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# A Failed Attempt to Develop a Measure of Engineering Students' Subjective Task-value for Diversity and Inclusion in Engineering

**Ms. Ashley R. Taylor, Virginia Tech**

Ashley Taylor is a doctoral candidate in engineering education at Virginia Polytechnic and State University, where she also serves as a program assistant for the Center for Enhancement of Engineering Diversity and an advisor for international senior design projects in the Department of Mechanical Engineering. Ashley received her MS in Mechanical Engineering, MPH in Public Health Education, and BS in Mechanical Engineering from Virginia Tech. Her research interests include access to higher education, broadening participation in engineering, the integration of engineering education and international development, and building capacity in low and middle income countries through inclusive engineering education.

**Dr. Walter C. Lee, Virginia Tech**

Dr. Walter Lee is an assistant professor in the Department of Engineering Education and the assistant director for research in the Center for the Enhancement of Engineering Diversity (CEED), both at Virginia Tech. His research interests include co-curricular support, student success and retention, and diversity. Lee received his Ph.D in engineering education from Virginia Tech, his M.S. in industrial & systems engineering from Virginia Tech, and his B.S. in industrial engineering from Clemson University.

**Mr. Benjamin David Lutz, Oregon State University**

Ben Lutz is a Postdoctoral Scholar in Engineering Education at Oregon State University. His research interests include innovative pedagogies in engineering design, conceptual change and development, school-to-work transitions for new engineers, and efforts for inclusion and diversity within engineering. His current work explores how students describe their own learning in engineering design and how that learning supports transfer of learning from school into professional practice as well as exploring students' conceptions of diversity and its importance within engineering fields.

**Dr. Holly M. Matusovich, Virginia Tech**

Dr. Matusovich is an Associate Professor in Virginia Tech's Department of Engineering Education. She has her doctorate in Engineering Education and her strengths include qualitative and mixed methods research study design and implementation. She is/was PI/Co-PI on 10 funded research projects including a CAREER grant. She has won several Virginia Tech awards including a Dean's Award for Outstanding New Faculty. Her research expertise includes using motivation and related frameworks to study student engagement in learning, recruitment and retention in engineering programs and careers, faculty teaching practices and intersections of motivation and learning strategies.

**Cynthia Hampton, Virginia Tech**

Cynthia Hampton is a doctoral candidate in Engineering Education at Virginia Tech. Her research centers on change agency, system structures, and factors that relate to broadening participation of unserrepresented groups in engineering.

# A Failed Attempt to Develop a Measure of Engineering Students' Values and Beliefs about Diversity and Inclusion in Engineering


## Abstract

While several studies have advanced the engineering education community's understanding of the experiences of students from underrepresented groups, less work has focused on unpacking the beliefs of engineering students more broadly as it relates to diversity and inclusion. Because generating such information is a challenging task, the purpose of this paper is to discuss the methodological lessons learned in our attempt to advance understanding of the values and beliefs students' hold about these topics. In this paper, we discuss in detail the development of instrument items, subsequent data analysis, and lessons learned in the process. Overall, our analysis suggests that our instrument failed to define task values at a level specific enough for students to discriminate one task from another. Ultimately, we concluded that instrument items were highly correlated, thus not suitable for confirmatory factor analysis. Based on these insights, we offer pragmatic suggestions for refinement of the instrument. In these suggestions, we aim to enlighten future efforts to engage students in the diversification and inclusivity of the engineering field, and prevent future researchers from making similar methodological mistakes.


## Introduction

Since the U.S. Congress passed the *Science and Technology Equal Opportunities Act* in 1980, diversifying the engineering workforce has remained a national priority [1]. This act underscored the desire to reach equal representation of genders, races, ethnicities, and economic statuses in the engineering profession [2], and emphasized the support of groups that are traditionally underrepresented in engineering, such as women, African Americans, Hispanics, and Native Americans [1], [3]. Diversity advocates have since expanded the conversation to recognize additional dimensions of identity, such as students with veteran status [4], [5], students who identify as lesbian, gay, bisexual, transgender, queer, or questioning [6], [7], and students with disabilities [8].

Most recently, the conversation has expanded to consider the role of members of predominant groups [9], [10]. For example, the *Engineering Allies* program at Ohio State University aims to educate men surrounding implicit and explicit masculine workplace cultures and their impact on women faculty in engineering [9]. As we work to engage more students, it is imperative to understand and measure their beliefs, which may be neutral and or negative [11]. A deeper understanding of students' beliefs about diversity in engineering may help identify areas of opportunity, design effective interventions, and measure progress. Unfortunaltey, while several studies as noted herein have advanced the engineering education community's understanding of the experiences of underrepresented students, less work has focused on unpacking the beliefs of engineering students more broadly as it relates to these topics.

### Purpose

Accordingly, the purpose of this paper is to discuss the methodological lessons learned in an attempt to advance understanding of the values engineering students' hold about diversity. Leveraging Eccles' Expectancy Value Theory [12], we explored the following question: *What* *values and expectations do engineering students have as it relates to diversity-focused learning opportunities in engineering?* Instead of attempting to answer this question herein, we discuss the development of measures for students' subjective task value about diversity, providing an overview of our operationalization of the constructs, process to develop measures, and results from an exploratory factor analysis. We offer recommendations for instrument development, and aim to enlighten future efforts that focus on understanding the beliefs and attitudes students hold.

## THEORETICAL FRAMEWORK

We leveraged the Expectancy Value Theory (EVT) of Achievement Motivation [12]. Originally developed to understand young women's career choices related to science, technology, and math [13]–[17], EVT has since been used increasingly to study students' career choices, [13], [18], motivation [19], and overall perceptions of engineering education [20].

At the highest level, EVT asserts that a learner's motivation to engage is comprised of the value they attribute to completing a task (i.e., *subjective task value)* and the degree to which they believe they can succeed at that task (i.e., *expectancy for success*) [12]. Other aspects of the model identify factors contributing to success and value beliefs. We justify the use of EVT by highlighting a central tenet of the theory: students are more inclined to engage in activities in which they expect to succeed and value in some way [12]. Specifically, we used *subjective task value* (STV) and *expectancy for success* constructs of EVT to investigate the degree to which students view diversity-focused learning opportunities in engineering as valuable and believe they be would successful in learning as a result of participation. EVT highlights four types of *subjective task values,* including attainment, utility, and intrinsic (or interest), and cost [21]. Attainment value pertains to how important the task is to an individual's self-concept. Utility value relates to an individual's perception of how important the task is to their future. Intrinsic (or interest) value is the value an individual places on enjoyment of doing the task. Lastly, cost is an individual's perception of the investment of time, effort, and/or psychological impact to succeed as the task. Therefore, based on theory, we expected a four factor solution to our exploratory factor analysis. Our supposition is that if we can understand these aspects of motivation, we can tailor efforts in a way that will most effectively engage students.

## METHODS

### Development of Items and Measures

*Item Development*

We developed items based on a synthesis of the research team's prior experience, literature related to diversity and inclusion, meetings with practitioners who work in this area, and existing EVT-based surveys. We invited practitioners from the local engineering diversity office (or student support center) to inform item development because their efforts to engage first-year engineering students served in large part as an impetus for this study. The instrument contained items related to student opinions on: (1) their ability to learn about diversity; (2) their current knowledge of current diversity issues; (3) the importance of learning about diversity; (4) their interest in learning about diversity; (5) the usefulness of diversity education; (6) their expectancy for success in learning about diversity; (7) their perceptions of engineering; and (8) their perceptions of diversity's contribution to various engineering tasks. To ensure that constructs were captured appropriately, or had a chance at being captured appropriately, over four items were developed per construct, following recommendations for best practice [22]. In total, 80 items were developed as part of this pilot instrument, which can be found in Appendix A. It should be noted that the development of the instrument was a collaborative and iterative process consisting of conversations among the research team. These conversations served to eliminate, add, and revise items in order to create a succinct and consistent instrument. The addition of undergraduate team members also allowed feedback to ensure that the items read in a manner that was appropriate in language and concept for the population sampled.

*Measure Development*

The developed measures consist of self-reported items asking students to rate *to what extent do you agree or disagree with the following statements: on an anchored scale from 1- 'strongly disagree' to 7- 'strongly agree'*. Based on suggestions from literature [23], [24] , the research team anchored the measurement scale (i.e., scored the measurement scale from 1 to 7) to support the interpretation of data as continuous rather than ordinal [24], [25]. Put simply, literature suggests that the distance between responses of 6 to 7 on an anchored scale is conceptually easier to understand than the distance between "agree" and "strongly agree". Conceptually, the seven-point bipolar scale ranges from negative infinity to infinity [26].

