

A Narrative Approach to Understanding Underrepresented Students' Pathways Into Engineering

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Abstract— This work-in-progress research paper begins to explore stories told by 12 diverse engineering undergraduates about how they chose engineering as a major in their studies. The students were interviewed during Fall 2016 about their pathways into engineering, their identities, and their belongingness in engineering. The participants were selected from a pool of students who completed an attitudinal survey during Fall 2015. They were purposefully recruited to maximize the number of women, students of color, first-generation students, students with visible and nonvisible disabilities, and LGBTQ+ students. These attributes were self-identified by students, and, in this work, we report them in their own words and in rich detail rather than binning students into fixed categories. We focused on multiple intersections of diverse and underrepresented identities to uncover and explore the counter-narratives that these students co-constructed with the researcher to answer the question, “What are the converging and diverging stories about particular influences on diverse students’ choice of engineering in college?” We used narrative methods to identify where student stories share similarities and differences to understand some of the pathways underrepresented students take into engineering. These stories may provide insight into recruiting and supporting other diverse students.

Keywords—*narrative approaches; diversity; engineering pathways*

I. INTRODUCTION

Significant research, both qualitative and quantitative, has been conducted to understand students’ pathways into engineering to improve recruitment and retention of diverse students [1], [2]. Despite these efforts, the number of underrepresented students in engineering has not increased dramatically [3]. Often research on diversity in engineering has focused on comparisons of men and women or majority students and minority students. These comparisons either over represent the responses of white students or men due, respectively, to the fact that engineering consists of mostly white, male students.

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More recent research has focused on the intersections of multiple identities, but still often explores only gender and race. Our work explores the stories of students with demographic diversity along multiple lines.

The goal of this work-in-progress study is to begin to tell the stories that are counter to or often hidden by the dominate narrative in engineering. Many studies highlight a deficit of underrepresented students including lack of confidence or self-efficacy for women [4], lack of academic preparation for students of color [2], or lack of social capital for first-generation students to name a few [5]. Our work moves to take an assets-based approach in co-constructing and understanding students’ narratives that would be overshadowed or unheard in other approaches. This “voice-centered interpretation” is a first step in understanding the value these students bring to engineering and the ways in which their multiple identities interact within the multifaceted social structures of college life and more specifically, engineering education.

This research is part of a larger study exploring how students with diverse attitudes navigate their pathways through engineering programs. We surveyed 2,916 students from four different institutions. From those surveys, 12 students who self-identified as an underrepresented student (women, Black, Hispanic, and American Indian and Alaska Native students, students with disabilities, and LGBTQ+ identifying students [6]) were purposefully sampled to participate in semi-structured interviews focused on students attitudes in engineering and how their intersecting identities impacted their experiences in engineering.

A. Research Questions

From those interviews, we begin to answer the following research questions:

- How can the stories of traditionally underrepresented engineering students be used to support diverse students in engineering?
- How do their stories converge and diverge?
- What assets, or capital, do students from diverse cultures and communities that are underrepresented in engineering bring to the classroom and the university?

- Does the intersectionality of underrepresented students' identities present itself within their stories, and how does it play into their engineering pathways?

II. THEORETICAL FRAMEWORK

To answer these research questions, we use three theoretical frameworks to explore diverse students' pathways in engineering using a narrative approach: narrative inquiry, intersectionality, and community cultural wealth.

A. Narrative Inquiry

Narrative inquiry is both a theoretical frame as well as a methodology [7] that places value in the socially constructed stories of individuals. Bruner explores the value of narrative in his book *Actual Minds, Possible Worlds* [8]. Bruner describes narratives as "good stories, gripping drama, believable (though not necessarily true) historical accounts" (p. 13). Bruner also claims that narrative is one of two forms of knowledge, the other being paradigmatic. Although Bruner looks at narrative as a mode of thought, narratives also have a relationship with sociocultural theory. Narratives have also been described "as socioculturally situated tools that are used ... to make sense of ... experiences and, therefore, to give them meaning" [9]. A narrative approach provides a way to acknowledge multiple identities and experiences in students' own stories. By valuing and collecting the narratives of the individuals traditionally underrepresented in engineering, we provide a voice and forum for their stories to be heard.

