

## **Forget Diversity, Our Project is Due**

### **Mr. Hector Enrique Rodriguez-Simmonds, Purdue University - Engineering Education**

Raised in South Florida, born in Mexico. Half Colombian and half Mexican; proud MexiColombian. Héctor earned his MS in Computer Engineering and is currently pursuing a PhD in Engineering Education, both from Purdue University. His research interests are in investigating the experiences of LGBTQ+ students in engineering, tapping into critical methodologies and methods for conducting and analyzing research, and exploring embodied cognition.

### **Mr. Nelson S. Pearson, University of Nevada, Reno**

Nelson Pearson is an Ph.D. student at the University of Nevada, Reno. His research interest includes, social networks and the integration of diverse populations, engineering culture as well as engineering pedagogy. His education includes a B.S. and M.S. in Civil Engineering from the University of Nevada, Reno.

### **Ms. Jacqueline Ann Rohde, Clemson University**

Jacqueline Rohde is a senior undergraduate student in Bioengineering at Clemson University. Her research in engineering education focuses on the development student identity and attitudes with respect to engineering. She is a member of the National Scholars Program, Clemson University's most prestigious merit-based scholarship. She is also involved in efforts to include the Grand Challenges of Engineering into the general engineering curricula at Clemson University.

### **Dr. Kyle Patrick Vealey, West Chester University of Pennsylvania**

Kyle P. Vealey is an Assistant Professor of English at West Chester University of Pennsylvania. His research interests include technical and professional communication, rhetoric of science, rhetorical theory, and public rhetoric.

### **Dr. Adam Kirn, University of Nevada, Reno**

Adam Kirn is an Assistant Professor of Engineering Education at University of Nevada, Reno. His research focuses on the interactions between engineering cultures, student motivation, and their learning experiences. His projects involve the study of student perceptions, beliefs and attitudes towards becoming engineers, their problem solving processes, and cultural fit. His education includes a B.S. in Biomedical Engineering from Rose-Hulman Institute of Technology, a M.S. in Bioengineering and Ph.D. in Engineering and Science Education from Clemson University.

### **Dr. Allison Godwin, Purdue University, West Lafayette (College of Engineering)**

Allison Godwin, Ph.D. is an Assistant Professor of Engineering Education at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. She is the recipient of a 2014 American Society for Engineering Education (ASEE) Educational Research and Methods Division Apprentice Faculty Grant. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and 2016 New Faculty Fellow for the Frontiers in Engineering Education Annual Conference. She also was an NSF Graduate Research Fellow for her work on female empowerment in engineering which won the National Association for Research in Science Teaching 2015 Outstanding Doctoral Research Award.

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## Abstract

This research paper examines how four first-year engineering students interact with one another in teams to answer two research questions: 1) How do students experience working in diverse teams? and 2) Do their perceptions of diversity, affect, and engineering practice change as a result of working in diverse teams? Despite engineering's emphasis on developing students' teaming skills, little research has been conducted on how students develop sensitivity to students from different cultures and backgrounds within diverse teams. We interviewed four students in a first-semester, first-year engineering team twice for a total of eight interviews to understand their experiences working in diverse teams. Each interview was analyzed using a modified form of Interpretative Phenomenological Analysis (IPA) to understand the lived experience of each participant. In this paper, we present the results from the qualitative analysis of one team's complete interviews as a first step in the larger research project.

Results from this first-year engineering team show that in spite of explicit instruction and discussions about the importance of diversity, these students did not wholeheartedly value diversity in teaming activities. This team renegotiated and compromised their operationalization of what diversity meant in their engineering team. While based on individual values, this compromised understanding of diversity in engineering-teaming tasks led to inequitable experiences and lack of growth across the team. It limited the roles students took on during teaming activities, helped establish boundaries around communication in the team, and influenced the type of work teammates were trusted to take on and complete. Despite being from diverse parts of the world, having different experiences with and perceptions of diversity, this student team felt they were more homogeneous than different. Our work highlights the need for a deeper examination of the intricate complexity of teaming experiences during inquiry and design activities.

## Introduction

In recent decades, engineering has become a globally focused career with the need to work with people from a variety of technical and diverse backgrounds. This trend has been reflected in engineering pedagogy with a rise in teaming experiences in first-year and capstone design courses of engineering curriculum in the U.S.<sup>1</sup> Additionally the ABET EAC Student Outcomes currently require students to have “(d) an ability to function on multidisciplinary teams”<sup>2</sup>. Even with recently proposed changes to the following criterion, “(7) An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment,” ABET Student Outcomes still emphasize the need for engineering students to be able to work in diverse teams upon graduation<sup>3</sup>.

In light of the rise in popularity and need for teaming skills, researchers seeking to improve students' teaming skills have found successful ways to assess team member effectiveness and help develop skills to work in teams<sup>4,5,6</sup>. These tools and pedagogies are important because developing teaming skills improves students' academic performance, motivation and their attitudes towards learning<sup>7,8</sup>.

