# Exploring changes in mental health conditions' stigma levels and help-seeking attitudes among engineering students

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## Abstract

Engineering students face significant barriers to seek support for mental health needs. Stigma around mental health acts as a major barrier for help seeking behavior. This study examines changes in mental health condition (MHC) stigma, help-seeking attitudes, and identity among engineering students at a U.S. East Coast institution over the course of a year (2022–2023). Using established survey instruments, we analyzed responses from 91 students through paired t-tests. Results indicate a decline in college-specific prejudice over time and a moderate decrease in engineering-specific social distance in online contexts. However, engineering identity and belonging also declined across all demographic groups. These findings underscore the need for targeted interventions to enhance inclusion and support student wellbeing within engineering education.


## 1. Introduction

Mental health challenges among college students have become a growing concern for institutions of higher education. These challenges, which include anxiety, depression, and other mental health conditions (MHC) [1], significantly impact students' academic performance and retention [2]. Despite the availability of resources and support services, many students remain reluctant to seek help due to stigma and other barriers [3]. This reluctance to seek help is particularly pronounced in engineering students, who face unique challenges stemming from the demanding nature of their academic programs and the high expectations of professional preparation. The combination of rigorous coursework, competitive environments, and limited time for self-care creates a culture that may exacerbate mental health issues and discourage help-seeking behaviors [4]. Therefore, understanding the dynamics of stigma and help seeking attitudes among engineering students is critical for addressing these barriers and promoting wellness.

While previous studies have highlighted the relationship between stigma and help-seeking attitudes, most research has primarily focused on cross-sectional analyses and mostly among non-engineering populations. Engineering students present a distinct context, where stigma around mental health might be intertwined with its unique cultural norms. Given the limited research exploring stigma levels and help-seeking attitudes across time, we seek to fill this gap by examining the changes over time in mental health stigma, help-seeking attitudes, and MHC status among undergraduate engineering students at a U.S. institution in the north-east. The following research questions guide this study:

RQ1: How does the stigma of mental health and help seeking attitudes evolve through time among undergraduate engineering students?

a. How do changes in stigma levels and help-seeking attitudes vary across demographic subgroups?

## 2. Background

The prevalence of mental health challenges among college students has significantly increased over time, posing serious concerns for higher education institutions. A study comparing birth

cohorts found that clinical scores for depressive symptoms have risen over recent decades among adults including college students [5]. Moreover, the prevalence of lifetime depression diagnoses has significantly increased, showing a rise of approximately 10% to 20% between 2000 and 2015 [6]. Moreover, national data has indicated a consistent growth among a variety of self-reported mental health conditions, including generalized anxiety, depression, social anxiety, family-related stress, and academic challenges [7].

The COVID-19 pandemic further exacerbated mental health issues, introducing stressors such as health fears, academic disruption, and social isolation. Research examining mental health prevalence during Covid-19 found significant increases in anxiety and depression, with ~70% of students experiencing elevated stress due to health concerns and reduced social interactions [8]. Similarly, Wang et al [9] found that nearly half of the students they studied during the pandemic exhibited moderate to severe symptoms of depression and anxiety. The shift to remote learning disrupted academic routines and support structures which intensified the feelings of isolation and stress [10]. These findings highlight the urgent need for higher education institutions to address mental health disparities and support student wellness.

While the prevalence of mental health conditions has increased among the entire college student population, disproportionately higher rates have been noted among women, students of color, LGBTQ individuals, and those from lower socioeconomic backgrounds [11]. Moreover, students from these marginalized groups are often prevented from seeking professional help due to cultural and systemic barriers [12]. Even during the Covid-19 pandemic, students with marginalized identities faced additional burdens due to the intersection of systemic racism and pandemic-related challenges [13]. These disparities highlight the need for targeted and inclusive mental health interventions in higher education.

