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Preliminary Themes about Engineering Identity and Community Developed from Longitudinal Interviews

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Shaylin Williams is invested in figuring out ways to improve the engineering education experience for future generations of engineers. She completed her Bachelor's in General Engineering with a Business Administration Emphasis at the University of Mississippi in May 2020. As an undergraduate McNair Scholar, Shaylin participated in several research projects. She worked on two projects in a chemical engineering lab related to creating thermal barriers for food packaging and soil remediation. She also completed an REU project in the area of healthcare engineering at the University of Wisconsin- Madison. Shaylin is currently pursuing a Ph.D. in Engineering Education at Mississippi State University. She is working on a partnered longitudinal study researching how varying first-year experiences (FYE) structures affect students' engineering identities and involvement in communities of practice. Shaylin is interested in figuring out what contributes to engineering students getting the most out of their undergraduate programs and how programs can be better designed to cater to those needs.

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Overview

To best support a range of engineering students, it is critical to understand how dissimilar first-year engineering (FYE) experiences impact students pursuing degrees through various matriculation pathways. FYE experiences often provide a foundation for success in engineering degree programs by introducing students to the field of engineering, helping students become acclimated to their chosen undergraduate institution, and more. Accordingly, experiences gained through differing pathways (e.g., FYE programs, transfer programs, major specific courses) impact students' community and engineering identity development in different ways during the first year and beyond.

Nationally, there is no standard format, content, or timing with regard to FYE experiences. However, engineering education researchers have created ways of classifying FYE differences (e.g., [1], [2]). We used those existing classifications to identify diverse engineering pathways and understand how those pathways impacted engineer formation with respect to participation in engineering communities and developing engineering identities. The knowledge our work generated is critical because participation in engineering communities and a strong engineering identity are positively related to student recruitment and retention [3]–[6]). Through our research, the engineering education community, specifically FYE administrators and instructors, will be better able to support and retain a range of engineering students regardless of pathway to or through engineering.

The research question guiding this paper was "How do divergent FYE experiences affect engineering identity and community?" This paper pulls on data gathered through a collaborative research project funded by NSF through the Division of Engineering Education and Centers. The collaboration was between two universities which employed different FYE experiences (common first-year program and direct matriculation approaches as defined by Orr et. al [1]). Additionally, students from two additional institutions (a regional campus with a common FYE program and an engineering branch campus with post-general education FYE structure) were included in the study. In this paper, we highlighted the experiences of ten students only from the common first-year program and direct matriculation pathways whom we interviewed during their sophomore, junior, and senior years to highlight the specific similarities and difference within these programs related to community and identity. Our aim was to determine and better understand the key longitudinal impacts of different FYE pathways. We expected there to be commonalities among students following similar pathways into engineering education. However, we acknowledge students' unique experiences.

Theoretical Framework Overview

This study employed Lave and Wenger's theory of communities of practice [7] to conceptualize community and identity. We operationalized engineering communities broadly to be the formal and informal groups that students participated in throughout their undergraduate careers. We were particularly interested in how these general communities, especially those which fit Wenger's definition of a community of practice, influenced engineering identity development.

The definition comprises a community that has mutual engagement, shared repertoire, and joint enterprise. In general, engineering communities have previously been shown to be important for engineering identity development [4], [8]. Therefore, we investigated how engagement with engineering communities, particularly those that have the elements of communities of practice, impacted engineering identity development for students of various pathways. Examples of communities of practice that our participants engaged with included teams such as design build competition teams and student government organizations. In our work, we initially conceptualized identity, specifically engineering identity, broadly using Gee's identity framework [9] along with the expanded definition from Weiner, Lande, and Jordan [10]. These frameworks were used throughout the analysis of the qualitative data, but in keeping with our constructivist paradigm and qualitative methodological approaches, additional definitions of community and identity were allowed to arise from the data based on the participation perspectives.

Participants

For this paper, the participants were enrolled full time at one of two participating institutions. Both institutions are large, land-grant institutions. Institution 1 is located in the rural southern United States, whereas Institution 2 is located in the urban midwestern United States. Participants were from a variety of engineering majors, and the majors varied across institutions. Participants' matriculation pathways at Institution 1 were direct-admit with discipline-specific introduction to engineering course, and at Institution 2 participants took part in a first-year engineering program with common introduction to engineering course [1]. The matriculation type varied based upon the participant's institution of enrollment. All of the participants included for this paper were recruited in 2018 and completed subsequent interviews in 2019 and 2020 for a total of three interviews over three years (generally from their sophomore to senior years).

Data Collection

A series of semi-structured interviews were conducted in the spring semesters of 2018, 2019, and 2020. Data was collected and stored for all three interviews for each participant to track any changes or developments throughout the duration of their engineering programs. The participant, one interviewer, and one note taker were present for each interview. The interviewer obtained consent and facilitated the interview following approved IRB procedures. The interviewer was trained to focus on active listening and showing interest such to engage the participant in the interview conversation. The note taker was charged with tracking details of the participants' responses to ensure follow-up questions were asked as needed at all necessary points to answer the research question that guided this work. Each interview was recorded and audio recordings were converted into transcripts via online transcription. All participant names and any other identifying information were replaced with pseudonyms and deidentified fillers. The transcriptions were cleaned and compared against the audio recordings to correct any errors resulting from the initial transcription.