Despite the emphasis on developing students' teaming skills, little research has been conducted on how students develop sensitivity to students from different cultures and backgrounds within diverse teams in undergraduate programs. Research findings regarding working in diverse teams are mixed, depending on what differences constitute the "diversity" in question<sup>9,10</sup>. Researchers have examined the impact of diversity in identity group memberships, such as race and sex<sup>11</sup>; organizational group memberships, such as hierarchical position or organizational function<sup>12</sup>; and individual characteristics, such as attitudes, values, and preferences<sup>13,14</sup>. Although certain types of diversity appear to be beneficial, studies focused on race and gender have demonstrated both positive and negative outcomes<sup>15,16</sup>, suggesting that context may moderate these outcomes. Heterogeneous teams have been shown to outperform their homogeneous counterparts on divergent thinking and creativity. However, the inclusion of diversity on these heterogeneous teams also decreases affect, possibly due to diverse approaches to problems and a more frustrating experience for diverse individuals to work together<sup>17</sup>. These findings illustrate that successfully forming diverse teams that effectively work together, appreciate each other's differences, and develop engineering teaming, communication, and diversity sensitivity within engineering classrooms is a complex issue.

An ethnographic study of diverse teams in first- and second-year, as well as capstone design courses at one institution, showed that campus culture reached into social interactions between teammates via engineering identities produced on campus<sup>18</sup>. Students in these teams took on engineering archetype identities of "Nerds," "Academic-Achievers," or "Greeks." These identities allowed students to access particular positions with the social hierarchy and their engineering teams. However, these identities were only accessible to majority students and underrepresented students were often left out of the team dynamics. This study emphasized the best practices of promoting teamwork with diverse students including: (1) teaching about diversity, especially teaching how to respect one's teammates and the client's needs; (2) organizing teams to reduce conflict, balance gender composition (or have all-men or all-women teams), and improve trust; (3) incorporating peer feedback throughout the duration of the team and using it to mediate disrespectful interactions and unacceptable practices; (4) including a wide range of teamwork expectations in grading practices; and (5) better training faculty about ways to incorporate teamwork. Tonso also made a call to investigate how engineering culture and student attitudes inform both technical and non-technical teaming interactions at multiple institutions. Our work begins to fill this gap by examining the attitudes that students bring with them into engineering, thus actively shaping engineering culture. We also examine how these attitudes affect student interactions in diverse teams and change over the course of this particular experience.

In this study, we use cultural diversity to examine the research questions, 'How do students experience working in diverse teams?' and 'Do their perceptions of diversity, affect, and engineering practices change as a result of working in diverse teams?'

## **Theoretical Framework**

Cultural diversity refers to the representation of people with distinctly different group affiliations of cultural significance<sup>19</sup>. Prior research suggests that there is a human tendency to respond

positively to similar others and negatively to dissimilar others<sup>20</sup>. Additionally, groups have to work through a number of stages before they can be successful as a team<sup>21</sup>. Participants usually start in a state of high member uncertainty and search for common goals, work to develop group norms, begin to exchange information, and, if effective, stabilize into team roles. Teams are only able to achieve these steps if they develop a group identity<sup>20</sup>. Diverse team members have a variety of social identities based on backgrounds, cultures, and prior experiences. To develop a group identity, team members need to develop diversity sensitivity and multicultural effectiveness; these traits aid in integrating individual identities into a group identity<sup>22</sup>.

Acknowledging that student formation of and participation in welcoming teams are important to retention and persistence is consistent with research on cultural diversity. Management literature emphasizes the need for employers to create more diversity in the workforce to enhance group effectiveness<sup>23,24,25,26</sup>. However, there is little empirical evidence on how diversity in these teams directly affects diversity sensitivity and team effectiveness<sup>20,27</sup>. There is little to no research on the mechanisms for how diverse teams influence engineering students' effectiveness and perceptions of diversity.

This research paper highlights the emerging findings that may provide particular evidence for the leverage points to change student attitudes about diversity and teaming and improve the experience of working in teams for *all* students.

## **Research Study Context**

### *Institution*

The larger research project examines teaming behaviors of first-year introductory engineering students at a large Public, Midwestern university using mixed methods. This research was conducted over the 2015-2016 academic year. First-year students were selected as they have had few experiences working with diverse populations on engineering projects<sup>28</sup>. The university has a large international student population when compared to United States public universities and universities outside the United States<sup>29</sup>. This large international population makes first-year student teaming experiences interesting due to the increased possibility of interacting and working in teams with students from different backgrounds and cultures.

### *First-Year Engineering*

As a part of the first-year engineering curriculum, students were placed into diverse teams of four for an entire semester-long class using the Comprehensive Assessment of Team Member Effectiveness (CATME) team formation tool<sup>4</sup> and evaluated their teammates' effectiveness several times throughout the semester<sup>6,30</sup>. The CATME tool assigned students to teams of three or four people using the data collected in the survey and pre-defined criteria by the instructors. The Team-Maker algorithm is described elsewhere<sup>6</sup>. For this course, the criteria used to form teams were: 1) availability for meeting outside of class, 2) team size (maximum 4), 3) language of previous instruction (dissimilar), 4) Gender (do not outnumber), 5) race/ethnicity (do not outnumber) and 6) Class level (dissimilar). The team-formation criteria were the same for all 15 sections<sup>31</sup>. Three times throughout the semester, students were asked to evaluate the effectiveness of their teammates on the five dimensions of team member effectiveness in the

CATME peer evaluation tool. These validated dimensions are contributing to work, interacting with teammates, keeping the team on track, expecting quality, and having knowledge/skills.

In the first week of class, the topic of diversity was introduced and a whole class discussion on diversity in the engineering classroom is facilitated. Throughout the semester, diversity was revisited in teaming assignments, roles, and engineering design scenarios. A key learning objective of the courses was contributing effectively to team products and discussions. As a part of working in teams, students were expected to take on alternative perspectives in listening, working, and communicating effectively with one another. These approaches are consistent with best practices outlined in prior research and highlighted by Tonso<sup>18</sup>.