Within engineering, the prevalence of mental health conditions among undergraduate students is comparable to that of their peers in other disciplines, with nearly 30% potentially experiencing a diagnosable MHC and over 80% reporting moderate or higher stress levels [14]. However, research has consistently identified disparities in mental health outcomes within this population, with female students and those from historically marginalized racial and ethnic backgrounds reporting elevated rates of panic disorder and PTSD [14].

Furthermore, engineering students are less likely to utilize mental health resources compared to students in other fields [15]. In recent research, gender differences in help-seeking behaviors were found to be particularly noticeable. Whitwer et al [16] found that male engineering students experiencing distress were 9% less likely to pursue professional mental health assistance compared to males in non-engineering fields, while female engineering students demonstrated a smaller but still significant 3% lower likelihood of seeking help than their non-engineering counterparts.

Research efforts to understand these help-seeking gaps have revealed complex cultural and systemic barriers. In a study exploring first year engineering students help seeking, [17] found that while engineering students may hold positive attitudes toward seeking help, many of them lack the intention or perceive a lack of support for doing so. Similarly, Miller and colleagues [18] explored key beliefs about help seeking among engineering students and found a preference for self-reliance, fear of stigma, and a reluctance to appear vulnerable as significant barriers to

help-seeking. Moreover, the competitive and demanding culture of engineering programs often discourages students from prioritizing mental health which contributes to low confidence in navigating available support systems [19].

Alongside the various elements that influence the help seeking for mental health across disciplines such as nature of curriculum and lack of discipline specific interventions, stigma of mental health conditions is also considered as an important factor [15]. Previous research on stigma on a large sample of students across universities found that while perceived public stigma was high, personal stigma was notably elevated in specific groups, including male, younger, Asian, international, more religious, and lower socioeconomic status students which was found to be negatively correlated with help seeking measures [3]. Similarly, within engineering education, a negative relationship between stigma and help-seeking attitudes among engineering undergraduates was identified by Sanchez-Pena and colleagues [20] where both general and engineering-specific stigma measures impacted helpseeking attitudes.

Research on mental health stigma has grown in recent years, yet longitudinal studies on this topic, particularly among college students, remain limited. Among the existing studies, Golberstein et al [21] explored the role of perceived public stigma in shaping help-seeking behavior using longitudinal data from the Healthy Minds Study. They surveyed a random sample of 732 undergraduate and graduate students at a large public university in 2005 and followed up with them in 2007. The results showed no significant association between perceived public stigma and subsequent help-seeking, suggesting that public stigma might not be a primary barrier to mental health service utilization in this population.

However, recent studies indicate that stigma could have implications for those already experiencing mental health conditions. For instance, O'Reilly and colleagues [22] explored how stigma and barriers to care influenced suicidal ideation (SI) among undergraduate students over a six months period. They found that while stigma and barriers to care were stable, self-stigma and barriers were significantly associated with sustained or increased SI in students with a history of SI, particularly those from younger or minority groups. The evidence from these studies suggests the need for further longitudinal exploration of mental health stigma to better understand its dynamics and impacts.

Specific interventions aimed at addressing stigma have also been studied longitudinally and provide important insights. For instance, Pescosolido et al [23] evaluated the effectiveness of the "University Bring Change to Mind" (UBC2M) program, a student-led initiative to reduce mental health stigma. The study analyzed data from Indiana University's class of 2019 across multiple waves, with 1,132 students completing surveys in their first and third years. Findings revealed that active engagement in the program significantly reduced stigma-related attitudes, while passive engagement enhanced perceptions of campus mental health culture and increased mental health-related conversations. This study highlights the potential of institutionally supported, student-led interventions in addressing mental health stigma over time.

Given the limited longitudinal exploration of mental health stigma both in general and within the specific context of engineering education, this study aims to address this gap by examining the progression of mental health stigma, and help-seeking attitudes among engineering students over time. While previous studies have highlighted the impact of mental health stigma on help-seeking behaviors and the potential of institutional initiatives to reduce stigma and improve attitudes, there is a need to understand these dynamics within the rigorous and unique culture of

engineering education. In this study we build on the existing literature by longitudinally exploring changes in stigma levels, and help-seeking attitudes among engineering students at an institution in the north-east United States.

