning to institutions of higher learning [3]. Rural students may be hindered from entering the engineering pipeline due to geographic isolation and economic factors resulting in limited advanced math and science curricula and lack of STEM outreach opportunities at the K-12 level [1], [2], [4]. There are also cultural constraints on rural students that may impact their decision to pursue and their transition into higher education. Education is not identified as a top priority for most adults in rural communities, resulting in a lack of mentorship and role models for students. Many parents in rural areas have not attended college themselves, and therefore they are less likely to encourage their children to attend college. It has also been noted, many rural Americans tend to be committed to their communities and have little desire to leave their hometowns. There is also evidence that rural students have lower expectations and confidence in their ability to succeed in an engineering course of study [5]. Finally, rural students are more likely to experience anxiety or depression over the difficulty adjusting to college life and are less likely to seek counseling when dealing with struggles [6].

The aim of this study is to explore the experience of rural students in their first-year of study at a large university as they transition into an engineering course of study. The following research question guides the work: *What perceived barriers do rural students face when starting an engineering major?* This work will explore the challenges rural students face, including institutional factors such as course options, STEM exposure and lack of resources. We will also address students' perception of themselves and their community, both at home and in the university setting. Finally, we will address the practical challenges that students face when they adapt to life in a larger city and how it impacts their pursuit of becoming an engineer.

Background

Tinto's theory of student attrition asserts that student success in higher education can be attributed to two factors: personal characteristics the student brings with them, such as skills and abilities, and interactions using these characteristics across a range of college experiences [7]. Early retention research tended to focus on the first factor: personal characteristics of students. Several student characteristics have typically been found to be predictors of student success, such as high school GPA, standardized test scores and high school class rank [8]. However, a more recent body of research has emerged showing that students' college experiences can also be predictors of their success and retention [9]. Tinto asserts that the first-year of college is a

critical period of time to support student persistence and breaks down these college experiences into three stages: separation from the membership of past communities, transition, or the period of passage between the associations of the past and the hoped association with the students' new community and incorporation, or the adoption of the new norms and patterns of behavior consistent with the communities of college life [10]. The scope of the transition stage can be measured by the degree of change it entails, that is the degree of differences between the norms and patterns of behavior in the students past versus those required for incorporation into college life [10]. This transition to a higher education institution can be particularly difficult for those from small rural communities because of the larger degree of difference between their hometown and the typical university.

The study of rural students poses a unique challenge for researchers. There is no standard definition of "rural." The United States government has six different definitions of rural that counties and communities can be categorized in depending on population, distance from a metropolitan center, geographical features or level of economic and industrial development [11]. Additionally, rural regions and populations can have vastly different social and economic characteristic [12].

Recent studies have begun to shed light on the issues faced by the rural student populations as they start in engineering programs. Efforts have been made to determine the distribution of students from rural communities who enter and persist in engineering programs. A 2013 study looked at the geographic distribution of students enrolled in six Midwestern chemical engineering programs, discovered all six universities had rural student populations less than geographical proportional parity, meaning that the rural population was under represented in all departments [2]. Additionally, there was no rural student representation at three of the institutions. The authors propose that this may represent a leak in the STEM pipeline and efforts need to be made to increase rural recruitment in order to increase rural representation in engineering [2]. Other recent work has investigated the impact of rurality on engineering persistence and graduation rates. Using a regression model, it has been shown that rural students are 7% less likely to graduate than students coming from a suburban area [13].

In their seminal longitudinal study of engineering, Felder et. al. uncovered some of the key difference and challenges rural students face compared to their urban and suburban classmates[5]. These challenges included lower parental education levels, lower confidence in engineering abilities and higher failure rates. Additionally, this study highlighted the difference in motivation for students choosing engineering depending on their rural status: students from rural communities reported higher likelihood to enter engineering at the suggestion from a high school teacher or advisor unlike students from urban/suburban areas who tended to have a family member influence their decision to pursue engineering.

Although not specific to engineering, Ganss probed many of the challenges rural student face with a qualitative study on the first-year experiences of students from rural Oregon Communities [3]. The study presented here, aims to expand upon Ganss's broad first-year experiences and bring the focus specifically to first-year engineering students at a large midwestern university.