### *Data Collected*

Throughout the Fall 2015 semester, we collected quantitative survey data (pre and post) as well as conducted three observations each of five teams working on engineering design. These methods were used to understand how students' underlying attitudes about diversity, interest working in teams, and attitudes about engineering changed over the semester. We were also interested in how students actually interacted in their teams. The teams observed in this study were selected from the entire population of students based on their responses to the initial survey at the beginning of the Fall 2015 semester. We selected for maximum variation in our teams on multiple criteria including the overall team's diversity sensitivity scores; the variability of team member's scores; and diverse team composition (e.g., race/ethnicity, international status, gender, disability status). During the observations, we focused on students' communication, body language, and bids for recognition within their team. Additionally, during the Spring 2016 semester, we asked the 20 students observed (i.e., five teams of four students) to participate in two different interviews. We had 18 of the 20 students agree to interviews and completed a total of 24 interviews. Four students did not return for the second interview. We also asked students to complete a skin-tone and gender and science implicit association test to understand their unconscious bias related to race and gender that may not have been elicited through survey responses or interviews.

### **Research Methodology**

Interview data related to student perceptions of diversity and their teaming experiences were analyzed using Interpretative Phenomenological Analysis (IPA)<sup>32</sup>. IPA has been described in detail previously in other fields<sup>32</sup> and engineering education<sup>33</sup>. In brief, IPA is concerned with understanding how individuals make sense of their lived experiences. Interpretations of experiences can manifest in tangible (e.g., changes to work patterns due to injury) and/or physiological ways (e.g., working in fear of a new boss). The goal of any IPA is to leverage and understand the participants' views of their experience rather than capturing the "truth." In contrast to thematic analysis, IPA brings forward tensions within and between participant's narratives. IPA argues that both the researcher and the participant cannot remove themselves from their prior experiences and knowledge, and specifically incorporates these prior experiences and knowledge when understanding how an experience is interpreted.

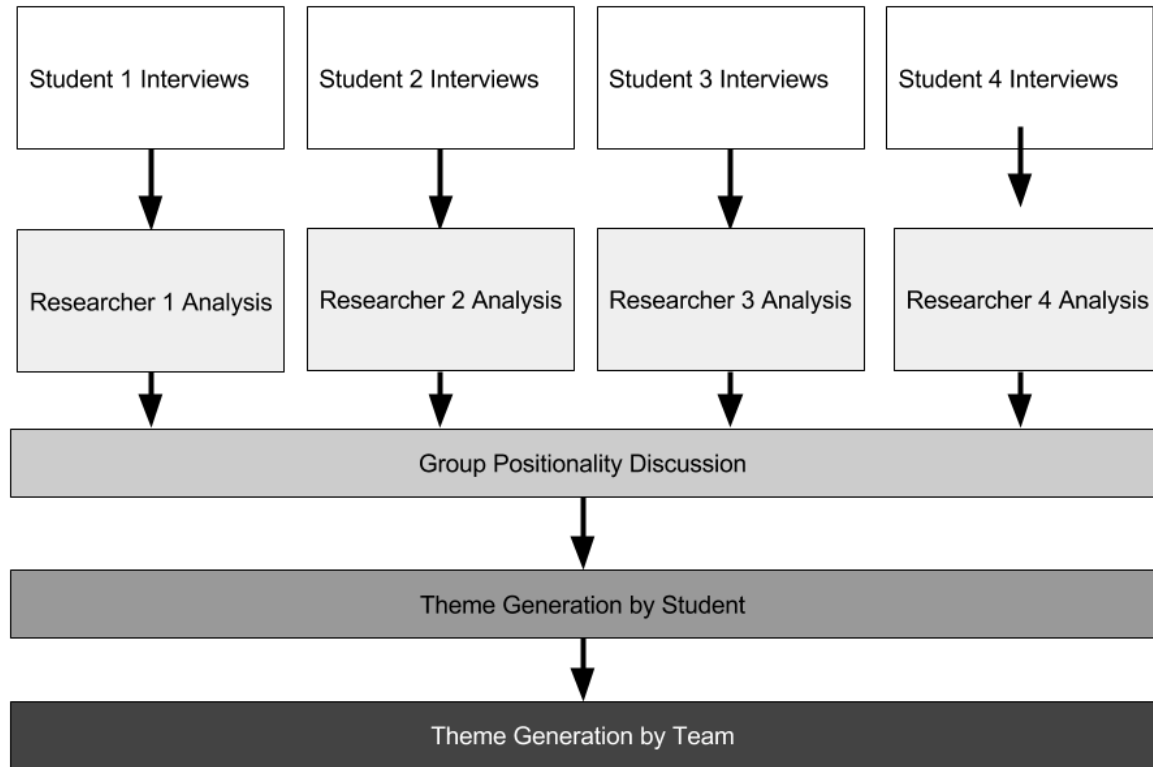
IPA allows for a robust exploration into how individuals and teams understand diversity in engineering. We sought to understand how student experiences working in diverse teams

influenced their attitudes towards diversity and their practice of engineering. To understand these experiences the research team first sought to examine the student experience through the students' lens. The methodological decisions made align with the research questions we are asking.

We collected interview data related to student perceptions and experiences with diverse individuals and how diversity manifested on their engineering teams. Interviews were transcribed and checked for accuracy. Breaking from IPA tradition, one member of the research team was assigned to one participant, for a total of four analysts. Traditionally, IPA analysis is led by a single researcher. After assigning participants, each researcher familiarized themselves with the data by listening, re-listening, reading, and re-reading interviews. Once familiarized with the data, researchers conducted three analytic passes through the data. The first pass was a descriptive pass that reframed what was said by participants in the language of the researcher. Student use of language and patterns of language use were examined in the second linguistic pass. Finally, researchers compiled each of these passes to begin making interpretations of student experiences. This final step began to move the analysis away from the views of the participants to begin incorporating the views of the researchers.