## 3. Methods

This study draws from the data collected for a larger longitudinal (three-years) multi-institutional mixed methods study that explores the relationship of engineering culture and stigma of mental health conditions and help-seeking attitudes of engineering students and professionals. Thorough description of the project has previously been shared in [20]. This study is based on the data collected at one institution; a large public university located in the US East within the first two years of the data collection. With this study we aim to capture changes in the mental health stigma and help seeking measures between the first and second year of data collection.

### 3.1 Participants and Data Collection

The data for this study was collected at a large public institution located in the US East Coast, which is one of the institutions on our larger study. The School of Engineering at this institution enrolls approximately 4,000 undergraduate students across all departments. All students enrolled in the school of engineering at US East were invited to participate in an online survey during the first year of data collection (Fall 2022). A total of 211 representing 0.5 percent of the total student population, responded in Year 1, forming the baseline cohort.

For the collection of data, surveys were administered online during the Fall semester of each of the academic years 2022-2023 (Year 1) and 2023-2024 (Year 2). Recruitment emails were sent to all students in the school of engineering, containing an overview of the study and a link to the Qualtrics survey during Year 1. In the subsequent year only respondents for Year 1 were invited to participate in follow-up surveys for Year 2 (Fall 2023), a total of 120 responses were received for that year (56% retention). The survey was designed to measure MHC status, levels of stigma toward MHC, and attitudes toward help-seeking behaviors. Participation was voluntary, and respondents were free to withdraw at any time. Participants were compensated with $10 each time they took the survey. The study protocol was approved by the institution's Institutional Review Board (IRB).

### 3.2 Measures

We collected data for mental health stigmas, helps seeking behaviors and aspects of engineering experience among undergraduate engineering students by using various instruments tested for validity in previous research. We calculated evidence of validity for each instrument in our previous work [20].

The different aspects of stigma were assessed using the *College Toolbox Project (CTP)*[23] which measured three stigma dimensions: *General Prejudice* (8 items), *College-Specific Prejudice* (9 items), and *College-Specific Social Distance* (11 items). A subset of the *Social Distance Scale* (5 items) was adapted to engineering contexts, focusing on in-person and online interactions.

We assessed self-stigma among engineering students with mental health conditions using the *Stigma Scale* [24], a 28-item tool tested for validity. It measured *Perceived Discrimination* (13

items), Disclosure *Concerns* (10 items), and *Positive Aspects of having a mental illness* (5 items). This scale was administered only to students identifying as having an MHC.

The *Attitudes Toward Seeking Professional Psychological Help* scale [25], a 10-item instrument, captured three dimensions of help-seeking attitudes: *openness* to professional help (3 items), the *value* of professional support (4 items), and a preference for *self-reliance* (3 items). *Engineering identity and belonging* were also assessed using five previously validated questions used by Verdin et al [26]. While engineering identity and belonging were not the main focus of inquiry in this paper, we consider these elements as relevant factors to expand on how stigma of MHC might be intertwined with engineering culture. Therefore, we also map changes in these two critical variables of our analyses.

### 3.3 Data Analysis

With the aim to assess changes in the study variables between Year 1 and Year 2, we conducted paired t-tests on data from 91 students who completed the survey in both Year 1 and Year 2, ensuring that comparisons were based on identical participants across two time points. This statistical method was chosen to compare mean differences for identical participants across the two years, controlling for individual-level variability.

In addition to the comparisons across the whole group, we also conducted paired t-tests comparisons within different demographic subgroups. These comparisons allow to explore if the general differences take place among each subgroup. We executed such comparisons among groups derived from the demographic variables gender, sexual orientation, race, international status, and family education level. For some of these groupings, the number of students from marginalized groups was limited, therefore their analysis was omitted. For example, for the gender variable, the focus was limited to the men and women subgroups since the number of participants indicating the transgender or other categories was in the single digits, therefore limiting statistical power for our analyses. In what follows we offer our summary of the main results accompanied by each of the tables of results built for each of the analyses.