**Participants and Data Collection**

Subsequent to developing the instrument, data were collected at a large, predominantly white research institution in the southeastern United States. In order to better understand students' attitudes surrounding diversity in engineering, quantitative data were collected using a cross-sectional design [27] from undergraduate and graduate students enrolled in engineering programs at the research site. Our data constitutes a purposive sample [28] because initiatives to provide students with diversity-focused discussions were ongoing at the research site, both at the undergraduate and graduate level. Gatekeepers (i.e., those leading these efforts) served as a critical resource in recruiting participants for this study. Undergraduate students were recruited from an engineering living learning community (LLC), with invitations to participate in the study distributed via email by LLC leadership. Graduate students were recruited by graduate program directors, who also sent email invitations to all students enrolled in their graduate engineering programs. A total of 182 students completed the survey via Qualtrics, an online survey platform. Participant demographics are shown in Tables 2-5. Importantly, our sample is not representative of the institutional population, particularly as it relates to academic status (i.e., we have predominantly first year and graduate students). Our intention is not to generalize across all students. All data collection was approved by the Institutional Review Board (#16-130).

Table 2. Self-reported gender of study participants

| Self-Reported Sex | # of Respondents | % of Respondents |
|---|---|---|
| Female | 77 | 42% |
| Male | 103 | 57% |
| Another answer | 2 | 1% |

Table 3. Self-reported race/ethnicity of study participants

| Race/Ethnicity | # of Respondents | % of Respondents |
|---|---|---|
| White, non-Hispanic | 113 | 62% |
| Black or African-American | 8 | 4% |
| Hispanic/Latino or Spanish Origin | 10 | 5.5% |
| Asian-Pacific Islander | 34 | 19% |
| Native American or Alaska Native | 1 | 0.5% |
| 2 or more | 13 | 7% |
| Prefer not to answer | 3 | 2% |

Table 4. Self-reported academic major of study participants

| Reported Major | # of Respondents | % of Respondents |
|---|---|---|
| Chemical Engineering | 14 | 7.7% |
| Biological Systems Engineering | 12 | 6.6% |
| Computer Science | 5 | 2.7% |
| Mechanical Engineering | 36 | 19.8% |
| Computer Engineering | 11 | 6.0% |
| Materials Science Engineering | 3 | 1.6% |
| Aerospace Engineering | 26 | 14.3% |
| Civil Engineering | 5 | 2.7% |
| Industrial Engineering | 15 | 8.2% |
| Electrical Engineering | 12 | 6.6% |
| Mining Engineering | 8 | 4.5% |
| Engineering Science and Mechanics | 6 | 3.3% |
| Engineering Education | 14 | 7.7% |
| Biomedical Engineering | 8 | 4.5% |
| Other | 1 | 0.5% |
| 2 or more | 6 | 3.3% |

Table 5. Self-reported academic status of study participants

| Academic Status | # of Respondents | % of Respondents |
|---|---|---|
| Freshman | 58 | 32% |
| Sophomore | 8 | 4.0% |
| Junior | 3 | 2% |
| Senior | 1 | 0.5% |
| Masters' student | 40 | 22% |
| Doctoral student | 72 | 39.5% |

### Data Analysis

To analyze data, the RStudio® programming statistical software was employed. Descriptive statistics were computed for each item. Additionally, exploratory factor analysis was conducted for items relating to *subjective task value*. Data analysis will be further discussed below, as methods are integrated into the results section for ease of reading.

## RESULTS

To gain a better understanding of the dispositions and perceptions related to diversity in engineering, we asked participants about their confidence in diversity focused-activities, perceived relevance of diversity to engineering environments, and subjective values of diversity-focused tasks. In line with recent calls for exploring the broader elements of EVT [29], we developed our survey to investigate elements related to the culture and climate of diversity as well as expectancy and subjective task value (i.e., those most commonly studied in the literature). An important note, however, is that a *diversity-focused learning opportunity in engineering* is a decidedly nonspecific task, compared to completing a homework assignment or passing a test. Indeed, the larger project of which this research is a part demonstrates the challenges surrounding identifying a common definition of the task. As a result, we urge the reader to consider the multiplicity of definitions of diversity when interpreting the below findings.

In the following sections, we first discuss descriptive statistics for survey items. Following, we offer results from multiple iterations of exploratory factor analysis for items relating to *subjective task value.*

**Descriptive Statistics on Student Perceptions of Diversity**

*Confidence and Knowledge*

Related to expectancy for success, we asked students to rate their confidence in their abilities to engage in different kinds of diversity-focused tasks. Here, tasks are defined in terms of interacting with and learning about different social groups and the issues that might be uniquely facing them in engineering contexts. Table 6 and Figure 1 demonstrate that most respondents were fairly confident in their ability to learn about and interact with people from diverse groups in general, though scores are lower when it comes to articulating opinions rather than learning about diversity. Students were most confident in their ability to learn about ethics.

Table 6. Confidence and Knowledge

| **Item #** | **Item** | **Mean** | **SD** |
|---|---|---|---|
| | **I am confident in my ability to:** | | |
| **Q1_1** | communicate with people from different backgrounds. | 5.98 | 1.00 |
| **Q1_2** | articulate opinions on issues related to diversity | 5.53 | 1.20 |
| **Q1_3** | learn about race/ethnicity in an engineering classroom | 5.80 | 1.36 |
| **Q1_4** | learn about gender issues in an engineering classroom | 5.69 | 1.39 |
| **Q1_5** | learn about oppression and discrimination in an engineering classroom | 5.63 | 1.44 |
| **Q1_6** | learn about ethics in an engineering classroom | 6.18 | 1.05 |
| **Q1_7** | learn about gender in an engineering classroom | 5.68 | 1.44 |
| **Q1_8** | learn about sexual orientation in an engineering classroom | 5.40 | 1.63 |

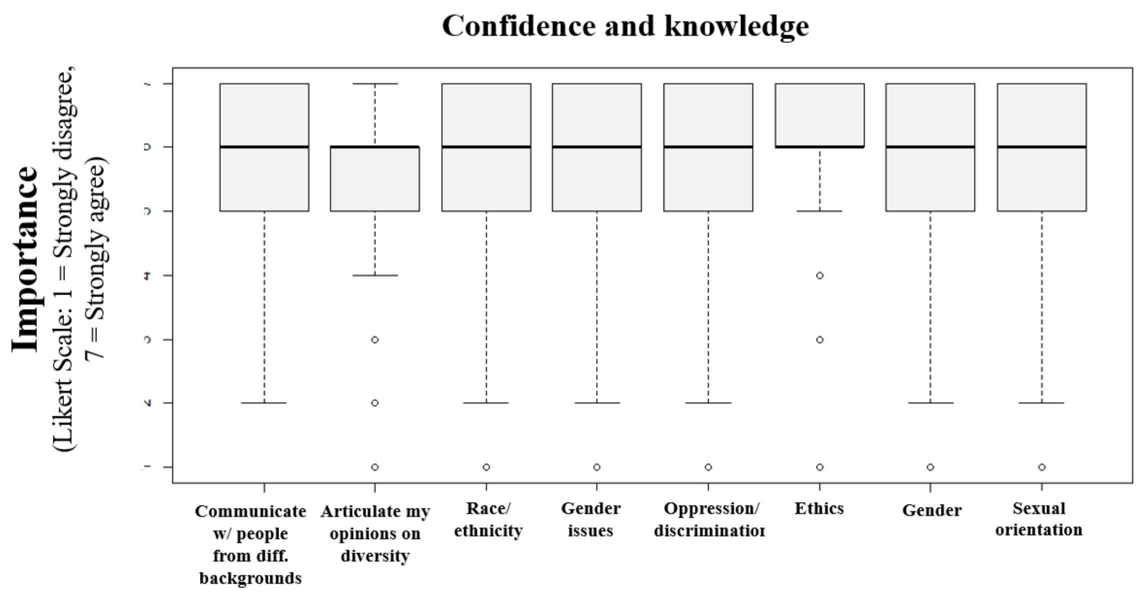


**Figure 1.** Boxplot comparison of students' confidence and knowledge about diversity

While participants reported relatively high confidence in their abilities to *learn about* diversity-focused issues in an engineering classroom, they reported lower levels of overall *knowledge* surrounding issues facing diverse groups in engineering. As shown in Table 7 and Figure 2, students reported being most knowledgeable about issues surrounding race and gender in an engineering classroom. Importantly, we did not ask students to note specific issues or define the terms. Still, scores in Table 6 and 7 reflect high self-reported understanding of current issues surrounding many intersections and axes of privilege and oppression.