Initial themes constructed from the data were further refined through examination of these initial themes through the preexisting knowledge of theory and of the engineering teaming experience by the research team. The above introduction and background sections begin to explain our theoretical stance prior to analyzing the data. To explain our experiential stance and create a unified interpretive mindset for coding, the research team underwent intense reflection on previous experiences in engineering teams and with diverse individuals. Specifically, the team answered versions of the questions used in the interview protocol independently and then brought these written reflections to a multi-hour group meeting where these positions were unpacked. Our research team possessed a wide range of teaming experiences from excellent to awful. We had experiences working in homogeneous teams and working in diverse teams. Some of these experiences led to reflection on the role of diversity in our lives, while others reflected the performance-oriented culture of engineering<sup>34</sup>. Additionally, our experiences with diversity were also wide ranging. Some participants were immersed in diverse and new cultures from an early age while others were not exposed to diverse individuals and cultures until later in life. Additionally, difficult conversations of our held biases manifested during the discussions of interacting with diverse individuals. The conversations of our teaming experiences, experiences with diversity, and potential biases were used to generate a shared mindset for coding. This time spent in reflection aids in outlining the interpretive stance taken by the coding team. Once our interpretive stance was outlined, the team worked to create overarching themes for each participant. Themes from each participant were then compared and contrasted with themes generated with other participants until super-ordinate themes for the team were created. The overall analytic process is outlined below in Figure 1.





**Figure 1.** Overview of Qualitative Analysis

The value of deeply studying small populations of students is not to generalize to a broad population. Rather, we seek a more layered depiction of the individual and collective experiences of these teams and its members<sup>35</sup>. We believe this enhanced understanding will help unpack the complexity of diversity in engineering teams and encourage dialogue amongst practitioners.

### **Trustworthiness and Authenticity**

Throughout this study, we engaged with an interpretive phenomenological approach that demanded that the researchers acknowledge their positionality and the influence of co-constructing the major findings. The emphasis of this methodology is to represent the idiosyncratic nature of human experience. In this paper, we balanced the complexity of data from multiple emergent perspectives and the differences across participant narratives. This approach was taken to provide meaningful, credible, and empirically supported results. We included rich quotes, transparent analysis, fair representation of each participant, and outside research to help support our findings. As students and faculty at the site of this study, we spent significant amounts of time engaging, discussing, and interviewing these students. Time spent during interviews building sound relationships with participants contributes to the trustworthiness of the data<sup>36</sup>.

As a part of our procedural validity<sup>37</sup>, we carefully documented our methods of inquiry and analysis process. We wrote memos throughout the analysis procedure to acknowledge personal biases, selective perceptions, and theoretical predispositions. As a research team, we reflexively

and openly discussed these reflections to account for multiple coders' results and interpretations<sup>36</sup>. While we do not report more than the in-depth qualitative analysis in this work, we crystallized the findings of this paper through multiple student perspectives within the same team, watching the video recording of the students in class, examining quantitative data results of attitude shifts over the semester, and studying the results of implicit association tests to understand unconscious bias. Crystallization is a poststructural approach to triangulation that stresses the socially constructed nature of reality and allows for a multifaceted, although partial and potentially different, perspectives within the same study<sup>38,39</sup>. In our work, we have prioritized the students' voices and perceptions over imposing our interpretation of their story onto their descriptions. The results presented in this paper are consistent with other streams of data. Future work will include a cross analysis of multiple streams of data.

## **Participants**

Diversity and its role in team interactions is a complex phenomenon to unpack. Due to the complex nature of the analysis and the depth and nuance of the results, this paper focuses on the eight interviews (i.e., two per person) of one team. This team was one of five selected to be interviewed based on quantitative survey results indicating a large variation in measures of students' diversity sensitivity and multicultural awareness attitudes across the team as well as the diversity (e.g., race/ethnicity, gender, or disability status) within the team. We selected this team for racial diversity and domestic/international status. While this paper focuses on analyzing this all-male team, other teams with majority women will be analyzed. This is just one team in a larger case study. The team in this paper included Ezekiel, Peter, Stanley, and Xander (these names are student chosen pseudonyms).

Ezekiel identified as a straight Black male exploratory studies major with ADHD and test anxiety disabilities. He preferred abstract concepts in math (favoring geometry over algebra); had had many Co-Op and internship experiences in engineering; would take initiative to pursue his own interests even apart from a team; and preferred reasoning through problems as opposed to rote memorization. He was an outgoing student that enjoyed new opportunities.

Peter identified as a straight, male, Asian-American student and was majoring in nuclear engineering. He grew up in the urban Northeast and rural Southeastern parts of the U.S. and associated culture with urban environments. A primary motivation of his pursuit of engineering was to avoid being stuck working at his parent's family-owned restaurant stating,

My parents were like, "Figure something out now or else you're going to be in the restaurant forever." I was like, "Okay." Then, one day my teacher recommended engineering ... Okay, I guess that sounds fine. It's not really by choice, but I guess at this point, it's fine because I do like it though. I realized I do like it. (Peter)

Peter traveled to China on several occasions and contrasted his experiences there with his experiences in the U.S., increasing his disassociation with rural environments. Peter often struggled with independence, seeking guidance and direction from others and relying on that direction more than his own opinion.