### 3.4 Researchers' Positionality

As researchers studying mental health stigma and help-seeking behaviors among engineering students, we acknowledge that our perspectives shape the framing of this study. In this study, we used quantitative survey instruments validated in previous research to enhance reliability. Nevertheless, we acknowledge that our role in survey design and data interpretation needs awareness of potential biases. First, in relation to the limited exploration of the selected specific set of demographic variables, which is shaped by our own world views and potentially conveys our blind spots. For example, none of our team members identify as non-binary or transgender, which might have offered a limited vision on the options offered to participants when gauging such information. Second, we recognize that for this specific study, we are using a one-variable-at-a-time approach to explore group differences, which limits our ability to explore intersectional issues such as those affecting individuals with multiple-marginalized individuals. We consider this first exploration as a starting point that could lead to a more complex understanding of these multidimensional dynamics when exploring the larger dataset, which was still under collection at the time of writing this paper.

## 4. Results

The distribution of the 91 participants across the four demographic variables considered is summarized in Table 1.

*Table 1: Demographics at US East Institution (N=91)*

| Demographic | Demographic sub-groups | Number of participants |
|---|---|---|
| Gender | Male | 45 |
| | Female | 42 |
| | Trans FTM | 1 |
| | Other | 2 |
| | Prefer not to answer | 1 |
| Sexual Orientation | Straight | 71 |
| | Uncertain | 4 |
| | Other | 12 |
| | Prefer not to answer | 4 |
| International Status | International | 22 |
| | Domestic | 69 |
| Race | Two or more | 11 |
| | Black | 6 |
| | White | 44 |
| | Pacific Islander | 1 |
| | Other | 8 |
| | Prefer not to answer | 8 |
| Family Education | First generation college student | 22 |
| | One parent with college degree | 27 |
| | More than one parent with college degree | 42 |
| Total | | 91 |

The analysis for the overall sample of students (n=91) revealed significant changes in several of the explored constructs over time, as shown in Table 1. College-Specific Prejudice decreased significantly ($t(90) = -3.75$, $p < .01$ with a mean difference of -1.57, suggesting a moderate decline (Cohen's $d = -0.39$) in perceived prejudice within the college environment. Additionally, College-Specific Social Distance increased significantly ($t(90) = 2.18$, $p = .03$) with a mean difference of 0.90, suggesting a slight increase (Cohen's $d = 0.23$) in perceived social distance among students within the college setting.

Engineering Identity exhibited a significant decline over time ($t(90) = -6.58$, $p < .01$) with a mean difference of -2.58, reflecting a substantial decline (Cohen's $d = -0.69$), in students' identification with the engineering field. Similarly, Engineering Belonging decreased significantly ($t(90) = -5.64$, $p < .01$) with a mean difference of -1.30, indicating reduced feelings of inclusion (Cohen's $d = -0.59$), and connectedness within the engineering community. Table 2 contains the full results for the complete sample of students.

*Table 2: Paired t-test results among the full sample (US East) (n=91)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.18 | -0.48 | 0.62 | [-0.94, 0.57] | -0.05 |
| College Specific Prejudice | -1.57 | -3.75 | 0.00** | [-2.40, -0.73] | -0.39 |
| College Specific Social Distance | 0.90 | 2.18 | 0.03* | [0.08, 1.72] | 0.23 |
| Eng. Specific Social distance (in person) | 0.15 | 0.46 | 0.64 | [-0.50, 0.81] | 0.05 |
| Eng Specific Social Distance (Online) | -0.02 | -0.08 | 0.93 | [-0.56, 0.51] | -0.01 |
| Self-Stigma | -3.22 | -0.94 | 0.35 | [-0.54, 1.41] | -0.1 |
| Help Seeking Attitude | 0.43 | 0.89 | 0.37 | [-0.54, 1.41] | 0.09 |
| Engineering Identity | -2.58 | -6.58 | 0.00** | [-3.36,1.80] | -0.69 |
| Engineering Belonging | -1.30 | -5.64 | 0.00** | [-1.76, -0.84] | -0.59 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.1 Mental Health Status*