B. Intersectionality

Intersectionality has its roots in critical theory and began with Crenshaw who explored the intersectionality of both gender identity and race identity, noting that with the combination of multiple identities is a unique identity [10]. She explored intersectionality of race and gender primarily focusing on how it appears within the justice system. Intersectionality has also been used within the engineering education research with the exploration of engineering identity and how it intersects with other identities; the observation of the effect of the intersection of gender and race on engineering professional skills [11]; and the application of intersectionality along with community cultural wealth theory and identity theory by categorizing Latinas/os engineering identity through an ethnography and survey based research design [12]. These examples help to show the applicability of intersectionality to the study of persons with different community and cultural backgrounds.

Because the population studied represents a purposefully sampled diverse group of people, who bring with them multiple identities, a holistic examination of how multiple identities provide particular affordances and challenges for diverse students is necessary. To apply intersectionality, we use the concept of "lens fatigue." This concept acknowledges the overwhelming experience of attempting to navigate multiple identities such as gender, age and ability [13]. The guiding principles behind this framework include power, reflexivity, time and space, diverse knowledge bases, social justice, equity, intersecting categories, and multilevel analysis. Although this

"lens fatigue" was developed for the medical field, this framework provides a valuable way to understand diverse student experiences across multiple identities.

C. Community Cultural Wealth

Community Cultural Wealth (CCW) theory seeks to provide an assets based approach when examining the different cultures that people bring with them into an organization. CCW theory also has roots in critical theory, more specifically critical race theory (CRT) [14]. However, while CRT often focuses on systematic disadvantages, CCW "focuses on and learns from the array of cultural knowledge, skills, abilities and contacts possessed by socially marginalized groups that often go unrecognized and unacknowledged" [14, p69]. CCW examines different parts of cultural identity as capital or funds from which an individual can draw from for success.

Yosso [14] discussed six types of capital: aspirational, familial, linguistic, navigational, resistant, and social. Aspirational capital refers to a positive outlook for the future, even when there are barriers. Familial capital includes family and community fostered cultural knowledge. Linguistic capital refers to both the social and intellectual skills through learning more than one language or way of communicating. Navigational capital includes the skills that help to trek through social institutions. Resistant capital refers to skills refined through challenging unequal treatment and social structures. Social capital includes community resources. All of these sources of "capital" contribute to community cultural wealth. Instead of looking at underrepresented groups as deficient in some way, this framework allows the researcher to identify capital that diverse students bring with them to the university.

D. Combining Theories into a Framework

The combination of the above listed theories is what shaped the framework, or lens for answering the research questions. Yosso [14, p69], who developed the community cultural wealth framework, described the theory as a "critical race theory (CRT) challenge to traditional interpretations of cultural capital". She described CRT as a way to examine race's impact on social structures. Intersectionality theory came from a combination of CRT and feminist theory, specifically, not adequately describing women of color, who have unique identities through the intersection of gender and racial identities amongst others. Critical theory can be seen more transparently through some of the subparts of CCW and intersectionality. Critical theory seeks to influence change through bringing to light the structures that continue to oppress the disenfranchised. Exposing this hegemony is a form of resistance, similar to the resistant capital that is referenced in CCW theory [14]. Intersectionality is influenced by social justice and equity as well as power dynamics [13], [15] which connects it to critical theory. This linked lens established the framework by which the stories will be collected, co-constructed, and analyzed.

This blending of theories provides a unique way of looking at the stories of those traditionally underrepresented in engineering. Combined, intersectionality and CCW both acknowledge that an individual is not just a sum of their parts, but each brings a unique and valued set of assets. Those assets can be lost in large studies where the voice of the

underrepresented are not the focus. A narrative approach to these frameworks aids in the creation and analysis of stories to examine and challenge university policies and structures.

III. METHODS AND METHODOLOGY

A. Research Design

The underrepresented students that are part of this study were purposefully recruited to maximize the number of women, students of color, first-generation students, students with disabilities, and LGBTQ+ students. Riley, Slaton, & Pawley [16] identify that much of the research used for diversity uses statistical approaches and counting to show improvement, but doing so lacks depth. Therefore, this research intends on using narrative methods to reveal the stories of individuals who are part of underrepresented groups in engineering.

