2018 CoNECD - The Collaborative Network for Engineering and Computing
Diversity Conference: Crystal City, Virginia Apr 29

Student Conceptualizations about Diversity: "How would you describe the diversity in engineering at your institution?"

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ABSTRACT

As the field of engineering continuously suffers from a lack of diversity, it is widely accepted that the engineering education community continue focusing on broadening participation. However, similar consensus does not exist as it relates to measuring progress. We argue that this is partially due to the ambiguity of the word *diversity*. Because people have different meanings for and associations with the concept of diversity, it can be expected that progress, and the extent of the problem, looks different to different people: what we consider "diverse enough" is thus a moving target. This paper examines the ways in which this target moves from person to person. We interviewed undergraduate (n=19) and graduate students (n=22) majoring in engineering at a predominately white, mid-Atlantic institution, asking them to describe the current level of diversity in engineering at their institution. Grounded in social constructionism, we explore students' rationale for determining the extent to which their shared environment is perceived as diverse. Our results suggest that engineering students use various environmental and social cues to reach conclusions about diversity.

Keywords: diversity; inclusion; student perceptions

1. INTRODUCTION

Engineering has historically had a challenge dealing with issues of gender, race, and ethnicity, as women, and numerous racial groups—such as Black, Latinx, Native American, Native Hawaiian, Pacific Islander, and other groups—continue to be underrepresented in the field (Bruning, Bystydzienski, & Eisenhart, 2015). Since the Civil Rights Movement, when the U.S. first gave broad legal protections to facilitate women and racial minorities' entrance into all professions, the enrollment proportions of these groups in engineering rose nationally (Slaughter, Tao, & Pearson, 2015). However, now almost 50 years after the Civil Rights Movement, organizations that employ engineers still have significantly low proportions of people from these underrepresented groups (Chen, 2014; Kokalitcheva, 2015), as do many colleges and universities. Unfortunately, everyone does not view this problem with the same level of urgency.

Whether or not an organization perceives a lack of diversity as problematic is important. At universities, strong legal policy to externally enforce levels of gender and race diversity is simply not present. Therefore, without legal enforcement, the driving force for change towards greater diversity is members of the organization itself. Under such circumstances, change is only possible if they acknowledge its lack of diversity and desire to change it. For example, the lack of addressing diversity issues in higher education broadly has led to nationwide protests across campuses, such as the hunger strike at the University of Missouri that led to the chancellor's removal (Libresco, 2015; Pearce, 2015). Protesters there demanded an administration that was willing to address the racism that Black students experienced (Svrluga, 2015). In the aftermath of these nationwide protests, many universities have installed chief diversity officers and have begun funding programs to improve diversity (Parker, 2015; Rosen, 2016). Ideally, such drastic measures would not be required to ignite the desire to change.

1.2 Purpose

Given the prevalent emphasis on diversity efforts in engineering, the purpose of this paper is to explore the various ways in which students describe diversity in engineering at an institution. To address this purpose, we explore the following question: *How do engineering students make meaning of and come to understand how "diverse" engineering is at an institution?* Ideally, answering this question will aid current and future efforts aimed at advancing diversity in engineering by advancing understanding of how students come to determine whether or not the level of diversity is "good enough" at their institution.

2. THEORETICAL FRAMEWORK

How an individual student conceptualizes diversity is related to their specific life experiences, the contexts where these experiences took place, and the manner in which they interpret these experiences. This assertion is grounded in a constructivist epistemology, positing that a person's process of making meaning and acquiring knowledge out of their social world is individualistic (Gall, Gall, & Borg, 2007). Consequently, we selected social constructionism as a theoretical framework through which to interpret engineering students' definitions of diversity. Social constructionism postulates that knowledge is fabricated "through daily interactions between people in the course of social life…Therefore, what we regard as 'truth' …is a product not of objective observation of the world, but of the social processes and interactions in which people are constantly engaged with each other" (Burr, 2015). By selecting social constructionism as our theoretical framework, we shift the center of meaning making from the person to the interactions between the person and their social world (Hernández, 2016).