The paired t-test among students diagnosed with mental health conditions indicate changes across two stigma-related measures, as well as across identity and belonging over time (Table 3). Specifically, a significant decrease in College-Specific-Prejudice was observed t (17) = -2.59, p = 0.01, with a mean difference of -1.33, showing a decline in prejudice towards those with mental health conditions on college campus. There were no changes in their self-stigma measures. A significant decline was also observed in Engineering Specific Social Distance in online setting t (17) = -2.17, p = 0.04, with a mean difference of -1 suggesting that participants felt less distant in online engineering spaces.

Conversely, a significant decline was observed for engineering identity among those diagnosed with mental health conditions t (19) = -5.98, p = 0.00, with a mean difference of -5.1, suggesting that students with mental health conditions experienced a considerable decline in how they identified as engineers. The same trend was observed for engineering belonging, t(19) = -2.45, p = 0.00, with a mean difference of -2.45 suggesting that those experiencing mental health conditions felt less belonged with engineering.

*Table 3: Paired t-test results (US East) Those with mental health conditions (MHC) (n=20)*

| Variables | | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|
| General Prejudice | | 0.05 | 0.07 | 0.94 | [-1.41, 1.51] | 0.02 |
| College Specific Prejudice | | -1.33 | -2.59 | 0.01* | [-2.35, -0.30] | -0.58 |
| College Specific Social Distance | | 0.65 | 0.89 | 0.37 | [-0.86, 2.16] | 0.20 |
| Eng. Specific Social distance (in person) | | -0.6 | -1.30 | 0.20 | [-1.56, 0.36] | -0.29 |
| Eng Specific Social Distance (Online) | | -1 | -2.17 | 0.04* | [-1.96, -0.03] | -0.49 |
| Self-Stigma | | -3.22 | -0.94 | 0.35 | [-10.40, 3.96] | -0.21 |
| | Discrimination | -0.61 | -0.47 | 0.63 | [-3.29, 2.07] | -0.11 |
| | Disclosure | -1.16 | -0.85 | 0.40 | [-4.03, 1.69] | -0.19 |
| | Positive Aspects | -1.44 | -1.16 | 0.25 | [-4.04, 1.16] | -0.26 |
| Help Seeking Attitude | | 1.75 | 1.57 | 0.13 | [-0.57, 4.07] | 0.35 |
| Engineering Identity | | -5.1 | -5.98 | 0.00** | [-6.88, -3.31] | -1.34 |
| Engineering Belonging | | -2.45 | -3.78 | 0.00** | [-3.80, -1.09] | -0.85 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.2 Comparisons across Gender*

The paired t-test within the men subgroup revealed significant changes in three variables over time among men (n = 45). As shown in Table 4, College-Specific Prejudice decreased significantly t (45) = -2.40, p = 0.02, with a mean difference of -1.75, indicating a decline among male students experiencing prejudice in the college context. Conversely, engineering identity exhibited a significant decline, t (44) = -4.57, p < .001, with a mean difference of -2.62, suggesting that students' sense of identity with the engineering field declined notably. Similarly, engineering belonging also decreased significantly t (44) = -4.58, p < .001, with a mean difference of -1.57, indicating a diminished connection within the engineering community.