B. Data Collection and Procedures

Data were collected through semi-structured interviews which were audio recorded. Those recordings were professionally transcribed. After transcriptions were received, they were “cleaned” to remove personally identifiable information and all names were changed to pseudonyms chosen by the participants. Additionally, the transcriptions were checked for mistakes and to ensure that the participants voice was not lost through transcription choices. The research described in this work in progress is part of a larger in progress study for an NSF CAREER grant, but this analysis is only concerned with the student’s story that is parsed together through combining responses to questions such as: Tell me about yourself? How did you get into engineering? and other questions that stemmed from their responses. These questions are open-ended and prompt students for a story. The responses of the students to the above questions generate rich detail that allows for a narrative approach to the data and the construction of their stories.

C. Plans for Analysis

Stories are at their heart socially constructed from both experiences and from the social context [17], [18]. A distinct form of qualitative research is narrative research. Like most qualitative approaches to research, narratives allow for great depth within the experiences of the research subject at the cost of generalizability found within quantitative research. Narrative research is used when it is desirable to tell the stories of individuals willing to share them [19], [20]. “Patients, analysts, natives, and subjects recount the events of their lives and narrate them into temporal order and meaning and physicians, analysts, fieldworkers, and re-searchers, in turn, narrate their versions of those lives in their clinical case studies, research reports and scientific treatises” [21, p161].

Shared stories are told through many forms of narrative research, and some examples of different forms of narrative research include: autobiographies, narrative interviews, oral histories, ethnobiographies, autoethnographies, testimonies and personal documents amongst others [20], [22]. In narrative research, the story or collection of stories is the data used for analysis [23]. This data can come from one or more individuals

[21]. After the story, or stories are collected, they are analyzed by the researcher and then retold, or re-storied, in a way that may be more chronologically organized than the original way the story was told [24]. Additionally, the stories can be coded to add depth to the understanding of individual experiences [25]. Analyzing the narratives of students allows their voices to come through within the research, giving the underrepresented a voice.

In narrative inquiry, both the researcher and the participant co-construct the stories that are told. For the purpose of this analysis, we intend to review and retell the stories with two lenses. The first lens is that of intersectionality, which looks at a person as more than the sum of their individual identities. The second lens is that of community cultural wealth (CCW) which considers the value of an individual’s culture in shaping their identity and their community. Finally, these re-storied accounts will be shared with students for member checking for additions or concerns.

The role of the researcher within narrative research is to act as a narrator, weaving and shaping intertwining storylines to make a cohesive whole. The researcher must also ensure that they, to the best of their ability, do not betray those participating in the study. As white and cisgender authors, we acknowledge that we come from a generally privileged perspective, rarely underrepresented within power positions. We know that this background has the potential to limit our perspectives within the data analysis. However, we believe in creating diverse and inclusive environments for engineering students to learn and grow, and it is this belief that inspires us to research these underrepresented students.

IV. ASHLEY’S STORY

The following is only one of the twelve participant stories that have been re-storied so far.

Ashley is from the Midwest. She grew up as a twin with younger siblings. Her twin brother and she are a lot alike except he excels at writing, while Ashley excels as science. Growing up, she would find herself doing engineering projects such as coming up with a more efficient way of raking leaves; finding a different way to build a pillow fort; and even cooking. When growing up, her house was full of loud talking. When her mom would call out from the kitchen to living room, Ashley would have a difficult time hearing her.

I’d be like, “Mom I know you’re talking in the kitchen but I’m in the living room and I can’t hear you.” And she’d just be like, “You’re selectively hearing.” I’m like, “Maybe, maybe not.”

Her parents knew she was hard of hearing, but they didn’t know how difficult it was for Ashley to hear. When Ashley started school, she acted like every other kid. She knew she had a hard time figuring out what people were saying, but compensated in many different ways.

One day, Ashley was pulled out of class. The teacher said she did not think that Ashley was hearing her correctly. While standing in the hallway of the school, Ashley was first told to repeat what the teacher said. Then she was told to cover her eyes and repeat what the teacher said. The teacher kept moving

around and talking to her. Standing to one side of Ashley, standing on the other side, moving behind her and then back to face her again. When the teacher was standing behind her, she could hear a mumble, but could not understand the teacher. Ashley's teacher identified that Ashley was hard of hearing, especially out of her right ear. Her teacher, in order to accommodate her, started speaking into a microphone to project her voice. Her teacher also added a note to Ashley's file that her subsequent teachers should do the same.