Stanley identified as an Asian international straight male student majoring in mechanical engineering. He was a self-starting learner pursuing opportunities to learn outside of school by teaching himself Chinese, working on extracurricular mathematics problems, and studying how movies are made. He had experience being recognized as good at technology and saw himself as more skilled in math and science than in the humanities. He was confident that mechanical engineering was the right major for him citing, “it’s very versatile” and would allow him “the freedom to pursue what [he] want[s] to do [...] especially because in Japan [...] they have a pretty strong automobile industry.” He stayed connected to family and friends through soccer and connected with Ezekiel through the sport.

Xander identified as a straight white male industrial engineering student who was born and grew up in the Midwestern United States. He talked about how he was good at math and science, but English did not “really interest” him. He chose industrial engineering because he was interested in integrating business and technical engineering and viewed this major as a route into the business sector. He picked industrial engineering over mechanical engineering because it seems more social to him, “you actually [interact] with people a lot more than you do with mechanical.” Xander had a strong desire to work with others as a part of his engineering career.

Each participant from the selected teams was asked to complete two semi-structured interviews the semester after their teaming experience. The first interview collected a “focused history”<sup>40</sup> of the participant’s prior engineering experiences and of their interests in, exposure to, and knowledge of diverse peoples and cultures and lasted an hour to an hour and a half. The second interview dealt with the participant’s experiences on their team with respect to their beliefs about working on teams and their perceptions of diversity. This interview also lasted for over an hour for each student.

## **Findings**

This study asked the questions: How do students experience working in diverse teams? and Do their perceptions of diversity, affect, and engineering practices change as a result of working in diverse teams? IPA allowed us to answer these questions through the construction of superordinate themes and subordinate themes from this team of four students. In this section, we’ll discuss how the superordinate (main) theme builds upon the smaller subordinate themes. These themes will help us answer our research questions.

For this study, we will be focusing our discussion on the superordinate theme: *Individual views of diversity are negotiated in the team and manifest in team behaviors*. To discuss the subordinate themes, we first describe each student’s definition and value of diversity and then unpack how each member of the team engaged in the teaming environment through these particular perspectives.

### ***Students defined and valued diversity differently based on prior experiences.***

Throughout the course of interviews, each member of this team described an appreciation of and connection to diversity based on previous life experiences. Each of the four participants leveraged experiences from immersion in different cultures and prior experiences with engineering. When asked about his peer group prior to engineering, Ezekiel described this group

as the “rainbow squad” identifying the ways in which this group was diverse ranging from descriptions of religion to those of culturally laden social identifiers.

We called ourselves the rainbow squad because we had everybody...We had black people, we had African people, we had Hispanic people, Filipino people. Of course, white people. We had everybody. Only race I can think of we didn't have might have been Native American, and I count myself Native American because my mom's side has Cherokee, so I'd say I'm the Native American of the squad... I've always been around other people. (Ezekiel)

Additionally, Ezekiel brought up religious and political diversity when discussing his home life. Specifically, he joked about the political diversity at family functions he said:

My family is split politically and it's quite entertaining. On my dad's side, half are Republicans, and they're die-hard Republicans, other half die-hard liberals, Democrats. If someone makes the mistake of mentioning Ronald Reagan once, it's lit.

When discussing his experiences with diversity, Ezekiel described the desire to understand difference and understanding how others lived saying, “[I want] to see how people actually live in a different environment with different circumstances.” In wanting to explore topics of diversity, Ezekiel sought to create diverse scenarios within his engineering team instead of following the patterns and habits of his other team members. He stated, “I was really confused as to why they wanted those specific seats. I guess that's just human nature. I mean, I don't know.” In this quote, Ezekiel discussed being confused or not knowing why individuals in his team sought out the same experience instead of different experiences. This homogeneity led to a level of discomfort for Ezekiel. He shared, “[I]f I'm a part of a team and we all see it from the same perspective, I get really antsy and I feel like we're missing something.”

Ezekiel's discussion of how he viewed diversity, demonstrated that he valued a range of diverse perspectives often driven by demographic characteristics, but he also valued variety in beliefs and attitudes. He used this value to examine or seek out diverse experiences and expressed discomfort when exposed to scenarios that did not reflect this diversity.

In contrast, Xander did not easily notice diversity or differences among team members. For him, diversity was about individual mindsets rather than visible aspects of diversity. He did not openly discuss racial diversity and seemed uncomfortable with the topic. At one point during the interview, he did mention ethnicity in passing stating, “It didn't really make that much of a difference to me at all because we were all contributing ideas and I guess it's more of the upbringing of the person that tells you how intelligent they are, more than their ethnicity.” In regards to demographic diversity, he focused only on gender in his engineering team experiences. When asked if diversity affected the types of solutions, his team came up with, he stated, “I don't know if it really affected us because I never had a girl in my engineering group so I wouldn't know.” Xander discussed the geographic homes of his teammates but noted, “It's not really different. I didn't really notice that much of a difference. I guess [their] ideas were a little

more different, but I couldn't really tell you how." He understood that his teammates were from diverse places but could not articulate the effect of this difference in the team.