There is limited research on the impact of rurality on the experience of engineering students. Most of the work in rural engineering education centers around K-12 outreach and recruitment of students into the STEM field. However, if we do not dig deeper into understanding the experiences of these students while pursuing their engineering education, we will not understand the unique challenges they face and will not be equipped to support their college transition, thus our efforts in recruitment may be in vain.

Methods

Setting

This study was conducted at a large public research university in the Midwest. The campus is located in a mid-sized city with a population of 115,000 and is 40 miles from a large urban center. The engineering college has an undergraduate population of 7,000 students and offers seventeen different engineering majors: aerospace engineering, biomedical engineering, chemical engineering, civil engineering, climate and meteorology, computer engineering, computer science, data science, electrical engineering, engineering physics, environmental engineering, industrial and operations engineering, materials science and engineering, mechanical engineering, naval architecture and marine engineering, nuclear engineering and radiological sciences, and space science and engineering. The office of the registrar does not collect any information on if a student is from a rural area.

Participants

Students were recruited from a first-year general engineering course. During the first year of study, all students were undeclared engineering majors and had not yet been admitted to a specific engineering department. The exclusion criteria were as follows: participants must be a first-year undergraduate student, be enrolled in an engineering major (enrolled in either of the first-year engineering courses), self-identify as a student from a rural community, and be over the age of 18.

This study is part of a larger study on the relationship between students' rural and engineering identities, therefore the definition of "rural" was purposefully left vague. It has been purposed that rurality is a component of identity formation [14], however, with multiple definitions and the "know-it-when-you-see-it" nature of rural communities, we felt it was important to allow students to determine for themselves if they consider their hometowns as "rural." Students who self-identified as coming from a rural area submitted the name of their hometown and high school. This information was used to classify students based on the National Center for Education Statistics School Locale Definition [15]. Students who attended schools that fit the category of "town" or "rural" were contacted for interviews.

Recruitment was conducted by posting a call for participation on the course message board and in-person recruitment. Initially, fifteen students responded to the call. Of these fifteen students, three were from a location that did not meet the criteria of "town" or "rural;" the remaining twelve were contacted for interviews. Students were sent one invitation to interview and one reminder; following those, seven students agreed to participate.

The demographic information for the seven participants can be found in Table 1. Students were assigned a letter identity A-G. All of the participants fit into the town or rural categories given by

the National Center for Education Statistics School Locale Definition [15] and are considered “in-state” students who were currently living on campus. All seven participants were 18-24 years old, single and had no religious affiliation. There were 6 participants who identified as male and one female. With the exception of student B, who was Asian-American, all participants identified as Caucasian. None of the seven participants were first generation college students. All of them had two parents with bachelor’s degree or higher and reported a household income of over \$40,000.

Table 1: Demographic information for the seven study participants

Name	High School Distance from Campus	High School Class Size	Age	Marital Status	Gender	Ethnicity	Religious Affiliation	Mother's Education	Father's Education	High School GPA	Annual Household Income
A	29 miles	68	18-24 years old	Single, never Married	Male	White	No Religious Affiliation	Bachelor's Degree	Bachelor's Degree	4.0 or above	More than \$80,000
B	166 miles	100	18-24 years old	single, never Married	Male	Asian or Pacific Islander	No Religious Affiliation	Master's Degree or above	Master's Degree or above	3.5-3.99	\$60,000-\$79,999
C	185 miles	150	18-24 years old	Single, never Married	Male	White	No Religious Affiliation	Master's Degree or above	Bachelor's Degree	3.5-3.99	More than \$80,000
D	135 miles	100	18-24 years old	Single, never Married	Male	White	No Religious Affiliation	Master's Degree or above	Bachelor's Degree	4.0 or above	\$60,000-\$79,999
E	422 miles	160	18-24 years old	Single, never Married	Female	White	No Religious Affiliation	Master's Degree or above	Master's Degree or above	4.0 or above	Unknown
F	164 miles	96	18-24 years old	Single, never Married	Male	White	No Religious Affiliation	Master's Degree or above	Bachelor's Degree	4.0 or above	More than \$80,000
G	35 miles	93	18-24 years old	Single, never Married	Male	White	No Religious Affiliation	Bachelor's Degree	Bachelor's Degree	4.0 or above	\$40,000-\$59,999

Data Collection

After approval of the study was granted through the IRB, data was collected in the fall of 2019 through one-on-one, semi-structured, in-person interviews held during the participants first semester of college. Ninety minutes were allotted for each interview and they were held in a study room on the college’s engineering campus. Participants were compensated with a \$20 gift card. Prior to the interview, students filled out a paper demographic questionnaire (Table 1) that assisted in framing the interview questions in a personalized manner. Interview questions from the thesis of Karen M. Ast [16] were specifically adapted for engineering students.