Social constructionism is comprised of four beliefs (Lock & Strong, 2010). First, meaning and understanding is the center of human activities. Second, meaning and understanding have their beginnings in social interaction. It is through interaction with others that our actions gain meaning. Third, ways of meaning making are specific to particular times and places because they are inherently embedded in socio-cultural processes. In other words, the context of a given interaction influences what is perceived. And fourth, people are both self-defining and socially constructed participants in their shared lives. Individuals both shape and are shaped by the social contexts in which they are located. These principles are important in terms of *diversity* because although most will regard diversity as important for engineering, it is unlikely that anyone is necessarily operating with a common, shared understanding. Guided by these four principles, social constructionism offers the following assertion as it relates to this particular study: conceptualizations of diversity are specific to the individual and their social interactions and are specific to particular times and places. The idea that knowledge is created through interactions helps us frame an individual's conceptualization of diversity as a product of their understanding of the world.

Though research is limited, other studies have explored the various ways people talk about and define diversity. For example, Fleming, Ledbetter, Williams, and McCain (2008) analyzed the results of a longitudinal study of sophomore engineering students from four schools. A major finding of their study was that students primarily used themes of gender, race, culture, and ideology when defining diversity; while diversity of major, geography, socioeconomic status, and political affiliation were among the less familiar themes. Chen, Jacqueline, and Hamilton (2015) found that undergraduates', especially minorities, perceptions of their campus diversity were based on their social acceptance on campus. With that said, the aim of our study is to understand student

perceptions of diversity in engineering. We are intentionally not trying to create a definition of diversity; instead, we explore *how* students come to rate diversity at the institution.

3. METHODS

The data presented in this study is part of a larger project exploring engineering student beliefs and motivations surrounding diversity education within engineering curricula (Taylor, Waters, Bhaduri, Lutz, & Lee, 2017). We analyzed data from qualitative, semi-structured interviews exploring students' conceptions and attitudes about diversity in engineering. Of particular focus in this paper are student answers to the question: *How would you describe the diversity in engineering at this institution?* We analyzed student responses to this particular question using an inductive, open coding approach. Our methods are further discussed in the following sections.

3.1. Data Collection

The data analyzed in this paper was collected at a large, predominantly white research institution in the mid-Atlantic U.S. Participants were recruited from a survey that was distributed to undergraduate students in a living-learning community (LLC) and graduate students, both enrolled in the same college of engineering. This sampling approach was *purposive* (Creswell & Plano Clark (2007) as diversity-related initiatives were ongoing at the institution and we aimed to leverage these efforts to facilitate discussion. Data was collected using semi-structured interviews, conducted by six different researchers. Though no attempts were made to match the race or gender of the participant with the interviewer, given that diversity-related topics can be sensitive to discuss, efforts were made during protocol development to avoid language that might stigmatize participants and prevent them from being authentic. In total, 19 undergraduates and 22 graduate students participated in the interviews (see Table 1). The interviews lasted between 30-75 minutes and all participants were compensated for their time with a $20 Amazon gift card.

Table 1: Summary of participant demographics

Race/Ethnicity	Gender		Total
	Men	Women	
Asian	3	5	8
Black/African American	0	2	2
Hispanic/Latino	3	0	3
Native American/Alaskan Native	0	1	1
Two or More Races	2	2	4
White	11	12	23
	19	**22**	**41**

3.2. Data Analysis

We focused on responses regarding student beliefs about the current state of diversity for two key reasons. First, such an answer will provide insight into the different ways students conceptualize and evaluate the idea of diversity in broad terms. Student beliefs about what constitutes diversity will directly impact the perceptions of the current environment. Second, responses to this question offer understanding of the perceived action needed to drive change in a given direction (e.g., increase diversity). More specifically, the way a student perceives diversity will influence whether that student sees the current state of the university as problematic.

Each response was coded based on how the student described diversity at the institution. The initial coding pass used was conducted by the lead author using open coding procedures (Miles, Huberman, & Saldana, 2014; Saldana, 2016). Open coding aligns with social constructionism as it allowed the authors to understand how a person's own understanding is shaped by their experiences and their interactions. An example of the initial coding pass can be shown below by the response of a graduate student.