The third member of the team, Stanley, identified diversity as a necessary component of any corporation he would work for saying,

I had one thing that was kind of important to me since I was of international background. I'd want to work with a diverse group of people and wanted to utilize my language skills. (Stanley)

Stanley treated the definition of diversity as solely an individual's national origin or personal background. Similar to both Ezekiel and Xander, he talked about the places his teammates lived and their family backgrounds. He also mentioned the languages people spoke as diversity, but rarely brought up other aspects of diversity outside of international or domestic student status. Despite this valuing of diversity, Stanley openly preferred that his friends and the people he worked with share similar opinions and interests (regardless of their origins). He described his friends in the following ways:

I feel like a lot of my friends, we kind of think alike. When we're just talking about politics, for example, I think a lot of my group of friends were pretty liberal, me included, in terms of political stuff, think the same. And in terms of interest, my closest friends - they all play soccer so that's one of the reasons I got to be friends with them in the first place. I think we had similar interests, like soccer and like video games, most definitely. That definitely was the beginning to our friendship. (Stanley)

When asked if his friends all thought similarly to himself, Stanley responded in terms of the political opinions and recreational activities that he and his friends shared. He also said, "Yeah, I definitely feel more comfortable hanging out with kids who think alike and like the same kind of stuff that I do." Despite having attended a high school that was internationally diverse, Stanley did not express value for demographic diversity in engineering or his social circles. His extensive experiences living with and going to school with an international population shifted his focus to look for underlying commonness as the most important foundation for a successful team. Of all the teammates, his definition of diversity was the least developed and, in his descriptions, did not influence his experience or value of diversity in engineering teams. We found this subordinate theme surprising because he had the most international experiences as a part of his background.

The final member of the team, Peter, was highly aware of his ethnicity growing up in a small, rural town in [Southern State]. This awareness made his identity as a minority particularly salient in his engineering team. Peter highlighted his Chinese heritage and compared his experiences growing up in the Southeastern and Northeastern U.S. sharing, "In [Southern State], it was a lot of trucks, hunting, a lot of ag[riculture] stuff in school. New York is just shopping, going out to eat, just hanging out. I think that's what I'm getting at. It's just different cultures." He talked about "white people" focusing on "just, hunting and trucks" in [Southern State]. When reflecting on going to school in [Southern State] he said,

There were a lot of people different from me, but that group of people were very similar to each other ... Literally speaking, me and my sister, we were the only ones there that were Asian. Besides that, there were white people, black people, and then the Hispanics. That was it. (Peter)

This perception of standing out in the crowd led to Peters' valuing of diversity in an engineering context that emphasized differences in interests and activities that improved the quality of the outcomes and viewed a team as greater than the sum of its parts. Peter mainly focused on the value of diversity for accomplishing tasks rather than for any other contribution to his engineering educational trajectory.

Each of the participant's discussions of diversity expressed an aspect of diversity that they valued (e.g., different mindsets or demographics). The value of these aspects of diversity was often driven by experiences, many of which fell outside of engineering coursework. These views of diversity were then linked to the ways in which the participants connected or did not connect diversity to engineering and teaming. These trends reflect cultural norms in engineering that have shown that diversity is often valued for innovation, but not for other substantive reasons<sup>34</sup>. This value for diversity only occurs when it does not disrupt the normative engineering practice. When the value for diversity conflicts with normative engineering practice, other considerations are often ignored. The results of our work show that the participants enter engineering with a value system for diversity that is based on prior experience. Students applied these value systems to their diverse engineering teams. While Ezekiel discussed a value of diversity based on demographics, beliefs, and attitudes, his teammates focused more on valuing diversity in thought, language, and class outcomes. Valuing thought or mindsets prioritizes the technical capacity of individuals over skills derived from diverse experiences, potentially reinforcing the social and technical divide in engineering<sup>41,42</sup>. As we will unpack in the next section, the different values for diversity were negotiated in this team into an overall team value for diversity that was put aside when working to accomplish an engineering task. This resulting discussion of the role of diversity in student teams highlights the ways students are potentially socialized to depoliticize engineering and renegotiate the value of diversity in engineering classrooms<sup>41</sup>.

#### ***A team conception of diversity was negotiated to accomplish a task***

When discussing engineering teams, the group saw teams as only necessary to efficiently complete tasks that were too great for an individual. Despite the different definitions and values of diversity espoused when directly questioned about the topic, students focused on getting assignments and projects completed as the particular value of working in diverse teams.

I mean, at that point you're forced to work together, even if you don't want to. I didn't mind it because ... you definitely can't do those [tasks] by yourself because that's an hour with a group. That's ridiculous if you want to do it by yourself. (Peter)

As projects become larger scale, and more complicated there's a limit to what one person can accomplish. (Stanley)

When expanding their discussion to examine the role of diversity in engineering teams, the team viewed diversity as a necessity to provide perspectives to achieve a pragmatic goal.

If you're an individual, you would only have one perspective, and working in a team gives you multiple perspectives. It would help improve on things you didn't see by yourself. (Xander)

There are definitely more positives than negatives, positives being you had a lot of different ways of thinking about things and different approaches to a problem. (Stanley)

Stanley's consideration of diversity in engineering teams mirrored that of Xander in its discussion of different ways of thinking but he also explicitly mentioned that there might be pros and cons to having a diverse team. Additionally, Peter discussed how teams provide a point to collaborate on solutions, thus reducing the personal burden when solving a problem. Peter felt that working in teams improved the quality of his work when compared to his individual work,

Something I like might not be favorable to someone else. They might look at it and say "Hey, this needs to be done or something." Definitely, different work, better quality of work, yes. (Peter)