Data Analysis

Using a codebook specifically designed to pinpoint key information related to communities of practice and identity within engineering, transcripts were collaboratively coded using Dedoose. While some codes were *a priori*, others were generated directly from the data during. Memos were created to highlight key information about each participant and to provide a "snapshot" or summary of each interview. This process was guided by the work of Lee et al. [11] and is described in more depth in our previous paper [12]. The research team engaged in meaning making meetings in order to compare findings from the coded transcripts and written memos. Both direct quotations and research interpretation were used as supporting evidence in the memos. Themes were suggested by individual team members and each suggested theme was discussed by the group in order to determine prevalent, common themes. Once the primary themes were agreed upon by the team, individual members mapped the themes to specific codebook items.

Themes

For this paper, we focus on findings on the three primary themes from our analysis. Our first theme was that engineering identity must be claimed by a student, and engineering identity is often claimed after an influential engineering experience. For example, one participant said they were an engineer (claimed engineering identity) only after completing a summer internship with an engineering firm where they performed engineering tasks (engineering experience).

"*I think prior to working at Disney I was still saying, "Yes, I'm an engineer" but it was more to convince myself. I think once I made it to Florida I was like, "Wow, I can really do this. Yes, I am an engineer." It was somewhat gradual I would say. It was building up ever since I first got to [Institution 2], and then once I hit like of course Disney I think it kind of pushed me to say, "I can do this" and I saw that potential in myself."*

Another common theme we identified was that participants attempted to find a "subpath" to make engineering "fit" if engineering was not naturally aligned with their current identity. For example, one mechanical engineering participant talked about being an "entertainment engineer," which allowed her to merge her identification with theater with her engineering expertise.

"*I feel like I feel more like an engineer working in the theater than I did before... Because I do feel like I have a lot of times that I'll go in and it'll be like, "Okay we want to make this, how do we do that?" And then I feel like I'm able to be like, "Okay, well we made this other thing and that kind of worked." I guess just I feel more able to creatively problem solve in the way that I feel like an engineer's supposed to...Because I feel like even people who work in the traditional STEM fields have to be creative."*

This theme was especially prevalent for participants who reached a point in their major where they believed it was "too late" to switch out of engineering.

Lastly, the opportunity to make a choice impacted participants' identity. Engineering identity was generally stronger for participants who believed they made their own choice to major in

engineering. On the contrary, participants who talked about choosing to major in engineering and staying in the engineering major because a parent "made them" or chose for them rarely claimed a strong engineering identity. For example, each year we asked participants "Are you an engineer?" One senior engineering student in their third interview still did not claim a strong engineering identity. Their response was to "Are you an engineer?" was "*Oof. Ah. I guess."* The participant had previously explained significant family pressure.

"I think I was pressured by my parents a little bit to go into a STEM field just because they have the mindset of there's no money in [theater]. And so they wanted me to be able to take care of myself and so that's why I chose [engineering] in the beginning. And then I kept kind of being like, oh, well I'll like [engineering] when I get to... It's like whenever I came to school I was like, well I'll like [engineering] whenever I get into my higher level classes because this is just the gen eds, I'll like it better later. And then I got to the higher-level classes and I was like, well I'll like [engineering] when I get a job and it's real-life application, I'll like that better. Then I got an internship and I was like, well now what I do, I still don't like [engineering]."

The participant remained in engineering and graduated, but was looking for ways to combine theater and engineering. The student planned to pursue a graduate degree in technical directing.

Discussion and Future Work

While the themes manifested themselves in similar ways across the two institutions, one theme highlighted differences between institutions with respect to matriculation pathway (direct versus common first year program matriculation). The common first-year students described limitations in their choices for majors after they completed their common first-year experience. Common first-year engineering students had to apply to and be admitted to engineering majors. Limitations occurred due to competitiveness for engineering majors as part of the engineering major application process. This affected the strength of students' engineering identity during athe time between first and second year, a particularly pivotal moment for retention [13], [14] Some participants did go on to find enjoyment in their new major but some tried to find a way (e.g., through a "subpath") back into the discipline they originally wanted to be in.

Finally, we note that, consistent with current literature [15], [16], our participants highlighted a strong positive correlation between the amount of hands-on engineering experience a student received (through internships or research) and the strength of their engineering identity. Students who did some type of engineering "work" felt more like an engineer and were more confident in their abilities than students who simply took all of the required engineering courses without getting experience outside of the classroom. Working alongside professionals in their fields helped students realize that they really were (or could be) engineers.

Our analysis around these themes, across the pathways, and over the longitudinal interviews continues. At this time, we are noting unique differences and similarities across pathways, but we are interested in looking more deeply into individual student's stories to uncover specific examples of impactful communities related to engineering identity development.

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