This study was designed using narrative inquiry and a lived experience framework. Narrative inquiry is a way of understanding and inquiring about the experiences of participants that accounts for the temporality, sociality and place dimensions in which they occur[17]. In this study, these three dimensions were relevant as the student participants were drawing on their past rural high school experiences to describe their current transitional experiences entering engineering school. Narrative inquiry allowed the researcher to illuminate the influences that rural culture has on a students’ perception of the challenges they are currently or have previously faced. Interview question were developed to be open ended and allow students to share their experiences in their own words.

This work was part of a larger study investigating the motivation and barriers rural first-year engineering students face as well as the formation of engineering identity. A sample of the questions developed to specifically probe the research question of this paper are as followed:

- How do you feel your high school experiences have prepared you pursue a degree in engineering?
- In what ways do you feel unprepared to pursue a degree in engineering?
- Before starting school, what was your relationship to engineering in your everyday life? Do you know any engineers who work in the field? What is your relationship to them?
- Have you faced any challenges so far as you've started school? If so, what are they and how have you handled them?

Data Analysis

Following data collection, interviews were transcribed using a transcription service. Each transcript was read multiple times in order to gain an understanding of each individual's student's experience as well as their connection to the larger collective experience of rural students. After the initial read through, the researcher used open coding to make note of the emergent themes of each transcript. Additionally, summary reports were written to capture the overall experiences of each participant, assist with coding, and allow for the sharing of information between research team members. Through an iterative process, emergent themes were grouped together and categorized. For example, lack of AP or STEM courses, and participation in dual enrollment programs were categorized as a single theme of "institutional support".

Researcher Background

Being an engineer and from a rural community, the first author of this paper is interested in learning about other rural student's experiences in the engineering education system. Attending a large university after graduating from a small rural high school, she has first-hand experiences how the culture, economy, and educational resources of individuals from rural communities might influence their transition into and motivation to pursue engineering. She is interested in learning how the experiences students had in rural communities shape their identity as an engineer.

Reflecting on her own path from a rural community to academia has sparked the curiosity and the desire to investigate other student's experiences. The authors recognize that these experiences will bias the research, however we also argue that they have allowed her to approach this study through the lens of "theoretical sensitivity" [18]. Her personal and professional experiences will allow her to build rapport with the participants in the study. She also has an enhanced ability to analyze the data and give meaning to the experiences of this population, having had many of the same experiences that the students report.

Results and Discussion

The guiding research question focuses on the experiences of rural students and what barriers prevent them from succeeding in engineering. As detailed in Table 2, five themes emerged from the semi-structured interviews: exposure to engineering, institutional support, student perception, adapting to living in a city, and social difference. Although these challenges may impact all

students starting at any university, these interviews uncover ways that rural students' first-years are uniquely impacted by their experiences.

Table 2: Emergent themes that pose barriers to engineering success

Barrier	Definition	Example
Exposure to engineering	Knowing an engineer or having participated in an engineering activity before attending university	Participating in Robotics team – "I wouldn't say, the actual, like, courses I'd take in high school prepared as much for engineering, as opposed to Robotics" –Student A
Institutional support	Outside factors influencing access to education	Lack of AP courses – "We don't have a lot of AP courses and he's the only one who's qualified to teach, AP Physics and AP Chemistry...he had to teach them every other year." –Student D
Perceptions of being underprepared	Thoughts, opinions or feelings of not receiving a strong education	H.S. comparison to hypothetical – "We do score better on standardized tests than the surrounding schools I guess, which isn't saying that much because we score about the average, which isn't like tremendous" –Student F
Adapting to living in a city	Elements related to living in a larger city	Crosswalks – "I never crosswalks for- I always have to, like, cross a crosswalk with someone else...because I don't feel confident at all." – Student D
Social Difference	Community cultural differences	Building Community - " <i>Yeah, definitely very tight-knit, where you know everybody in the community... which is crazy talking to people now, they're not used to that.</i> "-Student A

Exposure to engineering

All students reported some level of engineering exposure prior to enrolling in the engineering program; however, the perceived impact of this exposure varied greatly between participants.