Each individual's views reflected a homogenous narrative that diversity provided a means of accomplishing a task in a way that is better than what could be accomplished individually. Despite explicit classroom discussion that was repeated throughout the semester of a multifaceted view of diversity within teams, this particular team negotiated a definition of diversity that focused on deliverables and grades rather than particular experiences within their team. While the team expressed value from having multiple individuals to share the burden of engineering work for the course, Ezekiel did express concern when diversity was used only for pragmatic solution development (i.e., getting antsy when all ideas were the same, as quoted in the previous section). The valuing of task completion and the ability to get more work done in engineering teams reflects the meritocratic values of engineering that have been previously noted. In other words, instead of prioritizing unique mindsets or creativity of solutions, this team found the value of diverse teams in the ability to accomplish more. Despite Ezekiel's deviation from this trend (he desired to leverage diverse or creative thinking), this viewpoint was not expressed in the group leading to his overall discomfort with uniformity in different aspects of the engineering design process. Previous work in motivation has shown that when student values are not accepted in social environments (here, engineering teams) it can lead to the need for the individual to construct a new identity or to leave that environment for one that is more accepting of their identity<sup>43</sup>.

***This negotiated conception of diversity affected the individuals on the team as well as the whole team's experience***

The students in this team solely focused on final class deliverables, efficiency in completing assignments, and getting a good grade within their team over the role of diversity in teaming. For Peter, completion of the work in a timely manner indicated a successful teaming experience.

The work was easy. We got it done quick enough. We never had to worry about it after class. Everything was the same as any other group project. We went in, got the work done. I did get the shape of the house right, of course. We managed to achieve that. That was a little bit stressful, but we did it. (Peter)

One of the only team members that raised concerns, Ezekiel, acknowledged the team's focus on "getting it done" and although he wanted more out of working in a diverse team, he did not challenge the negotiated definition of the team.

So, I don't know. [We compromised], we ended up getting a good grade, so I was, like, okay, whatever. (Ezekiel)

While reluctant, Ezekiel shifted his stance to accept that getting a good grade was "okay." The discussion of success on the team did not reflect the role that diversity could have played in improving their solutions or deliverables for the course. When diversity was discussed, participants often expressed that the perceived limited diversity of their team, while not without limitations, was beneficial:

I thought [the team] was fine. We're all guys so we kind of think the same way. It I guess helped us, but I guess we didn't have that other perspective that could've been useful maybe at other times. (Xander)

Xander viewed being on an all-male team as something that helped the team even though he noticed they were lacking alternative perspectives that could have been useful. Stanley was pleased that there were no women on his team because he could be more "laid back," and he knew that his group would have shared interests. Although Stanley espoused particular values for diversity, he wanted to retain commonality between the team members – a commonality that can be better ensured by being on an all-male team. Ezekiel was "mad" that he had been placed in an all-male team. He stated he was "angry" about it at the beginning of the semester and noticed all the teams around him in class had "at least one girl." The case described in this paper is a highly diverse all-male team. Analyses of gender-diverse teams are under exploration for future work.

Compared to the other members of the team, Ezekiel was negatively affected by the team's initiative to do whatever it took to get the highest grade in the class. He was, self-admittedly, not the strongest student in math on his team saying,

I had no idea how to do the math for it. I was just going to brute force it. Peter actually knew what he was doing. There is the difference in approach in that. That is what led us to, "Peter's going to handle the math, Ezekiel, you handle the writing part." I was saying, "Explain to me how this works. I'm going to write it down and make sure that it all is formatted correctly so we get the good grade. I'm going to figure how to do this on my own at some later point so I'm doing well with the practical. For now, we need to get the good grade so let's figure out how we're going to get that. (Ezekiel)



This quote paired with his first quote in this section demonstrated Ezekiel shifting his value system (i.e., prioritizing diversity and creative thinking) to match that of his team (i.e., getting a good grade). These quotes not only show Ezekiel shifting his value system but also doing it to his own detriment. As the team continued to prioritize the accomplishment of goals over integrating diverse skill sets and valuing differences, an environment was created where implicit bias and unintentional exclusionary actions occurred. In the observations of this team, Ezekiel was seen regularly suggesting ideas that were then ignored or unacknowledged by his teammates. In his first-year experience, Ezekiel and his team members were undergoing professional engineering socialization, learning the tools, knowledge, and practices to “think like engineers.”<sup>41</sup> These students were learning to embody the beliefs and values of the culture of the engineering profession. Ezekiel and his teammates re-negotiated their individual value of diversity to a working definition that allowed them to accomplish engineering work. Unfortunately, these new values did not prioritize diversity and inclusion as an essential part of engineering work.

Through understanding the ways in which the value systems of individuals were prioritized or deprioritized in engineering teams, two main interpretations emerged for this team: *limited diversity* and *adaptation to the team norms* are better for engineering. Previous work has noted that individuals are more likely to associate with similar others due to shared backgrounds and experiences<sup>44</sup>. Working with similar others makes the process of team formation easier as these shared experiences can be used to craft team norms<sup>21</sup> and are more likely to lead to team satisfaction, commitment, and performance<sup>20</sup>. While engineering teams are temporary organizations that students operate within, they must still undergo the process of norming. Here, the participants crafted team norms around grade-based performance over performance in other areas (i.e., diversity). The prioritization of performance has been shown to lead to the adoption of maladaptive learning practices in engineering populations<sup>45</sup>. While the participants may have learned aspects of engineering design or about engineering teams, they sacrificed learning and implementing the conversations about diversity in order to do so. These practices may have unintended consequences on individuals that truly desire a deeper integration into the team and can reify a culture of engineering that emphasizes technical prowess over social integration<sup>34,41</sup>.