*Table 4: Paired t-test results (US East) Men (n=45)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.44 | -0.68 | 0.492 | [-1.74, 0.85] | -0.10 |
| College Specific Prejudice | -1.75 | -2.40 | 0.02* | [-3.22, -0.28] | -0.36 |
| College Specific Social Distance | 1.17 | 1.59 | 0.11 | [-0.30, 2.66] | 0.24 |
| Eng. Specific Social distance (in person) | 0.35 | 0.57 | 0.56 | [-0.89, 1.60] | 0.08 |
| Eng Specific Social Distance (Online) | 0.05 | 0.10 | 0.91 | [-0.94, 1.04] | 0.01 |
| Help Seeking Attitude | 0.13 | 0.19 | 0.84 | [-1.22, 1.48] | 0.03 |
| Engineering Identity | -2.62 | -4.57 | 0.00** | [-3.77, -1.46] | -0.68 |
| Engineering Belonging | -1.57 | -4.58 | 0.00** | [-2.27, -0.88] | -0.68 |

*+p<0.10, *p<0.05, **p<0.01*

A similar trend was also observed for women participants who also experienced a significant decline in College Specific Prejudice, t (42) = -2.59, p = 0.0, with a mean difference of -1.16. A decline was also observed in Engineering Identity (t (42) = -4.61, p=0.00, MD = -2.62) and Engineering Belonging (t (42) = -4.58, p= 0.00, MD = -1.57) suggesting that women students experienced a significant decline in connectedness with their major and the community over time (Table 5).

*Table 5: Paired t-test results (US East) Women (n=42)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.19 | 0.42 | 0.67 | [-0.71, 1.09] | 0.06 |
| College Specific Prejudice | -1.16 | -2.59 | 0.01* | [-2.07, -0.25] | -0.40 |
| College Specific Social Distance | 0.47 | 1.15 | 0.25 | [-0.35, 1.30] | 0.18 |
| Eng. Specific Social distance (in person) | -0.04 | -0.17 | 0.86 | [-0.59, 0.50] | -0.03 |
| Eng Specific Social Distance (Online) | 0.04 | 0.18 | 0.85 | [-0.48, 0.58] | 0.03 |
| Help Seeking Attitude | 0.35 | 0.48 | 0.63 | [-1.14, 1.85] | 0.07 |
| Engineering Identity | -2.57 | -4.61 | 0.00** | [-3.69, -1.44] | -0.71 |
| Engineering Belonging | -1.28 | 4.21 | 0.00** | [-1.90, -0.66] | 0.65 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.3 Sexual Orientation*

The trends remained the same in case of sexual orientation. While the statistical tests could not be generated for sexually marginalized students due to a smaller sample size, straight identifying students experienced a decline in College Specific Prejudice (t (70) = -2.50, p = 0.01, MD = -1.14). Moreover, a decline was also observed for engineering identity (t (70) = -6.20, p = 0.00, MD = -2.80) and Engineering Belonging (t (70) = -5.33, p = 0.00, MD = -1.36).

*Table 6: Paired t-test results (US East) Straight (n=71)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.14 | -0.32 | 0.74 | [-1.00, 0.72] | -0.04 |
| College Specific Prejudice | -1.14 | -2.50 | 0.01* | [-2.05, -0.23] | -0.30 |
| College Specific Social Distance | 0.81 | 1.79 | 0.07 | [-0.09, 1.72] | 0.21 |
| Eng. Specific Social distance (in person) | 0.04 | 0.11 | 0.90 | [-0.68, 0.76] | 0.01 |
| Eng Specific Social Distance (Online) | 0.13 | 0.40 | 0.68 | [-0.52, 0.80] | 0.05 |
| Help Seeking Attitude | 0.45 | 0.88 | 0.38 | [-0.57, 1.47] | 0.10 |
| Engineering Identity | -2.80 | -6.20 | 0.00** | [-3.70, -1.90] | -0.74 |
| Engineering Belonging | -1.36 | -5.33 | 0.00** | [-1.87, -0.85] | -0.63 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.4 Race*

Among Students identifying as white, stigma-related measures did not have a significant difference between the considered timepoints. However, engineering identity showed a significant decline over time (t (43) = -5.66, p < .001, MD = -2.97) reflecting a weakened sense of identification with the engineering field. Similarly, Engineering Belonging significantly decreased (t (43) = -4.99, p < .001, MD = -1.54) indicating diminished feelings of inclusion in the engineering community (Table 7).