Table 7. Knowledge of current issues

| | Item | Mean | SD |
|---|---|---|---|
| | **I am knowledgeable of current issues surrounding:** | | |
| **Q2_1** | racism in the US | 5.54 | 1.09 |
| **Q2_2** | sexism in the US | 5.59 | 1.16 |
| **Q2_3** | the LGBTQ community in the US | 5.36 | 1.29 |
| **Q2_4** | religious freedom and oppression in the US | 5.29 | 1.37 |
| **Q2_5** | disabled people in the US | 4.69 | 1.47 |
| **Q2_6** | poverty and/or socioeconomic disparities in the US | 5.14 | 1.33 |

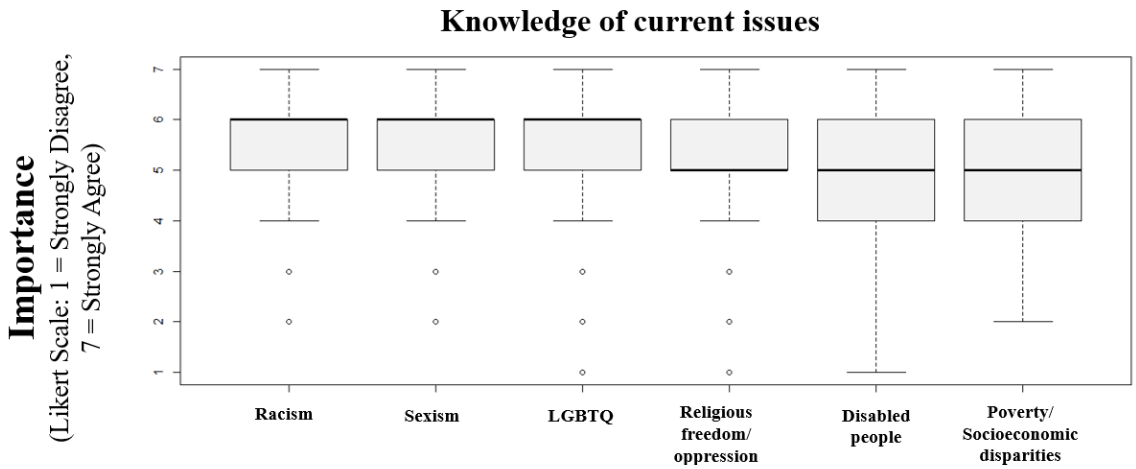


**Figure 2.** Boxplot of self-reported knowledge of current issues in the United States.

*Subjective Task Value*

We defined subjective task value in terms that are consistent with prior investigations using Expectancy Value Theory. More specifically, we developed questions exploring students' attainment value, interest value, utility value. Though we note cost is generally discussed alongside the other three constructs (because it often has a negative relationship with task engagement), developing meaningful quantitative questions proved challenging and the items were ultimately omitted from the instrument. Defining cost has remained a challenge for EVT researchers [30]–[32]. The following descriptive statistics help provide a more general understanding of the current sample in terms of their dispositions and beliefs surrounding diversity in engineering. In general, students saw value in diversity-focused activities or learning experiences, albeit to different degrees.

In terms of attainment value, students saw more value in the interactive or communicative aspects of diversity-focused learning than they did in learning about them in engineering. Table 8 and Figure 3 illustrate that most participants view learning how to communicate "with people from different backgrounds" and "articulating issues related to diversity" as important. At the same time, they saw activities in which they would learn about diversity as less important to them.

Table 8. Attainment Value

| **Item #** | **Item** | **Mean** | **SD** |
|---|---|---|---|
| | **Learning how to:** | | |
| **Q3_1** | communicate with people from different backgrounds is important to me | 6.25 | 1.06 |
| **Q3_2** | articulate my opinions on issues related to diversity is important to me | 5.93 | 1.23 |
| | **Learning about:** | | |
| **Q3_3** | race/ethnicity in an engineering classroom is important to me | 4.95 | 1.87 |
| **Q3_4** | gender issues in an engineering classroom is important to me | 5.01 | 1.84 |
| **Q3_5** | oppression and discrimination in an engineering classroom is important to me | 5.04 | 1.89 |
| **Q3_6** | ethics in an engineering classroom is important to me | 5.80 | 1.58 |
| **Q3_7** | gender in an engineering classroom is important to me | 4.81 | 1.90 |
| **Q3_8** | sexual orientation in an engineering classroom is important to me | 4.50 | 1.96 |

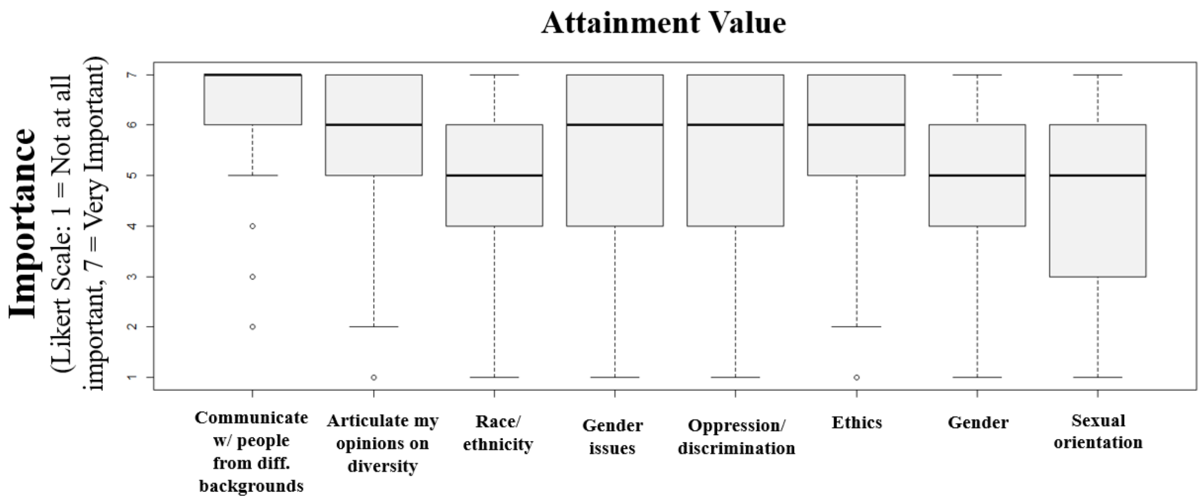


**Figure 3.** Boxplot comparisons of items relating to attainment value.

Similar to beliefs about attainment (or personal importance), participants were more interested in learning *how* than learning *about* diversity in engineering. Shown in Table 9 and Figure 4, respondents were interested in learning how to communicate with and articulate opinions regarding diverse groups and issues they might face. A potentially positive finding here is the preference for communicating with people over articulating opinions related to diversity.

Table 9. Interest Value

| Item # | Item | Mean | SD |
|---|---|---|---|
| | **I am interested in learning how to:** | | |
| **Q4_1** | communicate with people from different backgrounds | 6.10 | 1.28 |
| **Q4_2** | articulate my opinions on issues related to diversity | 5.81 | 1.43 |
| | **I am interested in learning about:** | | |
| **Q4_3** | race/ethnicity in an engineering classroom | 4.99 | 1.96 |
| **Q4_4** | gender issues in an engineering classroom | 4.92 | 1.98 |
| **Q4_5** | oppression and discrimination in an engineering classroom | 4.99 | 1.95 |
| **Q4_6** | ethics in an engineering classroom | 5.52 | 1.78 |
| **Q4_7** | gender in an engineering classroom | 4.76 | 2.01 |
| **Q4_8** | sexual orientation in an engineering classroom | 4.51 | 2.08 |