Students B, D, F and G all noted that they participated in their community's robotics team and that participation influenced their decision to pursue engineering. These students all noted that their robotics mentor played a large role in exposing them to engineering, as well as helping them apply and enroll in college.

Yeah, definitely my robotics mentor... he put me in contact with the admissions' rep here, talked to them. I also talked to a couple alumni...But it made me really involved and really fostered my interest in just building things and designing things and collaborating with other teams. I think he was probably one of my biggest inspirations to become, to go into engineering. He was our school's IT consultant. - Student B

As a small rural school you wouldn't think like, 'Oh, robotics program.' That's not the first thing you think of when you think of a rural farming school. But we had a really good mentor... he grew up in a rural area, but he works, he's a chief engineering working for GM.-Student D.

These experiences highlight the importance of engineering exposure and the impact that an engineering mentor can have in the decision to pursue engineering. What is especially telling is Student G's experience joining the robotics team the first year it was offered at his school, which was during his senior year:

In high school we got a robotics team, my senior was actually the first year they did it. So I did that, and at the time I still had to pick a major, so that was by, the fall of my, uh, senior year so, I join that, it definitely shaped being an engineer.... [I did not know any engineers] Not before the robotics team. We had two of the kids parents on it, were engineers, so they helped out.

Despite his involvement in robotics and having mentors who were engineers, when asked in what ways he felt unprepared to pursue engineering Student G responded: *"I guess not necessarily knowing what engineering is like, totally, you know, I'm not like, obviously I had the [robotics] mentors who talked about what their experience was, but I couldn't really tell you what an everyday like aerospace engineer does. I'm not, so sure on that."* This student was particularly vocal about his lack of exposure to engineering, noting that *"[engineering] that's not like a typical job around where I'm from,"* and *"I don't really have any like views on what [engineering] will be like exactly."*

Two other participants expressed confusion about engineering and what to expect in college. Student C said: *"I don't know anyone too close that's a engineer. I was always confused about the, the profession until, like, r- you know, a year ago. I was like, 'What actually is an engineer?' I know you design stuff, but that was about my extent of the, the job knowledge."* Similarly, Student A noted, *"I guess, I didn't know what to expect with the classes, but, like, I was expecting to not know what to expect, so .. Yeah, I was just prepared for whatever, so I guess I wasn't- I didn't have any hard expectations coming in."*

Although these students had exposure to engineering through robotics, they still did not see engineering as a job that those in their community typically had. This can leave rural students confused about what an engineer is and what a job in engineering looks like, and can make them question whether they should pursue engineering.

Institutional Support

All seven participants spoke about the perceived quality of their high school and how it impacted their decision to pursue and prepared them for engineering. Of particular note were students' assertions that they did not have as many course opportunities as their peers at the University. Many students measured this lack of course opportunities based on Advanced Placement (AP) options at their home high school. Of the seven participants, students reported between one and seven AP courses at their high schools, which they felt was less than the other students in their course of study. Even at the high end of this range, Student A mentioned: *"So I guess, also part of that is the classes that we can take, like, the opportunities, because, you know, we only had maybe six or seven AP classes.... But then I talk to people that took, you know, 10, 12, you know, even more."* Student D noted that his school only had one teacher qualified to teach AP courses: *"We don't have a lot of AP courses and [Teacher]'s, the only one who's qualified to teach AP Physics and AP Chemistry. So, he had to teach them every other year, so one year he'd teach AP Physics and the next year he teach AP Chemistry and that's the only way we could fit in the schedule."*

A lack of AP courses can impact a student in several ways. First, AP courses afford students to enter the university with college credit, which may allow them to have higher class rank,

schedule courses earlier or even skip courses, which may in turn allow them to graduate sooner, saving money in tuition. Additionally, one student noted that AP courses are “standardized” and having AP credit made them feel more comparable to their classmates. These comparisons will be analyzed more fully in a subsequent barrier theme.