> "I can really on speak for my department[1]. I'd say it's a fairly diverse program[2]. I know we specifically target minority students[3] to be part of our program. That's fairly diverse[2]."

This quote was initially given codes of *department*[1], *fairly diverse*[2], and *target minority students*[3]. First, the participant spoke specifically about diversity from the viewpoint of their department. The participant states in two places that he believes his department is fairly diverse. Lastly, the participant states that his department targets minority students. These codes were chosen because they represent and capture the quote while preserving the original meaning. After each interview was coded during the first coding cycle, interviews underwent a secondary coding cycle.

During the secondary coding cycle, the initial codes were sorted into groups, or preliminary themes. Two overarching clusters emerged from the preliminary themes: the ways students conceptualized diversity and the criteria they use to describe its presence (or lack thereof). Consequently, one cluster focused on how the student described diversity at the institution (*conceptualization*) and another cluster centered on how the student viewed or rated diversity at the institution (*rating*). For example, using the quote above, codes that spoke about the department, the college of engineering, or efforts by the institution were grouped together (conceptualization). At the same time, codes that spoke about a particular rating of diversity were grouped together (rating). The overarching clusters, *conceptualization* and *rating*, along with the codes that formed each preliminary theme were reviewed to ensure that each theme was accurately represented by its supporting codes. Once the preliminary themes were finalized, definitions were created. While the majority of the student responses included a rating and conceptualization of diversity, there were some student responses that only conceptualized diversity.

3.3. Research Quality & Limitations

To enhance research quality, peer debriefing and researcher triangulation occurred multiple times during the coding process. After the initial round of coding, two secondary authors used the preliminary codebook on a subset of data to verify, check the consistency, and check the clarity of the codes as well as establish inter-coder reliability. Any discrepancies were discussed until consensus was achieved, and code definitions were clarified as needed. To reduce researcher bias, no demographic information (e.g., race, gender, academic major) was connected to the responses until after the codebook and coding was completed. Once coding was completed, participants' demographic information was paired to the coding analysis and researchers were able to examine the extent to which the responses varied across groups. In regard to limitations, we acknowledge that students self-selected to participate in this study, which introduces the possibility of self-selection bias (Lynn, 2004)—that is, those who were willing to have conversation about diversity in engineering are also more likely to have positive, progressive views on the subject

4. RESULTS & DISCUSSION

The purpose of this research was to better understand the different ways students conceptualize diversity as well as if or how those approaches inform beliefs about their institution. The results first explore student conceptualization of the word diversity followed by beliefs regarding the current levels of diversity at the present institution. Students in this study conceptualized diversity through both personal criteria and institutional experiences. They also used these conceptualizations to inform their perception of the current state of diversity. While we did not find any patterns across demographics or academic status, we did find themes when it came to conceptualizing diversity. We begin by discussing the conceptualization themes followed by the rating themes that came from the interviews.

4.1. Conceptualization Themes

Participants' responses as to how they described diversity in engineering at an institution can be categorized into four primary areas: 1) who they see and meet on campus; 2) where they see and meet people on campus; 3) what they see being done by the institution; and 4) statistics of which they are aware. The following sections highlight the four ways that students responded.

Theme 1. Who They See and Meet on Campus

When participants described diversity at their institution some of their responses were based off of who they saw and met. Phrases categorized under this theme included visual markers, diversity of thought, and geography.

Visual Markers: Perhaps unsurprisingly, participants referred to observable aspects of difference to articulate their conceptualization of diversity. Thus, *visual markers* refers to a student describing someone's outside appearance such as their race, ethnicity, or gender. For example, one white woman (undergraduate student) reflected: *"...I see a lot of women in engineering... In the class, I think there's 4 people who are not a white male."* In the statement above, the student stated that they *see a lot of women* and there are *people who are not a white male*. Given the overrepresentation of white men in engineering, the perceived lack of white men in this student's experience serves as an indicator of the presence of diversity. These phrases align with the theme of visual markers because the student describes what they see in engineering using race and gender.