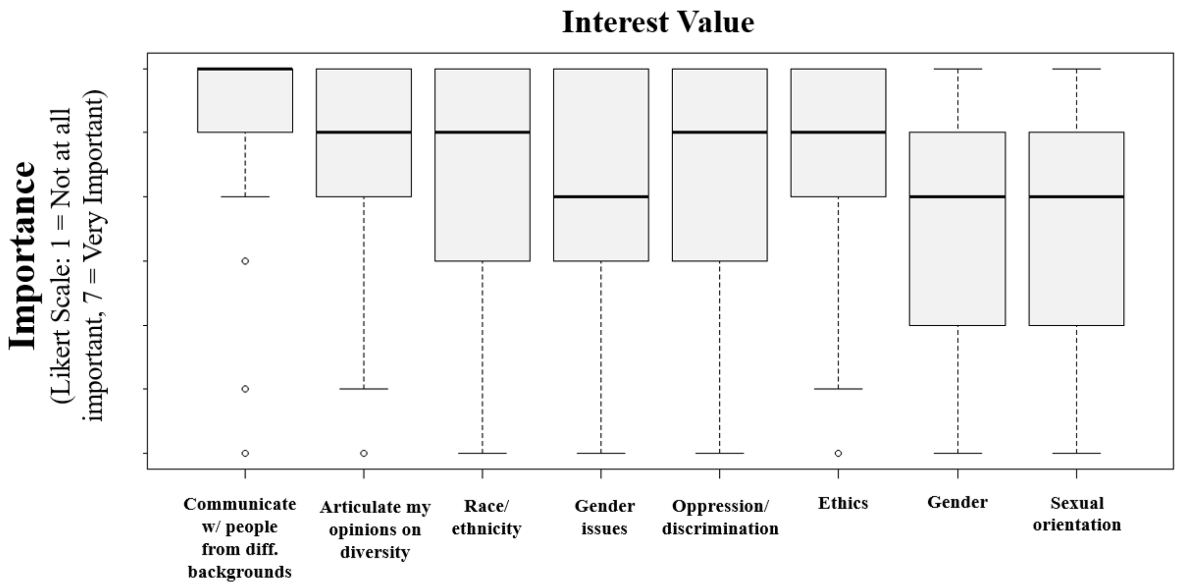


**Figure 4.** Boxplot comparisons of items relating to interest value.

The final component of STV we investigated was utility value, or the usefulness of an activity to meet current or future goals. Results in Table 10 and Figure 5 are generally consistent with findings regarding interest and attainment, with learning about ethics perceived as the most useful topic in this block of items.

Table 10. Utility Value

| Item # | Item | Mean | SD |
|---|---|---|---|
| | **Learning about ______________** | | |
| **Q5_1** | race/ethnicity in an engineering classroom is useful to me | 5.05 | 1.87 |
| **Q5_2** | gender issues in an engineering classroom is useful to me | 4.88 | 1.91 |
| **Q5_3** | oppression and discrimination in an engineering classroom is useful to me | 4.96 | 1.90 |
| **Q5_4** | ethics in an engineering classroom is useful to me | 5.68 | 1.69 |
| **Q5_5** | gender in an engineering classroom is useful to me | 4.67 | 2.01 |
| **Q5_6** | sexual orientation in an engineering classroom is useful to me | 4.35 | 2.04 |

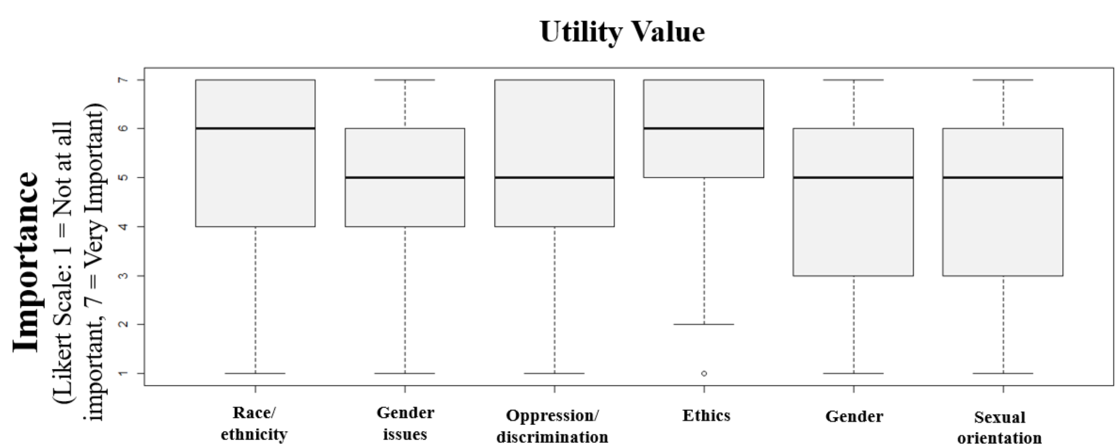


**Figure 5.** Boxplot of items related to utility value.

*Relevance to Engineering Context*
Finally, we asked participants to evaluate the importance of diversity in different engineering settings and for different engineering activities. At a high level, findings suggest that students recognize and value diversity in doing engineering tasks.

First, we asked participants about which *kinds* of diversity might be most relevant to the quality of an engineering solution. Shown in Table 11, Academic Major was perceived as the most important kind of diversity contributing the quality of a solution followed by age diversity Respondents viewed religious diversity and sexual orientation diversity as least important to the quality of solutions produced by engineers.

Table 11. Importance of Diversity to Quality of Solutions Produced by Engineers

| Item # | Item | Mean | SD |
|---|---|---|---|
| | **How important do you think the following characteristics are in contributing to the quality of solutions produced by a team of engineers?** | | |
| **Q8_1** | Gender Diversity | 5.05 | 1.83 |
| **Q8_2** | Racial/Ethnic Diversity | 4.97 | 1.88 |
| **Q8_3** | International Diversity | 5.24 | 1.72 |
| **Q8_4** | Socio-economic Diversity | 5.15 | 1.77 |
| **Q8_5** | Sexual Orientation Diversity | 3.65 | 2.05 |
| **Q8_6** | Age Diversity | 5.38 | 1.52 |
| **Q8_7** | Academic Major Diversity | 5.93 | 1.18 |
| **Q8_8** | Religious Diversity | 3.45 | 2.00 |
| **Q8_9** | Work Experience Diversity | 6.09 | 1.06 |
| **Q8_10** | Demographic Diversity | 5.02 | 1.73 |
| **Q8_11** | Diversity of Thought | 6.39 | 0.94 |
| **Q8_12** | Physical Ability Diversity | 4.40 | 1.88 |

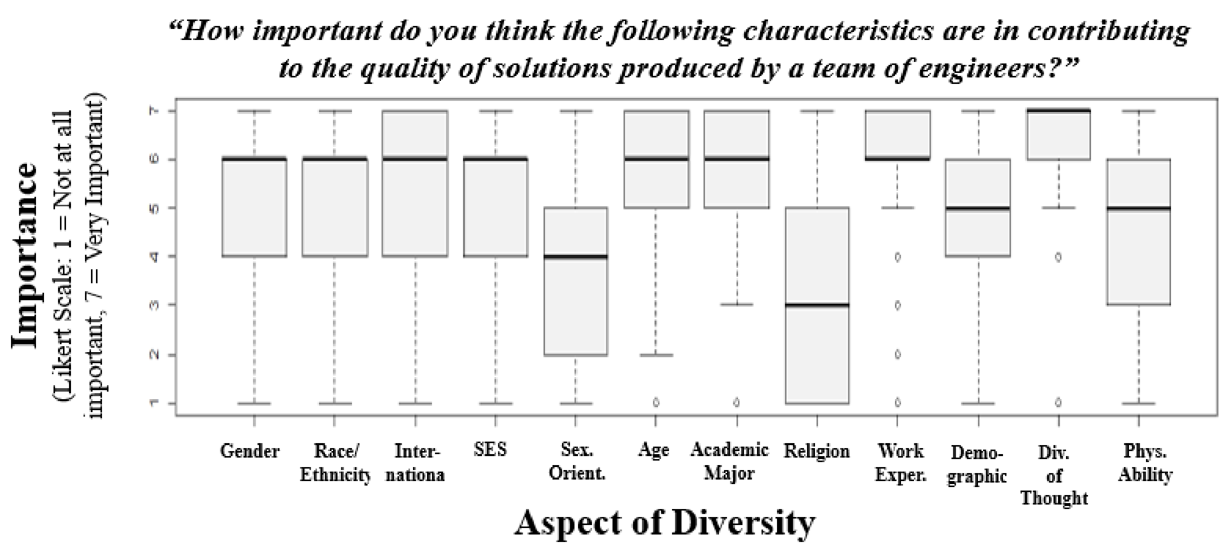


**Figure 6.** Boxplot comparisons of each aspect of diversity. Boxplot comparison of Likert scale (assumed to be interval) variables. Students were asked to rank the importance of each characteristic to the quality of solutions produced by a team of engineers.

We also asked participants to describe the role of diversity across a range of engineering activities. Table 12 provides an overview of the places in which respondents believed diversity was important. Activities include common elements of the engineering design process as well as those common in engineering education and practice. Overall, participants noted that diversity was generally important across the full range of engineering tasks, though there are certain tasks in which diversity takes on more central roles. The two activities participants identified as most important for diversity  were working in multidisciplinary teams and understanding the impact of engineering solutions.