The lack of course options extended beyond AP credit. Students specifically mentioned a lack of STEM, engineering and computer science courses. As Student D mentioned previously, it is common for rural schools to offer a class every other year or only one period of the day, which can cause scheduling conflicts as in the case of Student E:

I had, like, an online physics class in high school, and that was it. Because the physics class we offered in person didn't fit my schedule anywhere in high school. And I know there's a lot of physics in engineering, so I, I'm a little bit worried about when I take the physics courses here, how, how difficult it will be for me versus the people who had had physics in high school.

Students also mentioned computer programming as a course they wish they had an opportunity to take. Student C recognizes now that coding is an important part of engineering courses: “*I feel like, we didn't offer any programming at all. I'd never really touched programming, but now it's like such a big thing.*” Student G mentioned how he is spending a lot of his time learning that skill that one student came in with.

'Cause I know a lot of people had Computer Science classes, even in high school, and I just never had that way, I never got that chance.... No. Like in high school we didn't have any coding classes at all, so this semester's been a lot of learning, how to program.

Several of the students also participated in dual enrollment programs for college credit, or special programs for advanced math and science, however these programs offered challenges of their own. Student A notes how although this was a good experience, a lack of understanding prevented them from taking advantage of the college credit option offered by his high school

I guess my school paid for the, any college classes that we did. So it counted for high school and college credit....they do transfer to some schools. I kind of messed up, because I didn't know what I was doing a little bit. So most of mine didn't transfer here...they technically do transfer here, but if, since I took them online they don't, because that's just, University specification. They have to be in person.

Student B also spoke of a similar instance where participating in an advance math program caused a challenge at their high school:

They didn't want for me to take the extra Math program, it required me to not be at the school for two hours and the school loses funding for that. So the school is very against that...all of their staff was against it. And then when I started doing the program, they had this huge school board meeting, which I had to attend where they were like, "Hey, we're gonna start charging you even more to go there." And I'm like, "Well, I can't afford

that." So it's like, they kept doing all these things to try just make you like the regular student...And it felt like a lot of time, just dealing with the people was very rough.

Finally, many students talked about how they overcame the lack of institutional support through participating in community STEM activities such as Student D who, when asked how high school prepared them for engineering, responded: "Um... [I think of something that's] not really a part of the high school, it's actually separate, it's FIRST robotics team-... I wouldn't say the actual courses I'd take in high school prepared as much for engineering, as opposed to the FIRST." Still, others mentioned seeking out their own opportunities to prepare themselves for engineering such as Student C:

I've watched a lot of YouTube videos on engineering or just different, like sciences in that sense. But I hadn't really done much actual, you know, engineering of things... I've definitely taught myself a lot. A lot of stuff like the upper level material and when I was doing that dual enrollment, it was a little tougher.

Many of the students talked about this "learn-it-yourself" mentality that the lack of institutional support instilled in them. It was common for students to frame attending the University as an opportunity to take advantage of abundant resources that were not available to them in the past.

Student Perceptions of Being Underprepared

One of the largest barriers to emerge from the data was student's perceptions of their experiences and abilities and that they were underprepared. This is distinctly different than the tangible resources available to them, in that these perceptions do not relate to factors that are external to the student experience. Specifically, every participant made a comparison, either of themselves or their high school, to a hypothetical "average student" or "typical high school". Student A made reference to this hypothetical when describing the size of his high school:

There's a lot less people than normal in our school size. There's probably about 400 in our school. So I guess, normally, it's based off of that just because the smaller schools tend to be in more rural communities. I guess there's not, for me, there's not a definite like outline of the number or something, but I definitely consider my school to be on the smaller side.

Further, in each of these comparisons, the students' experiences are always framed as lacking in some capacity.

Feeling "behind" was a common theme among many student's comparisons of themselves to their classmates. Student A made note of this as they talked about the need to catch up to their classmates, "I think just, you know, I was prepared enough to get me by, but I'm still catching up, I feel like, sometimes, compared to other students." Student D mentioned that the feeling of being behind made him worry about future courses:

Yeah, I feel, there's a lot, there's a huge feeling of unpreparedness because, I've talked to some friends who are, they are already, in these super high level courses and stuff and they know a lot already coming in and I'm sitting in, my calculus 115 course because we

didn't have that good of a high school math program and I'm just like, "Oh wow, calculus sounds really scary, but I'll get there in, like, a year and a half." I kind of feel, like, I'm behind everyone,- Student D

Student B elaborated beyond course work, to include that it felt like their classmates had already figured out their futures.