*Table 7: Paired t-test results (US East) White (n=44)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | 0.31 | 0.64 | 0.52 | [-0.67, 1.30] | 0.10 |
| College Specific Prejudice | -0.11 | -0.25 | 0.80 | [-1.02, 0.79] | -0.04 |
| College Specific Social Distance | 0.36 | 0.67 | 0.50 | [-0.72, 1.44] | 0.10 |
| Eng. Specific Social distance (in person) | 0.29 | 0.78 | 0.43 | [-0.45, 1.05] | 0.12 |
| Eng Specific Social Distance (Online) | 0.20 | 0.59 | 0.55 | [-0.49, 0.91] | 0.09 |
| Help Seeking Attitude | -0.59 | -0.76 | 0.45 | [-2.15, 0.97] | -0.11 |
| Engineering Identity | -2.97 | -5.66 | 0.00** | [-4.03, -1.91] | -0.85 |
| Engineering Belonging | -1.54 | -4.99 | 0.00** | [-2.16, -0.92] | -0.75 |

*+p<0.10, *p<0.05, **p<0.01*

Among non-white students, College-Specific Prejudice significantly decreased over time (t (27) = -2.64, p = .01, MD = -2.21), suggesting reduced prejudiced perceptions within the college environment. College-specific social distance significantly increased (t (27) = 2.34, p = .02, MD = 1.60), suggesting a greater perceived distance within the college context. Additionally, Engineering Identity declined significantly (t (27) = -3.84, p < .001, MD = -2.10) and Engineering Belonging also showed a significant reduction (t (27) = -3.25, p < .001, MD = -1.07). Nevertheless, the effect sizes were smaller among the non-white group than in the white

group (Table 8). It is important to notice that we decided to group all non-white students for statistical power, therefore this group includes students of races that are considered underrepresented minorities as well as Asian students who are not considered an underrepresented minority in engineering. It would be critical to explore further the trends for each subgroup, if sizes allow.

*Table 8: Paired t-test results (US East) non-White (n=28)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.07 | -0.08 | 0.92 | [-1.72, 1.58] | -0.01 |
| College Specific Prejudice | -2.21 | -2.64 | 0.01* | [-3.93, -0.49] | -0.49 |
| College Specific Social Distance | 1.60 | 2.34 | 0.02* | [0.20, 3.01] | 0.44 |
| Eng. Specific Social distance (in person) | 0.17 | 0.31 | 0.75 | [-0.96, 1.32] | 0.05 |
| Eng Specific Social Distance (Online) | -0.24 | -0.64 | 0.52 | [-1.00, 0.52] | -0.12 |
| Help Seeking Attitude | 1.03 | 1.61 | 0.11 | [-0.28, 2.35] | 0.30 |
| Engineering Identity | -2.10 | -3.84 | 0.00** | [-3.23, -0.98] | -0.72 |
| Engineering Belonging | -1.07 | -3.25 | 0.00** | [-1.74, -0.39] | -0.61 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.5 International Status*

The paired t-test results for domestic students (Table 9) revealed significant changes in one stigma-related variable over time as well as engineering identity and belonging. College-specific prejudice decreased significantly ($t(68) = -3.43$, $p < .001$, $MD = -1.44$), indicating reduced prejudiced attitudes within the college environment for domestic students. However, these changes were not observed for the international students (Table 10). Nevertheless, as with the previous subgroups, engineering identity exhibited a significant decline ($t(68) = -5.66$, $p < .001$, $MD = -2.71$) suggesting a weakened sense of identification with the engineering field. Additionally, engineering belonging significantly decreased ($MD = -1.28$, $t(68) = -4.55$, $p < .00$), reflecting a decline in feeling connected with the engineering community.