Table 12. Importance of Diversity to Engineering Tasks

| Item # | Item | Mean | SD |
|---|---|---|---|
| | **How important do you think diversity is in contributing to the following engineering tasks?** | | |
| **Q9_1** | Project management | 5.44 | 1.62 |
| **Q9_2** | Ability to function on multidisciplinary teams | 5.85 | 1.43 |
| **Q9_3** | Identifying problems | 5.64 | 1.58 |
| **Q9_4** | Interpersonal relationships | 5.69 | 1.52 |
| **Q9_5** | Technical communication | 4.86 | 1.80 |
| **Q9_6** | Designing and conducting experiments | 4.84 | 1.91 |
| **Q9_7** | Developing systems and products | 5.33 | 1.63 |
| **Q9_8** | Data analysis | 4.52 | 1.95 |
| **Q9_9** | Solving problems | 5.45 | 1.70 |
| **Q9_10** | Understanding the impact of engineering solutions | 5.85 | 1.42 |

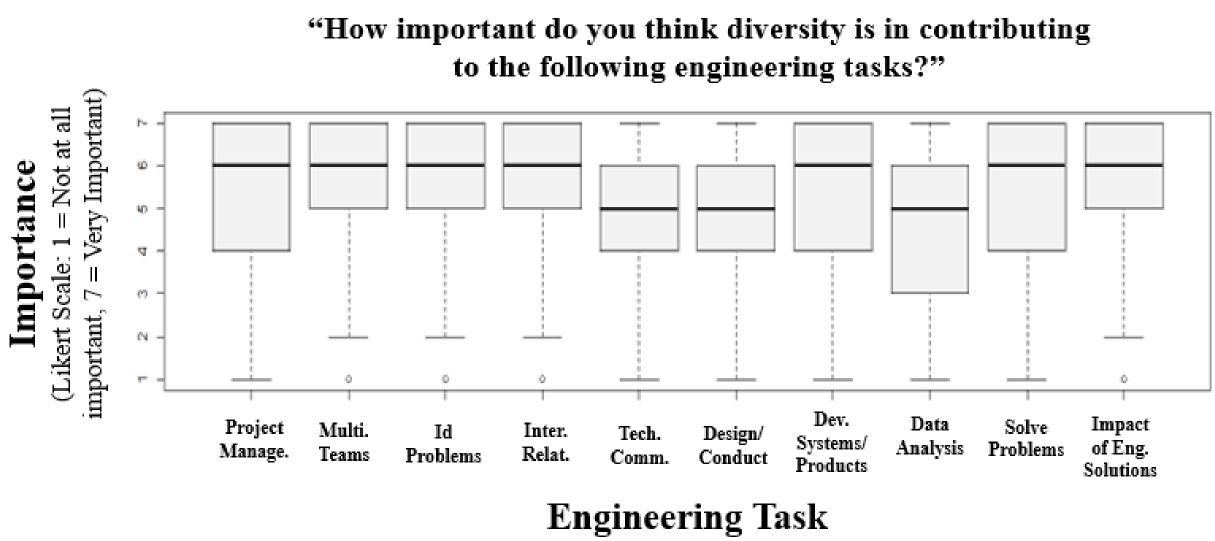


**Figure 7.** Boxplot comparisons of each variable. Boxplot comparison of Likert scale (assumed to be interval) variables. Students were asked to rank the importance of diversity to each engineering task.

### Factor Analysis of EVT Task Value

To examine latent variables in our instrument, we conducted several rounds of exploratory factor analysis based on critically examining the measurement instrument. For each round of factor analysis, the primary tool for examination of the STV constructs was the R statistical programming package. We note that in each iteration of maximum likelihood factor analyses, a promax (non-orthogonal) rotation was used. Literature suggests that non-orthogonal rotations are more accurate in social science research because rarely in social science are two factors truly orthogonal, or independent [33]. Because EVT posits that the value constructs we are measuring are often related, we also made this assumption in our factor analysis using a non-orthogonal rotation.

The following sections outline the process of exploratory factor analysis (EFA) for this measurement instrument. EFA was conducted for items 3, 4, and 5 (Appendix A), which relate to the construct of *subjective task value*. These items and the anticipated corresponding aspect of *subjective task value* (attainment value, utility value, or intrinsic value) are outlined in Table 13.

Table 13: Items developed to measure students' subjective task value for diversity education

| ***Item*** | ***Construct*** | ***Statement*** |
|---|---|---|
| 3_1 | Attainment Value | Learning how to communicate with people from different backgrounds is important to me |
| 3_2 | | Learning how to articulate my opinions on issues related to diversity is important to me |
| 3_3 | | Learning about race/ethnicity in an engineering classroom is important to me |
| 3_4 | | Learning about gender issues in an engineering classroom is important to me |
| 3_5 | | Learning about oppression and discrimination in an engineering classroom is important to me |
| 3_6 | | Learning about ethics in an engineering classroom is important to me |
| 3_7 | | Learning about gender in an engineering classroom is important to me |
| 3_8 | | Learning about sexual orientation in an engineering classroom is important to me |
| 4_1 | Intrinsic Value | I am interested in learning how to communicate with people from different backgrounds |
| 4_2 | | I am interested in learning how to articulate my opinions on issues related to diversity |
| 4_3 | | I am interested in learning about race/ethnicity in an engineering classroom |
| 4_4 | | I am interested in learning about gender issues in an engineering classroom |
| 4_5 | | I am interested in learning about oppression and discrimination in an engineering classroom |
| 4_6 | | I am interested in learning about ethics in an engineering classroom |
| 4_7 | | I am interested in learning about gender in an engineering classroom |
| 4_8 | | I am interested in learning about sexual orientation in an engineering classroom |
| 5_1 | Utility Value | Learning about race/ethnicity in an engineering classroom is useful to me |
| 5_2 | | Learning about gender issues in an engineering classroom is useful to me |
| 5_3 | | Learning about oppression and discrimination in an engineering classroom is useful to me |
| 5_4 | | Learning about ethics in an engineering classroom is useful to me |
| 5_5 | | Learning about gender in an engineering classroom is useful to me |
| 5_6 | | Learning about sexual orientation in an engineering classroom is useful to me |

*First Round of Exploratory Factor Analysis*

We first conducted exploratory factor analysis using all survey items in Table 13. To begin, we evaluated the multivariate normality assumption for each item by computing skew and kurtosis. Because no items had a kurtosis value of 7.0 or higher and an absolute value skewness of 2.0 or higher, assumptions of multivariate normality were not violated. Following these computations, maximum likelihood factor analysis was deemed an appropriate exploratory method [34], [35].

We then computed the correlation matrix to further examine the items. First, we ran Bartlett's Test for sphericity to evaluate if the correlation matrix was an identity matrix. If the correlation matrix is an identity matrix, we expect all correlation values to be zero [36], making dimension reduction through factor analysis impossible [37]. Bartlett's Test was used to examine our assumption that there are some correlations between the variables [36]. Bartlett's test was highly significant ($X^2(231) = 6467$, $p<0.001$), so we concluded that the R-matrix is not an identity matrix. Therefore, there are some relationships between the variables and factor analysis is an appropriate exploratory choice [36].

Next, the Kaiser-Myer-Olkin (KMO) test was used to evaluate if we had enough samples for the number of items. In order for the KMO function to run in the R statistical software, we changed all missing values to zeros. Kaiser suggests that KMO values should be at least 0.5; furthermore, he asserts that KMO values of 0.5 to 0.7 are mediocre, 0.7 to 0.8 are good, 0.8 to 0.9 are great and any KMO value higher than 0.9 is superb [36]. For the entire group of items, we calculate KMO of 0.91, indicating a superb degree of common variance.

Assumptions of multicollinearity were also evaluated. Upon examination of the correlation matrix, we observed many values greater than 0.9, which indicates that multicollinearity could be an issue. Essentially, the high correlation values in our matrix indicate that many of our variables are highly correlated [36]. The determinant of the correlation matrix was found to be 5.107E-17. Literature suggests that the determinant of the correlation matrix should be higher than 0.00001, so this is problematic, indicating that some of our variables are highly correlated [36]. Therefore, as recommended by Field [36], we evaluated the matrix to determine which values were most correlated.

