Exploring Student Motivation towards Diversity Education in Engineering

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***Abstract*— If the engineering education community is serious about improving its culture and climate for underrepresented groups, it is imperative to educate students about the importance of diversity and inclusion. Effectively incorporating diversity-related course content into the curriculum requires an understanding of student knowledge of and attitudes toward diversity. Accordingly, this work-in-progress explores engineering students' beliefs about the intersection of diversity education and the engineering curriculum. Informed by Eccles' Expectancy Value Theory (EVT), the authors pose the following research question: *What ability-related beliefs and subjective task values do undergraduate engineering students have in relation to diversity education?* This exploratory study resulted in the development of an interview protocol and survey instrument for exploring students' beliefs about diversity as it relates to engineering. Initial findings point to the need for closer examinations of student attitudes in subsequent research. Ultimately, the results of this study will directly informed diversity and inclusion efforts at our local institution.**

Keywords-- diversity; inclusion; motivation

I. Introduction and Background

The field of engineering has historically suffered from issues of compositional diversity and inclusion. More specifically, engineering is overwhelmingly white and male [1]; and many students from underrepresented groups experience a "cold climate" [2]. Consequently, there are persistent calls to recruit students from underrepresented groups and remove these barriers to participation. Despite such calls, to date, little effort has focused on incorporating diversity education into the engineering curriculum: diversity efforts primarily focus on supporting the students from underrepresented groups and position such efforts as bracketed or separate from discussions of diversity *within* engineering. We argue that the goal should not be to help people adapt to their oppressive conditions, but instead to develop culturally competent engineers that can build an inclusive community.

To achieve this goal, we must engage *all* students in conversations about diversity and its importance within engineering specifically. However, little is known about student motivation towards diversity education within the context of engineering; understanding student motivation is important because we need students to actively engage in these activities (i.e., be motivated to learn about these topics). Developing a better understanding of students' motivational beliefs at the intersection of diversity and engineering would allow educators to more effectively incorporate such education into current engineering curricula and provide students with a better awareness of the importance of diversity as it pertains to engineering contexts. Furthermore, current literature offers limited insight regarding instrumentation (e.g., survey instruments and interview protocols) designed to investigate topics of diversity with engineering students. Thus, there was an additional need to develop tools to examine student views of diversity as it pertains to engineering.

Given the sensitive nature of many topics typically associated with diversity (e.g., racism, sexism, etc.), it is imperative that we approach diversity education in ways that let students meaningfully engage with these difficult topics and make relevant connections to their own world. To do so, we must understand what motivates students to learn about diversity-related topics or issues in a setting primarily focused on engineering. To explore student conceptions of diversity within engineering, we posed the following research question: *What ability-related beliefs and subjective task values do undergraduate engineering students have in relation to diversity education?*

II. Framework

To answer this question, we leveraged Expectancy-Value Theory (EVT) [3, 4] to explore students' expectancies of success and subjective task values

regarding learning about diversity in engineering. To help contextualize our findings, we also explored students' prior knowledge of diversity. In its simplest form, EVT suggests that people tend to engage in tasks or activities in which they believe they can succeed (expectancy of success) and that are important to them (subjective task values). In this case, the task is learning about diversity in the context of engineering. Subjective task values include: interest in the task; the cost of participating in the tasks (in terms of time and effort required); the utility of the task; and the personal importance of the task (attainment value) [5]. Expectancies of success and subjective task values are shaped by factors such as perceptions of the task; ability beliefs with regard to the task; personal characteristics such as race, gender, ethnicity, etc; and the beliefs of others (valued socializers). Based on EVT, we posit that engineering students who believe they can learn about diversity and view it as important to their development as engineers will more readily engage in learning activities focused on diversity.

III. Methods

The overarching goal of this project was to develop new and innovative efforts for enhancing diversity in engineering. As a result, survey items and interview protocols were developed to probe students' motivational beliefs surrounding diversity education.

A. Participants

Participants were recruited from a living-learning community (LLC) at the researchers' home university. This LLC was chosen due to its environment—which offers opportunities for integration of diversity education that could be directly informed by the findings of this study.

First-year LLC students participate in a seminar and various (e.g., academic, professional, and service) community activities designed to enrich their experience. Part of this enrichment includes diversity education, including opportunities for students to discuss topics of diversity, engage in self-reflection, and participate in other activities designed to explore the various identities of engineers. While these activities are helpful, the current approach to address diversity education employed by the LLC is limited in conveying the importance of diversity for engineers; consequently, students treat diversity as an issue that, although important, is distinct from engineering topics. Hence, our work seeks to *explore* engineering students' conceptions of diversity as it relates to the engineering curriculum.

In total, 70 LLC participants responded to the survey—approximately an 11% response rate. It should be noted that students self-selected into participation and the demographics of our sample match neither the demographics of the LLC nor the engineering student population more broadly. Women are substantially overrepresented in our sample, which suggests that we may be overlooking or failing to sufficiently capture the voices of young men in engineering. Future iterations of this work will strive to capture a more representative sample.

B. Expectancy Value Theory

We leveraged EVT concepts to design the survey questions. We reviewed existing EVT survey structures and used aspects of diversity to situate the task of learning about diversity in an engineering classroom. Table 1 presents the three elements of EVT that our survey instrument focused on (i.e., ability beliefs, expectancy for success, and subjective task value) and includes sample questions from the resulting instrument.

Table 1 - Elements of EVT with definitions and sample survey questions.