Diversity of Thought: Beyond what was directly observable, participants also noted differences in the way people think about and solve problems as contributing to diversity. *Diversity of thought* included statements related to having a variety of options. It also included statements based on something that the student and/or someone else experienced while interacting with someone who was not like them. This included items based on skills, language, and culture. A multiracial man (undergraduate student) reflected: *"A lot of people with their own ideas, individual ideas... There's a lot of different options out there, too, a lot of different ways you can get involved in engineering..."* Here, the participant describes diversity as having a lot of people with their *own* and *individual ideas*. In contrast to *visual markers*, the participant relies on the perceived differences as indicator diversity.

Geography outside the Institution*: Geography outside the institution* referred to the macro level of geography at the institution. It was used when a participant referred to a state, country, or nation whether in or outside the U.S. to describe the diversity in engineering at the institution. For example, an Asian woman (undergraduate student) responded: *"I feel like I'm lacking in different*

ethnicities or people who, then again, this is a state school. I feel like everyone is from [state], lived in [state]." In this quote, the participant leveraged diversity at the macro level of geography, referring to geography outside the institution to describe diversity at the institution.

Theme 2. Where They See and Meet

Some participants described diversity based on where they were at the institution. This theme included phrases based off of classroom interactions or other locations at the institution.

***Classroom Interactions**: Classroom interactions* referred to a micro level of geography of the institution. This code was applied when a participant defined diversity using a classroom experience at the institution. For example, a white man (graduate student) commented: *"At least in my experience in the classes I've taught ...The intro engineering course seemed more diverse in terms of who was in the room than say a computer engineering course."* Graduate students often described the classroom interaction from either the perspective as an instructor of the class or as a student in the class while undergraduate students described their experience based on their perspective as a student.

***Other Locations at the Institution**: Other Locations at the Institution* referred to a meso level of geography of the institution. This code is specific to a location at the institution, such as an engineering building. A multi-racial woman (graduate student) responded: *"I think in general just walking across campus at [institution], there is just a huge international presence which I think is awesome*." In this quote, the participant describes diversity leveraging what they see when *walking across campus at the institution*. This line refers to a meso level of geography of the institution because it is one level above a classroom interaction on campus.

Theme 3. What They See Being Done by the Institution

Some participants described diversity based off of what they saw being done by the institution. These phrases were coded under institutional efforts.

***Institutional efforts*:** *Institutional efforts* encompassed responses related to institution action. In this theme, participants described different efforts by people and programs at the institution. For example, a Hispanic/Latino man (graduate student) commented: *"The new president, he created a new division about diversity. I think it's pretty cool from what I've seen and the emails I think they're working on that..."* In addition to people and programs, participants commented on various recruitment and inclusion efforts by the institution and the admissions office using mediums such as emails. Some participants described the institutional focus from the overarching viewpoint of the university, while others highlighted efforts of specific engineering departments.

Theme 4. Statistics of which They are Aware

Lastly, some participants described diversity based off of any statistics of which they were aware.

Statistics: *Statistics* was applied when a participant described diversity using a numerical value such as a statistic, raw number, and/or percentage. Statements under this theme normally occurred when a student would quantify gender; however, there were some occurrences where race/ethnicity was also quantified. For instance, a White woman (undergraduate student) stated: *"...I know women are still like 23% or something. Yeah, it's like somewhere around 20."* Here, the participant approximates the percentage of women in engineering to be 23 or 20 percent.

Conceptualization Summary

Seen through a social constructionist lens, students form ideas about what diversity is and looks like through a range of interactive contexts. By describing diversity in terms of the people they see and actions they observe around campus (Themes 1 and 3), participants articulated the ways in which knowledge is formed through interactions with others. Further, by positioning diversity in terms of *where* they are (Theme 2) and current demographics (Theme 4), participant perceptions also demonstrate the importance of social and material context and location on diversity. Taken together, these results suggest that a wide range of factors influence engineering students' definition and concept of diversity.

4.2. Rating Themes

Unsurprisingly, participants rated diversity in a variety of ways despite being enrolled at the same institution, including: 1) not diverse; 2) moderately diverse; 3) very diverse. Statements that aligned to a more negative viewpoint of diversity were coded *not diverse*; statements that had a more positive viewpoint of diversity were coded *very diverse*; and statements between both of these ratings were coded *moderately diverse*.