Based on the near-zero determinant, three items with the highest correlations were eliminated. These items are presented in Table 14. We note that when eliminating variables in exploratory factor analysis, we must be able to argue conceptually for their elimination. The variables in Table 14 were eliminated based on the conceptual argument that respondents may not differentiate between "gender" and "gender issues." For instance, item 3_4 about importance of "gender issues" was highly correlated with item 3_7, which dealt with importance of "gender." Therefore, positing that these items capture similar information, items were eliminated.

Table 14. Items eliminated from instrument due to high correlations with other items

| ***Item*** | ***Statement*** |
|---|---|
| Q3_7 | Learning about gender in an engineering classroom is important to me |
| Q4_7 | I am interested in learning about gender in an engineering classroom |
| Q5_5 | Learning about gender in an engineering classroom is useful to me |

Maximum likelihood factor analysis with a promax (non-orthogonal) rotation was then run with the newly shortened set of items. From theory, we would expect three factors (attainment STV, utility STV, and intrinsic STV), so a three-factor analysis was run first. Results from the three factor maximum likelihood analysis are provided in Appendix B. We note that all items meet recommendations for minimum loading of 0.32 onto a factor [38], except for the item that asked "I am interested in learning how to communicate with people from different backgrounds". However, factor correlations ranged from -0.51 to -0.81, indicating that two of the factors are highly correlated. Therefore, the three factor solution is not appropriate based on our data. Additionally, we could not conceptually argue for why these items might load together onto a factor, making the factor analysis less useful. Subsequently, we explored a two factor solution.

Maximum likelihood factor analysis with a promax (non-orthogonal) rotation was then run for a two factor solution. Results from the two factor maximum likelihood analysis are found in Appendix C. Correlation between the factors was -0.59, which indicates that the factors are moderately correlated. The KMO for the reduced set of items was found to be 0.91, indicating a superb degree of common variance and suggesting that we have enough samples for the number of items in our analysis [36]. Bartlett's test was used to test the assumption that there are some correlations between the variables [36]. Bartlett's test was highly significant ($X^2(171) = 4973$, $p<0.001$), so we conclude that the R-matrix is not an identity matrix.

We can conceptually argue why the items in each factor of the two-factor solution may loadonto the same factor. Factor 1 (in green, Appendix C) seems to center around all aspects and or specific issues of diversity, such as sexual orientation, race/ethnicity, gender issues, and broadly, oppression and discrimination. We named Factor 1 "Dimensions and Issues of Diversity" as it broadly encompassed these topics. Factor 2 (in orange, Appendix C) is focused on interactions associated with diversity in engineering, with each item containing verbs such as "communicating" or "articulating" *with other people*, whereas Factor 1 does not involve two-way human interactions. We named Factor 2 "Diversity Interactions". We note that the items do not group as factors as we anticipated from EVT, which is an important finding.

We also generated a scree plot to confirm how many factors were appropriate for our analysis. Because scree plots can be difficult to interpret [33], parallel analysis was also conducted. Both parallel analysis and the generated scree plot suggest that two factors were optimal for this analysis. However, when we again examined the correlation matrix, many high correlations (>0.8) were still found. After dropping the three items discussed in Table 14, the determinant increased slightly from the previous exploration (det=3.56E-13). However, this determinant indicates that there are still multicollinearity issues, so additional options were explored as described below.

*Second Round of Exploratory Factor Analysis: Dropping Attainment STV Items*
Recognizing the high correlations between *many* of the items being measured, we revisited the correlation matrix to determine items to eliminate, focusing on a conceptual basis for elimination. In the second round of exploratory factor analysis, attainment value was eliminated. The conceptual argument for this choice was that the attainment and intrinsic values were similar, and respondents may not distinguish between the STV of "… is important to me" and "I am interested in…". Mathematically, this choice was made to eliminate variables that were highly correlated with other variables. Table 15 shows an updated list of items used for the secondary round of exploratory factor analysis. We note that, as before, we also excluded items about "gender", arguing that they might coincide with questions about gender issues.

Table 15. List of items used in secondary round of exploratory factor analysis

| *Item* | *Statement* |
|---|---|
| Q4_1 | I am interested in learning how to communicate with people from different backgrounds |
| Q4_2 | I am interested in learning how to articulate my opinions on issues related to diversity |
| Q4_3 | I am interested in learning about race/ethnicity in an engineering classroom |
| Q4_4 | I am interested in learning about gender issues in an engineering classroom |
| Q4_5 | I am interested in learning about oppression and discrimination in an engineering classroom |
| Q4_6 | I am interested in learning about ethics in an engineering classroom |
| Q4_8 | I am interested in learning about sexual orientation in an engineering classroom |
| Q5_1 | Learning about race/ethnicity in an engineering classroom is useful to me |
| Q5_2 | Learning about gender issues in an engineering classroom is useful to me |
| Q5_3 | Learning about oppression and discrimination in an engineering classroom is useful to me |
| Q5_4 | Learning about ethics in an engineering classroom is useful to me |
| Q5_6 | Learning about sexual orientation in an engineering classroom is useful to me |

Next, maximum likelihood factor analysis for a two factor solution with a promax (non-orthogonal) rotation was run. Results from the two factor maximum likelihood analysis are shown in Appendix D. Correlation between the factors was 0.82, which indicates that the factors are still highly correlated. With the elimination of the STV attainment value items, the determinant was calculated to be 7.69E-08, which violates assumptions of multicollinearity. Additionally, we cannot conceptually rationalize these factors. Therefore, we conclude that this data does not contain distinct factors. High correlations exist among many items. Participants appeared to have responded the same way on many items.

## DISCUSSION AND FUTURE WORK

### Survey Results

As previously discussed, items were developed using Eccles' Expectancy Value Theory [12]. Related to *expectancy for success,* students were most confident in their ability to learn about ethics in an engineering classroom. This finding may reflect current engineering curricula, which often integrate topics of ethics [39]. Additionally, ethics are emphasized in engineering curricula through national accreditation standards (i.e., ABET). Regarding *attainment task value,* respondents viewed learning how to communicate "with people from different backgrounds" and "articulating issues related to diversity" as important. At the same time, they saw activities in which they would learn about diversity as less important to them. The preference of learning *how to* engage with diversity versus learning *about* diversity potentially underscores the importance of experiential learning when approaching such topics in engineering settings. For *intrinsic (or interest) task value*, respondents indicated interest in learning how to communicate with and articulate opinions regarding diverse groups. A potentially positive finding here is the preference for communicating with people over articulating opinions related to diversity. Respondents also indicated that ethics and race/ethnicity were most useful (e.g. *utility task value*) to learn about in an engineering classroom. Interestingly, scores for *utility task value* were generally rather high given what one might expect from current engineering cultures and discussions of diversity. An interesting follow up might ask about the importance of non-diversity-focused engineering topics alongside of those with a focus on diversity.

Overall, participants' responses reflect high self-reported understanding of current issues surrounding many intersections and axes of privilege and oppression. Because these are self-reported responses, they are not a measure of student's actual abilities. We recognize the possibility of the Kruger-Dunning effect, whereby novices—as a result of their limited understanding in a field—drastically overestimate their own abilities [40]. This effect has been demonstrated in other subjects in engineering [41], and it is possible that respondents to this survey are actually novices with respect to most aspects of diversity in engineering and, therefore, misrepresent their actual skill level relative to those with more skill. More work is needed to unpack students' interpretation of these items as well as their actual skill in these different areas, especially as they intersect with engineering.

We also asked students to rate the importance of diversity for various engineering tasks. Academic major was perceived as the most important kind of diversity contributing the quality of a solution. This makes sense, of course, as multi- and interdisciplinary teams are often needed to solve any modern engineering problem [42]. At the same time, a large proportion of our sample was first year engineering students in a general engineering program where a portion of the content focuses on choosing academic majors so this may have been on student's minds. Of particular note is the perceived importance (or lack thereof) of sexual orientation on the quality of engineering solutions. Such a result is challenging to interpret; for example, the low score for the importance of sexual orientation does not necessarily imply that respondents do not "value" diversity in sexual orientation, though it could. Instead, a low score might imply that respondents do not understand how or why someone's sexual orientation might influence the quality of an engineering solution. In this way, scoring sexual orientation low in importance to the quality of solutions produced by engineers might indicate inclusivity, suggesting an ability to work with persons of various characteristics without drawing undue attention to those characteristics in inconsequential ways. Put simply, students might see diversity of sexual orientation as something that does not (or should not) influence the way an individual engages in engineering problem solving—which is different from the more obvious ways academic major (or perhaps disability status) might impact problem solving approaches. Further examination, perhaps through qualitative inquiry, is needed to understand students' responses. Additionally, in order to interpret responses, more robust demographic information for respondents is needed. We cannot fully understand students' responses without analyzing results in conjunction with student demographics. It is also important to note that sexual orientation diversity is a newer entrance to the literature on diversity in engineering [10], with significant recent contributions by Patridge et al. [7] and Cech et al. [6]

Respondents indicated that diversity is most important for working in multidisciplinary teams and understanding the impact of engineering solutions. The former aligns with previous notions of the importance of diversity of academic major, and the latter suggests that students recognize the value of diverse perspectives on understanding impact of a solution. One interpretation of this finding is that students recognize that their own experiences ultimately limit the ways they can imagine or anticipate broader impacts of engineering work. Perhaps, by soliciting the input of people with diverse backgrounds, a fuller understanding of the potential impacts is made possible.