Ability Beliefs	
Definition	An individual's perception of their current competence at a given activity
Sample Items	• I am confident in my ability to communicate with people from different backgrounds. • I am confident in my ability to articulate my opinions on issues related to diversity. • I am confident in my ability to learn about race/ethnicity in an engineering classroom.
Expectancy for Success	
Definition	An individual's expectation that they can produce a particular outcome
Sample Items	• I will find it difficult to participate in activities focused on diversity in an engineering classroom. • I am well prepared to engage in educational activities focused on diversity. • I expect my opinions about issues related to diversity will not change based on an engineering class.
Subjective Task Value	
Definition	An individual's belief about the value of doing a task. Broken into four subcategories: attainment value, intrinsic value, utility value, and cost.
Sample Items	• Learning how to communicate with people from different backgrounds is important to me. • I am interested in learning about ethics in an engineering classroom. • Learning about gender issues in an engineering classroom is useful to me.

C. Data Collection

To ensure that we were covering appropriate topics when talking about diversity, we reviewed articles on diversity paradigms and expanding underrepresented minority participation [6-8]. Next, we brainstormed survey and interview topics to generate questions, referring back to the LLC seminar course outline when necessary and including questions related to the following aspects of diversity: race, ethnicity, gender, oppression/discrimination, ethics, sexual orientation, disability, and socioeconomic disparities. We then pooled the subsequent questions and sent them to local subject-matter experts to be reviewed for clarity, cohesiveness, and acceptability. Finally, we aligned our questions with EVT by referencing the structure of an existing instrument.

We distributed the finalized survey instrument to the entire LLC community, approximately 600 students. We asked students to indicate the extent to which they agreed or disagreed with statements such as those in Table 1. We included questions pertaining to the student's views of engineering in general and requested demographic data such as sex, ethnic/racial group, and academic year.

We also solicited volunteers to participate in interviews. We interviewed all participants that volunteered. This included 5 men and 14 women. The interview protocol addressed content similar to the survey but used open-ended questions that allowed us to probe deeper and seek explanations. Although we have not finished interview analysis, preliminary interview data informed our survey analysis process.

D. Data Analysis

After distributing the survey and conducting 19 interviews, we (i.e., each researcher who participated in conducting interviews) discussed trends in the qualitative and quantitative data. These trends guided our decision to choose which questions from the survey to present in our preliminary findings. Importantly, the last question on the survey asked students, "*In general, do you believe it is important for engineers to learn about diversity as a part of their undergraduate education*?" We used the responses to this question (*Yes* or *No*) to divide the results because we were curious to see if there was any difference in the way students ranked different aspects of diversity.

IV. Preliminary Results

For preliminary findings, we present descriptive statistics separated by students' belief that either (*Yes*) it is important for engineers to learn about diversity as a part of their undergraduate education or (*No*) it is not important for engineers to learn about diversity as a part of their undergraduate education. Table 2 and 3 show the mean response on a scale of 1 (not at all important) to 7 (very important) for two questions.

As seen in Table 2, regardless of student beliefs of the importance of diversity in engineering education, respondents valued the various aspects of diversity similarly, albeit to different degrees. That is, diversity of thought, academic major, work-experience, and age are perceived to be the four most important elements of

diversity, regardless of whether or not students think those aspects are important for engineers, to learn about during undergraduate education. Conversely, students saw religious diversity and sexual orientation as the least important factors in the quality of solutions produced by an engineering team.

Table 2 - Importance of different aspects of diversity on quality of engineering solutions.

Types of diversity	Mean (yes) n =57	Mean (no) n =13
Diversity of thought	6.54	5.38
Academic major	6.09	4.77
Work-experience	6.04	4.92
Age	5.67	3.62
Gender	5.61	2.77
International	5.60	3.54
Demographic	5.54	2.85
Socio-economic	5.44	3.62
Racial/ethnic	5.44	2.92
Physical-ability	4.53	2.77
Religious	3.98	2.00
Sexual orientation	3.98	1.62

As seen in Table 3, regardless of student beliefs of the importance of diversity in engineering education, respondents rated functioning on multidisciplinary teams and understanding the impact of engineering solutions as the most important aspects diversity contribute to engineering tasks. Diversity was seen as least important in data analysis for both groups.

Table 3 - Importance of diversity in contributing to these engineering tasks.

Engineering Task	Mean (yes) n=57	Mean (no) n=13
Functioning on multidisciplinary teams	6.19	5.00
Understanding the impact of engineering solutions	6.12	4.62
Interpersonal relationships	6.07	4.15
Solving problems	6.00	4.23
Identifying problems	5.93	4.46
Developing systems and products	5.77	3.46
Project management	5.68	4.46
Designing and conducting experiments	5.53	3.15
Technical communication	5.11	3.23
Data analysis	5.02	3.08

V. Discussion and Future Work

Our preliminary results suggest that there may be motivation-related trends for engineering students who are positive and negative in their views of diversity: students who are more skeptical about the connection between diversity and engineering rank aspects of diversity similar to their more motivated counterparts, just to a lesser magnitude. That is, even though all aspects of diversity might be perceived as less important for these students, aspects are perceived in the same order of relative importance.

In the next phases of the study, we will redistribute the survey and conduct factor analysis on the survey results to see how different aspects of diversity load. This will aid in determining the internal validity of the scales included in the survey instrument. We will also see if the separation between students who answered *Yes* or *No* to the last question is statistically significant. This will allow us to make more concrete recommendations moving forward. Lastly, we will code the interview transcripts to find emergent themes in the data.

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