In high school, Ashley began to fit in at school. She worked in the school's office and delivered messages to teachers in their classrooms and got to know the teachers, and they her. Additionally, Ashley was in small classes, making it easier for her both engage with the teacher and hear what the teacher was saying. Since starting college, she had struggled. Her first semester, she was caught within a teacher-student power dynamic, which prevented her from approaching her teachers about not being able to hear them, especially when they "taught" directly into a chalk board and didn't turn to face the students. She would frequently ask a neighboring student, "What are we supposed to be doing?" or sometimes she would have to reach around a desk, attempting to see their face.

When I first came here, most of the classes were these giant lectures and the rooms and way some of the teachers position themselves or spoke, it's just like you guys are just the sea and I'm just preaching to the sea kind of thing.

Now she engages with the professor after the first two or three classes, letting them know what she needs from them to be able to engage in the class and learn from the instruction.

Ashley spent a lot of time in and out of the hospital as a child. It was through these hospital visits and doctor appointments that she discovered what she wanted to do—become a biomedical engineer. Ashley learned to advocate for herself and research her condition to better understand her treatment plans. Ashley would ask the doctors what they were trying and why they were doing what they were doing. She wanted to know how things worked. She would study different medical conditions, trying to learn about the interactions between the conditions and their underlying causes.

I'd come up with my own questions. And, doctors would look at you like, I'm going to give you an answer, I don't know if this is what you are looking for. Most of the time it was like no. And then it is just like kind of the information behind what they're pulling like oh she gave you this medicine and the reason behind they do certain practices was just always in my interest and I want to know how to do that. I want to know how to then help other people. Because I know there's going to be other people who have questions and they're not answered either and it's frustrating when you sit there and you're just not getting any farther.

These experiences inspired her to pursue biomedical engineering. She cited the common reasons for choosing engineering—being good at math and science and was always fixing things—but she felt that was only a small part of her decision to enter engineering. She sees an engineer as a critical thinker; someone that can create something new; someone that

is a lifelong learner; and someone who thinks analytically, which are all characteristics with which she identifies.

She feels she has a unique way of connecting with people. When she was a child, she was reading lips and watching facial expressions. As she has gotten older, her ability to perceive emotions and connect with people on a different level has grown. She watches how people move their hands and even feet when they communicate and how they position their shoulders. She watches people that are more quiet and reserved as they are put in a situation where they have something that they need to say and observes how their demeanor completely changes as they begin to speak.

Part of the reason why I love interacting with people is because I feel like I can connect with people in different ways and sometimes the movements in what you say or just even a change in movement or a change in lack of movement can mean something and just finding that interest and know more about why they did it can be enough. And, building on that connection you end up learning quite a bit about the person.

She feels that these skills will be particularly valuable to her as she pursues an engineering degree.

V. DIRECTIONS FOR FUTURE WORK

Ashley's story only begins to help us answer questions of how diverse students describe how their multiple identities influence their pathways into engineering. Her story provides multiple ways to consider how an educator can make their classrooms more welcoming for those with disabilities, allowing the students to feel comfortable enough to approach and identify their needs. Her challenge in a traditional classroom provides ways in which particular adjustments may be beneficial for not only students with particular needs but for all students [26].

Her story also prompts us to ask, "What particular backgrounds and capital do students bring with them into the engineering classroom?" and "How can these forms of capital be leveraged to support students in engineering?" If we conducted a study of Ashley only binning her responses woman, we might not have gotten her full story of how her attitudes about engineering have been shaped from prior experiences.

These ideas represent just a few questions generated from one interview, this story has more to offer and in conjunction with the other stories will provide a unique insight into the experiences of the underrepresented in engineering. Using this data, we can inform recruitment and retention as well as classroom behaviors to make our institutions more welcoming and more diverse. Our future work will analyze the other 11 stories and understand common ways of supporting diverse students in their engineering pathways.

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