On the other hand, data analysis was considered the least important task in which diversity might be important. This finding makes intuitive sense, as data analysis in engineering can sometimes be thought of as prescribed and formulaic [43]. Moreover, repeatability of particular analytical procedures might be an important aspect of an engineering task, making diversity less relevant. However, the same might not be true for qualitative or other kinds of interpretive data analysis. In fact, diversity might become critical to such analysis procedures to ensure validity and reliability across groups of people. More research is needed to understand the rationale behind these responses and students' interpretation of these items.

**Lessons Learned**

One of the central hypotheses of EVT is that students are more inclined to engage in activities—such as diversity and inclusion efforts in engineering—that they value in some way. Therefore, in an effort to enlighten efforts to engage students in diversity and inclusion initiatives in engineering, we utilized EVT to develop our measures and operationalize students' beliefs and attitudes.

Additionally, a central idea of EVT is that students hold expectancies and values about individual *tasks*; in other words, *value* constructs of EVT are specified to be at the **task** level [12]. On this note, we acknowledge that our items asked about very broad issues; thus, questions may have been difficult for students to relate to a "task." It could be argued that tasks such as "learning about gender issues" are much broader than a task such as "I will enroll in the honors math class;" our measures included the former task, while EVT was developed with the latter "task", and importantly, it is conceivable that these tasks are not equal. Additionally, the language we use to diversity initiatives and issues surrounding diversity learning need to be further explored. For instance, some of our items use "gender issues" while others use "sexism". We need to further explore how the language we use might impact students' responses. Our findings are consistent with prior research that suggests the task value constructs of EVT can be difficult for students to distinguish between, particularly when the task is not well defined [13], [19], [20].

This study points toward the need to carefully define tasks related to diversity-focused learning opportunities in engineering. Future work will leverage mixed methods research strategies to draw upon strengths of both qualitative and quantitative inquiry [44]. We note that students' beliefs and values about diversity-focused learning opportunities in engineering are complex, making mixed methods a particularly salient strategy for inquiry [45]. In particular, Creamer's [46] suggestions for fully-integrated mixed methods research inquiry, in which mixing is integrated into each phase of the research process, will guide our future work. Though we discuss only the quantitative data in this study, the larger study context included concurrent collection of both quantitative and qualitative data. Because both strands of data were collected simultaneously, the qualitative data was not used to develop instrument items. Future work will utilize a sequential exploratory mixed methods design for instrument development, in which qualitative inquiry guides the development of measures [46]. Ultimately, the results of this study reflect the difficulty of defining tasks in EVT and the need to incorporate qualitative inquiry to understand how students define "task" relating to diversity-focused learning opportunities.

## Conclusion

Decades of national efforts have aimed to broaden participation in engineering, focusing largely on underrepresented groups. More recently, the conversation on broadening participation has expanded to also engage members of predominant groups. However, few studies have furthered our understanding of the perspectives students hold about diversity in engineering. To enlighten this gap in literature, this paper aimed to discuss methodological lessons learned in an attempt to advance understanding of the values engineering students' hold about diversity. Grounded in Expectancy Value Theory, our work explored the following question: *What values and expectations do engineering students have as it relates to diversity-focused learning opportunities in engineering?*

By discussing the development of measures for students' subjective task value about diversity, we have aimed to provide an overview of our operationalization of the constructs, process to develop measures, and results from an exploratory factor analysis. We also offer insights into students' values and beliefs about diversity; however, we cannot fully interpret meaning of the results without further research. Future work will leverage mixed methods research designs to leverage the strengths of both quantitative and qualitative work. Our continued work aims to enlighten future efforts that focus on understanding the beliefs and attitudes students hold.

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## Appendix A: Data Collection Instrument

**Questions 1 through 7 were on a 7-point Likert scale as follows:**

| 1 Strongly Disagree | 2 | 3 | 4 | 5 | 6 | 7 Strongly Agree |
|---|---|---|---|---|---|---|

1. **We are interested in your opinion on these items related to your confidence in your ability to learn about diversity. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q1_1:** I am confident in my ability to communicate with people from different backgrounds
   **Q1_2:** I am confident in my ability to articulate opinions on issues related to diversity
   **Q1_3:** I am confident in my ability to learn about race/ethnicity in an engineering classroom
   **Q1_4:** I am confident in my ability to learn about gender issues in an engineering classroom
   **Q1_5:** I am confident in my ability to learn about oppression and discrimination in an engineering classroom
   **Q1_6:** I am confident in my ability to learn about ethics in an engineering classroom
   **Q1_7:** I am confident in my ability to learn about gender in an engineering classroom
   **Q1_8:** I am confident in my ability to learn about sexual orientation in an engineering classroom

2. **We are interested in your opinion on these items related to your knowledge of current diversity issues. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q2_1:** I am knowledgeable of current issues surrounding racism in the US
   **Q2_2:** I am knowledgeable of current issues surrounding sexism in the US
   **Q2_3**: I am knowledgeable of current issues surrounding the LGBTQ (lesbian, gay, bisexual, transgender, and queer) community in the US
   **Q2_4:** I am knowledgeable of current issues surrounding religious freedom and oppression in the US
   **Q2_5:** I am knowledgeable of current issues surrounding disabled people in the US
   **Q2_6:** I am knowledgeable of current issues surrounding poverty and/or socioeconomic disparities in the US

3. **We are interested in your opinion on these items related to the importance of diversity. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q3_1:** Learning how to communicate with people from different backgrounds is important to me
   **Q3_2:** Learning how to articulate my opinions on issues related to diversity is important to me
   **Q3_3:** Learning about race/ethnicity in an engineering classroom is important to me
   **Q3_4:** Learning about gender issues in an engineering classroom is important to me
   **Q3_5:** Learning about oppression and discrimination in an engineering classroom is important to me
   **Q3_6:** Learning about ethics in an engineering classroom is important to me
   **Q3_7:** Learning about gender in an engineering classroom is important to me
   **Q3_8:** Learning about sexual orientation in an engineering classroom is important to me

4. **We are interested in your opinion on these items related to your interest in diversity. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q4_1:** I am interested in learning how to communicate with people from different backgrounds
   **Q4_2:** I am interested in learning how to articulate my opinions on issues related to diversity
   **Q4_3:** I am interested in learning about race/ethnicity in an engineering classroom
   **Q4_4:** I am interested in learning about gender issues in an engineering classroom

**Q4_5:** I am interested in learning about oppression and discrimination in an engineering classroom
**Q4_6:** I am interested in learning about ethics in an engineering classroom
**Q4_7:** I am interested in learning about gender in an engineering classroom
**Q4_8:** I am interested in learning about sexual orientation in an engineering classroom

5. **We are interested in your opinion on these items related to the usefulness of diversity education. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q5_1:** Learning about race/ethnicity in an engineering classroom is useful to me
   **Q5_2:** Learning about gender issues in an engineering classroom is useful to me
   **Q5_3:** Learning about oppression and discrimination in an engineering classroom is useful to me
   **Q5_4:** Learning about ethics in an engineering classroom is useful to me
   **Q5_5:** Learning about gender in an engineering classroom is useful to me
   **Q5_6:** Learning about sexual orientation in an engineering classroom is useful to me

6. **To what extent do you agree or disagree with the following statements:**
   **Q6_1:** I will find it difficult to participate in activities focused on diversity in an engineering classroom
   **Q6_2:** I expect my opinions about issues related to diversity will not change based on an engineering class
   **Q6_3:** I am well prepared to engage in educational activities focused on diversity
   **Q6_4:** The university makes it difficult to participate in educational activities focused on diversity