Theme 1. Not Diverse

Not diverse responses described the institution with phrases such as dismal, nonexistent, and terrible. For example, a Hispanic/Latino (graduate student) noted: *"I don't think we are a diverse institution, especially in engineering, I think engineering classrooms are very non-diverse."* In this statement, the participant stated they *don't think the institution is diverse* and that the engineering classrooms are *very non-diverse*. The participant used his experiences in the classroom to inform his beliefs about the level of diversity at the institution.

Theme 2. Moderately Diverse

Participant responses that were coded as *moderately diverse* acknowledged that while there was some diversity at the institution, there was not enough to consider it diverse. For example, a White man (graduate student) articulated: *"...It's somewhat diverse, but I wouldn't really call it really..."* Here, the participant mentions that the institution is *somewhat diverse*, but not *really* diverse. Participants also articulated that while diversity was not at an ideal level, diversity was improving and that it would get better with time. For example, a White man (undergraduate student) stated: *"...It's like I guess better than how it probably was like forty years ago or something, but maybe in ... Like you have to give it time, so maybe in like another fifty years it will be like if you were to go an English class and it would be completely diverse."* In the statement above, the participant mentions that diversity is *better than how it probably was* and that you have to *give it time*. The participant has a positive viewpoint of diversity and that with time, diversity at the institution will be where it should be.

Theme 3. Very Diverse

Very diverse responses described the diversity using phrases such as, it's tremendously diverse and really good. For example, a White woman (undergraduate student) responded with: *"Honestly I think it's very diverse... I think it's great. I think at [institution] we've got a pretty good diverse community."* Here, the participant describes diversity at the institution as *very diverse* and *pretty good*.

Rating Summary

As shown in the Table 2, the majority of participants stated statements that ranked the institution as moderately diverse, while fewer participants ranked the institution as not diverse or very diverse. When interpreting this table, it should be noted that not all of the participants mentioned a rating of diversity when they described diversity during their interviews, and some participants provided multiple rankings, altering back and further as they responded. Thus, each rating was coded as they appeared in the participant responses.

Table 2: Numerical count of participant rating themes

Demographics	Rating		
	Not	Moderately	Very
Male	4	12	4
Female	4	13	4
White	5	15	3
Asian	0	4	1
Black	1	0	1
Hispanic/Latino	1	0	1
More than One Race	1	1	1
Native American/Alaskan Native	0	1	0

5. IMPLICATIONS & CONCLUSION

The purpose of this paper was to understand how engineering students make meaning of and come to understand how "diverse" engineering is at a university. In order to address this purpose, we interviewed students about how they would describe diversity in engineering at their institution. We determined that students' ratings of diversity at a university ranged along a spectrum from not diverse to very diverse, even though students were all attending the same institution. We also found that participants used different criteria to reach conclusions as to whether an environment was diverse. These criteria were based on who they saw and met on campus, where they saw and met, what they see being done by the institution, and statistics they are aware of.

The different ratings combined with the different criteria provided by students reinforces the idea that the meaning of diversity differs for different individuals. The implication of this work is that the ways in which students conceptualizes diversity is specific to an individual, and the range of beliefs about the current state of diversity at the same institution can be radically different. Though we did not identify a relationship between what participants used to reach a conclusion and the conclusions reached, it is our hope that the themes identified herein advance understanding of various ways that students conceptualize diversity and offer insight into improving efforts aimed at advancing diversity. Understanding differing conceptualizations of diversity can provide valuable information for those leading diversity efforts based.

ACKNOWLEGMENTS

We would like to acknowledge Cynthia Hampton, Sarah Williams, Camilio Riascos, Corinne Wells, Dr. Christian Matheis, Susan Arnold Christian, and Dr. Catherine Amelink for their important contributions to this work. We gratefully acknowledge the contributions of the Center for the Enhancement of Engineering Diversity. We are also grateful to members of the GUIDE Research Group, including Ashley Taylor and Raeven Waters.

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