So it's kind of overwhelming. I just feel like there's all these people that are like, they definitely know what they wanna do and they're so set on that track and they're so far ahead already. 'Cause I feel like I'm lacking behind a lot....I feel like compared to my school I'm very far ahead, but compared to other people around the state, around the country, I'm very behind. I just don't know as much. I don't have skills in engineering as well as other kids might. Um, especially with how [University], picks kids compared to other school. So like me being the best of my school is nothing compared to the kid, coming from a high end School who's the best at his school. I feel like there's a giant gap there and I'm just not extremely, comparable to him or her. -Student B

This leads to the next comparison theme that was identified: students often referred to the “big fish, small pond” mentality, or the idea that these students used to be the smartest students at their high school and are now feel that they cannot “compete” with their classmates and thus become a “little fish in a large ocean.” Student E said:

I was in the top of my class at my high school, and so coming here and being in, within the top of the top. Like I, it, it's hard to get used to not being at the top anymore and, um, just being ready to like, not always pass exams and stuff and that was definitely a shock.

Although the “little fish in a large ocean” mentality was a challenge that needed to be overcome, two students mentioned they now see it as a positive step toward being a successful student:

But it's really interesting. I definitely remind myself each day that even though I'm the smartest from where I came from or I'm one of the smarter ones than where I came from, I'm definitely not the smartest everywhere. I'm definitely not the smartest here nor will I be where I work, but that's okay. And helps me think that it's just doing the best I can. - Student B

You know the whole big fish in a small pond thing? Yeah, that was kinda my situation, and I knew I was coming into a place where I'd just be middle of the road, and I was kinda worried about that, but like it's actually been really nice because there's been a lot less pressure from others, like from others, or from my reputation to do certain things. - Student F

As Students B and F demonstrate in the above quotes, another common theme among all participants, was framing their “lacking” experiences as “it could have been worse” or “we were fortunate to at least have this opportunity even if it wasn’t the best.” This theme was very prevalent when students compared their high schools to the hypothetical high school they constructed (unprompted). For example, Student E said the following about her high school teachers: “Um,

well we did have some pretty good math and science programs. Our, math teachers and our science teachers in our school were probably the best that we could have asked for in our area.”

This student recognized that her teachers were good teachers, however, if she was living in a different area, (suggesting an area that is not rural) she may have had higher quality teachers. Student F shared a similar sentiment about his “average” school:

Teachers were actually pretty good I have to say as, as a whole sup- surprisingly for a, for a smaller school they ... We do score better on, um, standardized tests than the surrounding schools I guess, which isn't saying that much because we score about the average, which isn't like tremendous, but it is better than ... So we're like one of the better academic schools in the area I guess

Although some students were able to frame the struggles they faced moving from a small rural high school to a large engineering school in a positive light, it is worrisome the impact this may have on their confidence, self-esteem, and ability to persist in the program. For example, Student F asserts that his school is average based on standardized measures, meaning that his school meets the requirements of a quality education, however, he still perceives the school as falling short of the standard he perceives.

Adapting to Living in a City

Five of the seven participants noted that there were specific challenges they faced moving to a larger city for school. These challenges ranged from figuring out how to meet basic needs in a new setting, to emotional distress that they needed to overcome.

Student E talked about the shock some of her classmates had when she shared about her “outdoorsy” eating habits:

We eat all this wild game and then, when I mention it to people, they're normally, like, 'Wait. You, like, actually eat that stuff?' I'm like, yeah! I normally eat more wild game than I do beef or chicken at home. Which I guess to some people is not normal, but from where I am from, that's just the norm there's a lot of, like, vegetarians and vegans here. And I'm used to eating, like, wild game all the time, and I'm like, 'you guys don't eat any meat?' Like I'm used to eating bear and venison and duck and all these different things that people from other areas are like, 'you guys actually eat these things?' So... Yeah, that was a little- It's a little weird going to the dining hall and not knowing exactly where these things are coming from because I always knew where my meat was coming from.- Student E

Student D shared several examples of tangible differences between his hometown and new college environment that were particular challenging to get used to. The first challenge he expressed the need to overcome was the number of people:

Something that was difficult for me was just all the people. Because that was just a whole lot of sensory overload for me and being in an environment with that many different people is really like, 'Oh my gosh, this is overwhelming.' And that whole overwhelming

feeling really knocked me over a lot when I was first getting here and I couldn't handle it all.-Student D

He went on to share how he overcame this challenge by slowly exposing himself to new environments: *“Slowly, I'd go to Central Campus and just walk around for a while and with these large groups of people a little bit at a time....I think that's kind of helped me adapt.”*

One note about this student's experience, the university campus is divided into two, Central Campus which is near the city's downtown, and a campus a couple miles away referred to as North Campus. The majority of first-year courses are on Central Campus, however all engineering facilities are located on North Campus. Student D gives the following descriptions of the two campuses:

North Campus is always really quiet and serene, there's a lot of nature. Where Central Campus there's more just, concrete, lots of people and more cars running back and forth, constructions everywhere. I think that's the big difference, there's, noise. There's more animals on North Campus. Because the only thing on Central Campus that's living is, like a squirrel.

The student expresses that they live on North Campus and enjoys it, despite his classmates perception of it. *“I'm living on North Campus right now, which I'm glad for even though some people would complain, ‘Oh, no it's awful.’ And most of your classes is on Central, but it's a lot less noisy”.*

Finally, the Student D shared two stories that uniquely frame the challenges he faced when moving to a larger city. First, he spoke about learning to navigate the city on his own:

..in general, getting used to the city. I never [use] crosswalks- I always have to cross a crosswalk with someone else or already leading because, I don't feel confident at all. Because crossing a road where I come from, when the person's coming, they're not going to stop for you... So, I'm always worried. It's like, "I'm not going to cross this crosswalk until someone else goes." I'll just stand around on my phone pretending I'm not paying attention and then I'll cross when they cross.

Finally, Student D shared about the guilt he sometimes feels being the child of farmers who had previously relied on his support tending to the animals on his family's farm:

I do feel, some tension because I was, the last kid working at the farm for my parents. And I was a lot of the manual labor, so, it's a lot harder for them, to work with all the animals and stuff- It's a lot slower for my mom. And my dad needs me because, his- his back's not too great, so, I help him out with a lot, getting down low and working under some equipment. So, that's one thing I feel kind of guilty about for going to college, is, I'm just, kind of, leaving them.

These are just a few of the examples of situations unique to rural students. It is important that educators recognize that students from rural communities may be dealing with issues navigating their environments and these challenges could impact their ability to learn.

Social Difference

The final theme to emerge from the data were the social differences students perceived between themselves and their peers. All seven participants described their home community as a place where “everybody knows everybody else”. Student A said this was very different from the experiences of their classmates, “*Yeah, definitely very tight-knit, where you know everybody in the community. You know, I know everybody in the grade, and then the grade above, grade below, which is crazy talking to people now, they're not used to that.*”

Student E shared a similar sentiment commenting when at home, “*I can go to the store and I'll run into so many people. I have to plan for extra time whenever I'm going anywhere. I run into people and talk with them for a while.*” Later in the interview, they shared that being on at a large campus “*it's very easy to feel like just a number in the class*”. This student shared the desire to make campus feel smaller by joining a living learning community called “WISE” Women in Science and Engineering. This alleviated the intimidation they felt when taking large classes.

“My chemistry class is a very large lecture hall. Going into that first day was a little intimidating, but then I looked around, and there were at least three other girls from WISE that were also in that class. So it was nice to know that no matter which class I'm in, there's always one person that I know already that's just there to support me and I can support them.” -Student E

Many of the students shared that arriving at college was the first time they had to make new friends:

“You just don't make new friends in high school. I mean that's just, like, at a small community that's just how it goes. Like even my friends that I hung out with since, you know, elementary school, all the same people, and you can't really change it if you, like you could if you really wanted to, but they're always still there.” -Student A

Student B expressed that growing up in a town where everyone knew him, made it hard to make friends once they arrived at college. “*Yeah, so growing up where everybody just automatically knew you versus coming [here] and like nobody knows you. It's, it's really crazy 'cause I find it harder to make friends.*” He said that he found it hard to share experiences with his classmates and he felt they were better equipped to participate in clubs and class.