7. **We are interested in your opinion on these items related to your perceptions of engineering. There are no right or wrong answers. To what extent do you agree or disagree with the following statements:**
   **Q7_1:** People's positions on issues related to diversity are fixed by the time they start college
   **Q7_2:** Learning about diversity is useful to being a successful engineering professional
   **Q7_3:** Diversity education is a matter of individual responsibility and should not be taught in the engineering classroom
   **Q7_4:** It is important to value cultural differences in engineering
   **Q7_5:** Diverse groups of engineers lead to better results
   **Q7_6:** The demographics of our domestic population are shifting so engineers need to know how to interact with diverse groups of people
   **Q7_7:** Diversity contributes to engineering by expanding the talent pool of potential engineers
   **Q7_8:** Diversity contributes to engineering by enhancing innovation
   **Q7_9:** Diversity is a societal problem that is not relevant to engineering specifically
   **Q7_10:** Diversity impacts how engineering problems are solved
   **Q7_11:** Diversity impacts which problems engineers focus on
   **Q7_12:** The ability to communicate with people from different background is important in engineering
   **Q7_13:** Engineering requires an understanding of oppression and discrimination

**Questions 8 and 9 were on a 7-point Likert scale related to importance as follows:**

| 1 Not at all important | 2 | 3 | 4 | 5 | 6 | 7 Very important |
|---|---|---|---|---|---|---|

8. **How important do you think the following characteristics are in contributing to the quality of solutions produced by a team of engineers:**
   **Q8_1:** Gender diversity
   **Q8_2:** Racial/ethnicity diversity

**Q8_3:** International diversity
**Q8_4:** Socio-economic diversity
**Q8_5:** Sexual orientation diversity
**Q8_6:** Age diversity
**Q8_7:** Academic major diversity
**Q8_8:** Religious diversity
**Q8_9:** Work-experience diversity
**Q8_10:** Demographic diversity
**Q8_11:** Diversity of thought
**Q8_12:** Physical-ability diversity

9. **How important do you think diversity is in contributing to the following engineering tasks:**
**Q9_1:** Project management
**Q9_2:** Functioning on multidisciplinary teams
**Q9_3:** Identifying problems
**Q9_4:** Interpersonal relationships
**Q9_5:** Technical communication
**Q9_6:** Designing and conducting experiments
**Q9_7:** Developing systems and products
**Q9_8:** Data analysis
**Q9_9:** Solving problems
**Q9_10:** Understanding the impact of engineering solutions

**Questions 10-14 are to collect demographic and interview participant data:**

**Q10: Please indicate your sex:** Write in

**Q11: Which of these ethnic/racial groups do you most closely identify with:**
1 - White, non-Hispanic
2- Black or African-American
3 - Hispanic, Latino, or Spanish Origin
4 - Asian-Pacific Islander
5- Native American or Alaska Native
6 - 2 or more
7 - Prefer not to answer

**Q12: Please indicate your academic status:**
1 - Freshman
2 - Sophomore
3 - Junior
4 - Senior
5 – Masters Student
6 – Doctoral Student

**Q13: Which degree do you intend to earn from [institution]:** Write in

**Q14: In general, do you believe it is important for engineers to learn about diversity as a part of their undergraduate education?**
1 - Yes
2 – No

Appendix B: Results from Maximum Likelihood Analysis for Three Factor Solution

| Statement | Factor 1 | Factor 2 | Factor 3 | Uniqueness |
|---|---|---|---|---|
| I am interested in learning about gender issues in an engineering classroom. | 0.56 | 0.44 | | 0.13 |
| I am interested in learning about oppression and discrimination in an engineering classroom. | 0.53 | 0.49 | | 0.09 |
| I am interested in learning about sexual orientation in an engineering classroom. | 0.5 | 0.44 | | 0.21 |
| Learning about race/ethnicity in an engineering classroom is useful to me. | 0.72 | | | 0.18 |
| Learning about gender issues in an engineering classroom is useful to me. | 1.04 | | | 0.09 |
| Learning about oppression and discrimination in an engineering classroom is useful to me. | 0.88 | | | 0.09 |
| Learning about sexual orientation in an engineering classroom is useful to me. | 0.91 | | | 0.24 |
| Learning about race/ethnicity in an engineering classroom is important to me. | | 0.94 | | 0.07 |
| Learning about gender issues in an engineering classroom is important to me. | | 0.79 | | 0.11 |
| Learning about oppression and discrimination in an engineering classroom is important to me. | | 0.88 | | 0.11 |
| Learning about sexual orientation in an engineering classroom is important to me. | | 0.76 | | 0.21 |
| I am interested in learning about race/ethnicity in an engineering classroom. | 0.41 | 0.57 | | 0.11 |
| Learning how to communicate with people from different backgrounds is important to me. | | | 0.90 | 0.34 |
| Learning how to articulate my opinions on issues related to diversity is important to me. | | | 0.64 | 0.46 |
| I am interested in learning how to communicate with people from different backgrounds. | | -0.31 | 1 | 0.24 |
| I am interested in learning how to articulate my opinions on issues related to diversity. | | | 0.75 | 0.32 |
| Learning about ethics in an engineering classroom is important to me. | | 0.49 | | 0.55 |
| I am interested in learning about ethics in an engineering classroom | | 0.39 | | 0.48 |
| Learning about ethics in an engineering classroom is useful to me. | 0.36 | | | 0.53 |

Appendix C: Results from Maximum Likelihood Analysis for Three Factor Solution

**KEY:**

| Factor 1: Dimensions of Diversity | Factor 2: Diversity Interactions | Dropped item |
|---|---|---|

| *Statement* | *Factor 1* | *Factor 2* | *Uniqueness* |
|---|---|---|---|
| Learning about race/ethnicity in an engineering classroom is important to me | 0.92 | | 0.15 |
| Learning about gender issues in an engineering classroom is important to me | 0.95 | | 0.15 |
| Learning about oppression and discrimination in an engineering classroom is important to me | 0.92 | | 0.17 |
| Learning about sexual orientation in an engineering classroom is important to me | 0.88 | | 0.25 |
| I am interested in learning about race/ethnicity in an engineering classroom | 0.94 | | 0.09 |
| I am interested in learning about gender issues in an engineering classroom | 0.98 | | 0.11 |
| I am interested in learning about oppression and discrimination in an engineering classroom | 0.99 | | 0.08 |
| I am interested in learning about ethics in an engineering classroom | 0.60 | | 0.47 |
| I am interested in learning about sexual orientation in an engineering classroom | 0.92 | | 0.20 |
| Learning about race/ethnicity in an engineering classroom is useful to me | 0.86 | | 0.23 |
| Learning about gender issues in an engineering classroom is useful to me | 0.91 | | 0.24 |
| Learning about oppression and discrimination in an engineering classroom is useful to me | 0.92 | | 0.17 |
| Learning about ethics in an engineering classroom is useful to me | 0.53 | | 0.54 |
| Learning about sexual orientation in an engineering classroom is useful to me | 0.83 | | 0.34 |
| Learning how to communicate with people from different backgrounds is important to me | | 0.90 | 0.33 |
| Learning how to articulate my opinions on issues related to diversity is important to me | | 0.70 | 0.47 |
| I am interested in learning how to communicate with people from different backgrounds | | 0.95 | 0.28 |
| I am interested in learning how to articulate my opinions on issues related to diversity | | 0.75 | 0.32 |
| Learning about ethics in an engineering classroom is important to me | 0.41 | 0.32 | 0.57 |

Appendix D. Results from Maximum Likelihood Analysis for Three Factor Solution

| Statement | Factor 1 | Factor 2 | Uniqueness |
|---|---|---|---|
| I am interested in learning how to articulate my opinions on issues related to diversity | 0.53 | | 0.69 |
| I am interested in learning about race/ethnicity in an engineering classroom | 1.02 | | 0.04 |
| I am interested in learning about gender issues in an engineering classroom | 0.73 | | 0.11 |
| I am interested in learning about oppression and discrimination in an engineering classroom | 0.81 | | 0.08 |
| I am interested in learning about ethics in an engineering classroom | 0.77 | | 0.47 |
| I am interested in learning about sexual orientation in an engineering classroom | 0.73 | | 0.21 |
| Learning about race/ethnicity in an engineering classroom is useful to me | 0.54 | 0.40 | 0.19 |
| Learning about ethics in an engineering classroom is useful to me | 0.52 | | 0.56 |
| Learning about gender issues in an engineering classroom is useful to me | | 1.00 | 0.00 |
| Learning about oppression and discrimination in an engineering classroom is useful to me | 0.40 | 0.59 | 0.10 |
| Learning about sexual orientation in an engineering classroom is useful to me | | 0.72 | 0.24 |
| I am interested in learning how to communicate with people from different backgrounds | 0.41 | | 0.86 |