Additionally, Ezekiel, as the lone member of the team, compromised his perspective and adopted the values of his team. As discussed previously, student identities can be rewarded or punished when expressed in different environments<sup>43</sup>. Work in engineering identity has shown that being recognized by others as an engineer supports the positive development of an engineering identity and choice of engineering<sup>46</sup>. Ezekiel established his engineering identity enough to pursue a degree in the field; however, when he expressed social values that were contrary to the team culture, he was ignored and met with resistance from his teammates. To maintain his integration in the team, Ezekiel shifted his values to match those of his team instead of maintaining his own. This shift may have serious implications for Ezekiel and students like him when they are asked to work in engineering teams. Suppressing particular values or orientations can be detrimental to motivation and belongingness and may increase students’ likelihood of leaving engineering<sup>47</sup>. While this shift aided Ezekiel’s academic success, it limited his ability to act in line with his identity and beliefs (i.e., learning about diversity) as he took on those of the team. The experience of Ezekiel begins to explain other quantitative findings from this research project that

students' willingness to take action to help diverse individuals goes down over the course of the semester<sup>48</sup>.

Despite this team conveying the importance of diversity, both individually and collectively as a team, this team struggled to embrace it throughout all the phases of their engineering practice. Pragmatism overrode their behaviors in their team. They focused on completing assignments and projects, which prevented them from challenging themselves and deeply considering and incorporating diverse perspectives in their teams. While the students in the team completed their projects on time and at an acceptable level of quality, their first-year experience marginally shifted their incoming attitudes about diversity and its practical role in engineering work.

## **Implications**

The results of this work indicate that students enter the engineering classroom with values of diversity based on their experiences that persist into engineering tasks. Students with views that match the dominant culture into which students enter are supported, while those who do not often shift their values to match the dominant culture are not supported. Engineering educators seeking to foster the development of attitudes that support diversity must target ways to prioritize this thinking in students who already have these values.

Additionally, first-year engineering instructors and staff must be aware that even the best practices of forming and educating students about working in teams do not fully address deep and underlying issues of how students interact with one another in teams. Students' attitudes are "sticky" and a single semester or first-year experience may begin to shift students' espoused values of diversity. However, without ways to connect these espoused values to engineering practice, students struggle with integrating lessons on diversity into teaming experiences. If we truly want to affect change in engineering culture and student experiences in teams, more targeted and distributed interventions must be present throughout an undergraduate education.

The best practices highlighted by Tonso and previous researchers are not enough to create inclusive teaming practices<sup>18</sup>. Simply focusing on building diverse teams based on outward aspects of diversity like race/ethnicity, international status, or gender identity does not ensure positive teaming experiences. This team is an excellent example. From outward appearances, this team was diverse in national origin, ethnicity, geographic location, religion, and disability status. However, this team focused on common aspects of their experiences and deemphasized diversity to accomplish engineering tasks. This step may be important in the norming phase of teaming development, but students must also be willing to discuss, confront, incorporate, and utilize differences to be successful.

Explicit instruction and best practices also did not create teams that are more inclusive. Instructors in the course in which this team was enrolled taught about the value of diversity and throughout the semester, incorporated experiences that discussed respecting teammates needs. Teams were organized using CATME to balance composition as well as give peer feedback anonymously to students throughout the semester. A wide variety of teaming expectations and grading practices were used including team activities, design deliverables, presentations, and even a team exam. These practices are important, and we want to acknowledge evidence in the

literature to support effective teams with less conflict. However, these practices are not sufficient to create teams that do more than espouse the value of diversity. All students could describe why diversity was important in engineering. In fact, many of their descriptions were eerily similar to class discussions. However, the team did not incorporate those espoused values into the way they work, group discussions, or engineering projects. This lack of translation emphasizes the need for additional work in understanding additional ways to create more inclusive teams starting in first-year engineering courses.

### **Limitations and Future Work**

We acknowledge that this study is limited to the experience of one exemplar team. We further acknowledge that this is an all-male team. Through this work, we seek to unpack the complexity of diversity in engineering teams by analyzing a layered depiction of individual and collective experiences of these teams and their members. We have data from an additional seven teams to continue to understand how students define and value diversity and how those individual perspectives are incorporated into teamwork in first-year engineering. These additional teams have a wider range of gender identity representation. We chose to analyze this team first because of the completeness of the dataset as well as the racial and ethnic diversity in this team.

Our future work involves further analysis of teaming experiences including continuing crystallization with other sources of data: video observations, implicit association tests, and pre- and post-semester survey data. This qualitative study provides rich nuance and adds to the future case study. We believe that these additional perspectives can provide a bigger picture of how students experience working in diverse teams in their first-year engineering classes and provide evidence-based leverage points for developing students' attitudes' about diversity and skills working with others in teams. This work is the first step in exploring a complex phenomenon with few mixed methods approaches and contrasting findings.

### **Conclusions**

After interviewing students in this first-year engineering team about their understanding of diversity, we found that while these students considered diversity important in their espoused values, it was difficult for this team of students to integrate diversity in teaming activities and behaviors. Individual understandings of diversity did not coalesce into an equitable team understanding and utilization of the different team members. This led to inequitable experiences and a lack of growth throughout the team. The comparison between the experiences of the members of this team of four shows engineering educators that diversity within a team is not always about outward markers of diversity. Despite being from diverse parts of the world, having different experiences with and perceptions of diversity, this all-male student team felt they were more homogeneous than different. Our work highlights the need for a deeper examination of the intricate complexity of teaming experiences during inquiry and design activities.

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