“But sometimes where it's like I can't share these same experiences with [my classmates] of like walking down in this metropolitan area, walking down town like that and doing, this amount of community service 'cause we didn't have a lot opportunities for that. [Or] having all these opportunities, especially going to huge competitions where our sports teams are super successful because our team wasn't. It's just crazy. Or like, fitting in. I

feel like all these people that come from larger schools, they're able to fit into clubs better...They're able to fit into, classes better.”-Student B

Finally, all of the participants noted that their hometowns were majority white, Christian and conservative. Many of them spoke of culture shock moving to a more progressive, open minded environment where they were introduced to new cultures and increased diversity. Student D summarized the struggle well when speaking about the friends he has made in college: *“Another big thing is a lot of my friends I talk to right now, the do not have to worry about cultural knowledge and stuff.”* He elaborated to explain how his friends have been exposed to other cultures and do not have to navigate diversity as a new experience.

Student G expressed dealing with culture shock and the need to learn to be more respectful of differences. In these quotes, Student G struggles to put words to this experience but shares that attending school was the first time they experienced these differences and now they have come to value them.

But, I know a lot of people talk about like culture shock, you know, you can't meet a lot of diversity, that hasn't really been a big deal. It's not, you know, I'm fine with everything, like, obviously a few times it's like, things are just like done differently here I guess. Like you can't say as many things, you know, and not in like a bad way, but just like, you gotta be more respectful here, more, I guess, understanding of what people, uh, do or say, or like, what their beliefs are.... And I don't know, it's, it's good. I don't know much about, like, I said, it wasn't really a culture shock, but it was just, I don't even know how to describe it. It's just different. You know, there's different people, you gotta be more respectful about who they are and what they do. Uh, I mean, I think it's great. It's awesome. -Student G

Uh, I mean like when I came for orientation, they, like everyone talked like, they introduced themselves with their pronouns. That's-... a big thing. I'm like, Whoa. Like, I've never heard anyone do that, or say that so, I mean, I wasn't used to that. That's a big thing. I mean, that's, that's proba- I mean, just little instances like that, where it's not like a big deal-... but it's just a different-... yeah, uh, to adapt in, you know, it's not like a problem at all, it's-... just different. -Student G

The “likes”, “ums”, and pauses were purposefully left in these quotes because they emphasize the sharp transition rural students face when moving to a more diverse environment and how difficult it can be to talk about the challenges it poses. It is likely that students from rural communities have never been confronted with issues of multiculturalism, social justice, and inclusion. It is important that universities recognize this contrast and meet students where they are, in order to foster an environment of growth rather than divisiveness.

Study Limitations

Participant recruitment was a major limitation of this study. The selection criteria was purposefully left open-ended (i.e. allowing students to self-identify as from a rural community), because this work was part of a larger study where the definition of rural was probed in order to explore the interaction of engineering and rural identity.

In future work, it would be advantageous to do targeting recruitment in order to hear voices from students with more various experiences. Specifically, speaking to more students who are first generation or have backgrounds with lower economic status would better aligned with the typically reported rural demographics. Additionally, as the only non-white participant, Student B shared valuable insight to being a minority in his home community. Although Asian-Americans are not considered an underrepresented minority on the University campus, this conversation reveled a dimension of background that may not often be considered. Finally, only one female student participated. Previous work has suggested that the rural females are more likely than urban females to restrict their career choices to female dominated fields and in turn, rural females who enter engineering show larger degrees of motivation and self-confidence [5]. Having a larger number of female participants would allow to probe this theory further and confirm the quantitative trends with qualitative experiences of female engineers.

Conclusions and future work

This study explored the lived experiences of seven first-year students from rural communities to uncover barriers and challenges they face in the pursuit of an engineering degree. Using narrative inquire, we identified five themes that pose barriers for students transition into an engineering course of study: exposure to engineering, institutional support, perceptions students have about themselves and their community, adapting to a new city environment and the social differences between rural students and their classmates.

The data has also given us insight into the ways rural students overcome obstacles. Many students noted the need to “do things themselves” and that college was an environment where they felt they could take advantage of opportunities they did not have in the past. This description of overcoming academic hurdles, should be probed further. In the future, it would be advantageous to explore the experience of rural students from the lens of resilience, persistence, and self-efficacy.

The barriers addressed in this study can help give educators insight into the unique challenges rural students face and ways to support them in their purist of an engineering degree. By understanding the struggles that rural students are facing, educators can help them better navigate the educational system and achieve greater success in engineering.

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