*Table 9: Paired t-test results (US East) Domestic Students (n=69)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | 0.43 | -1.08 | 0.27 | [-1.23, 0.36] | 0.13 |
| College Specific Prejudice | -1.44 | -3.43 | 0.00** | [-2.29, -0.60] | -0.41 |
| College Specific Social Distance | 0.50 | 1.15 | 0.25 | [-0.36, 1.38] | 0.13 |
| Eng. Specific Social distance (in person) | -0.05 | -0.18 | 0.85 | [-0.68, 0.57] | -0.02 |
| Eng Specific Social Distance (Online) | -0.27 | -0.96 | 0.33 | [-0.83, 0.29] | -0.11 |
| Help Seeking Attitude | 0.46 | 0.88 | 0.38 | [-0.58, 1.51] | 0.10 |
| Engineering Identity | -2.71 | -5.66 | 0.00** | [-3.66, -1.75] | -0.68 |
| Engineering Belonging | -1.28 | -4.55 | 0.00** | [-1.85, -0.72] | -0.54 |

*+p<0.10, *p<0.05, **p<0.01*

*Table 10: Paired t-test results (US East) International Students (n=22)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | 0.59 | 0.61 | 0.54 | [-1.40, 2.59] | 0.13 |
| College Specific Prejudice | -1.95 | -1.71 | 0.10 | [-4.31, 0.40] | -0.36 |
| College Specific Social Distance | 0.81 | 1.79 | 0.07 | [-0.09, 1.72] | 0.38 |
| Eng. Specific Social distance (in person) | 0.81 | 0.86 | 0.39 | [-1.14, 2.78] | 0.18 |
| Eng Specific Social Distance (Online) | 0.84 | 1.20 | 0.24 | [-0.62, 2.30] | 0.25 |
| Help Seeking Attitude | 0.36 | 0.29 | 0.77 | [-2.19, 2.91] | 0.06 |
| Engineering Identity | -2.18 | -3.46 | 0.00** | [-3.49, -0.87] | -0.73 |
| Engineering Belonging | -1.36 | -3.69 | 0.00** | [-2.13, -0.59] | -0.78 |

*+p<0.10, *p<0.05, **p<0.01*

### *4.6 Family Education Level*

The paired t-test results for first-generation students revealed two significant changes. College-Specific Prejudice significantly decreased ($t(21) = -3.72$, $p < .001$, $MD = -2.31$), indicating a reduction in prejudiced perceptions within the college environment. Engineering identity also significantly declined ($t(21) = -3.12$, $p < .001$, $MD = -2.45$), suggesting a weakened sense of alignment with the engineering field over time (Table 11).

*Table 11: Paired t-test results (US East) First Generation status (n=22)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.18 | -0.21 | 0.83 | [-1.94, 1.58] | -0.04 |
| College Specific Prejudice | -2.31 | -3.72 | 0.00** | [-3.93, -0.49] | -0.79 |
| College Specific Social Distance | 0.59 | 1.07 | 0.29 | [-0.55, 1.73] | 0.22 |
| Eng. Specific Social distance (in person) | -0.45 | -0.76 | 0.45 | [-1.68, 0.77] | -0.16 |
| Eng Specific Social Distance (Online) | -0.55 | -0.99 | 0.33 | [-1.71, 0.61] | -0.21 |
| Help Seeking Attitude | 1.31 | 1.35 | 0.19 | [-0.70, 3.34] | 0.27 |
| Engineering Identity | -2.45 | -3.12 | 0.00** | [-4.08, -0.81] | -0.52 |
| Engineering Belonging | -0.59 | -1.54 | 0.13 | [-1.38, 0.20] | -0.32 |

*+p<0.10, *p<0.05, **p<0.01*

The paired t-tests for students with college-educated parents showed several significant results (Table 12). College-specific prejudice significantly decreased ($t(68) = -2.59$, $p = .01$, $MD = -1.33$), indicating a reduction in prejudiced attitudes in the college context. College-specific social distance increased marginally ($t(68) = 1.93$, $p = .05$, $MD = 1.00$), suggesting a slightly greater perceived distance within the college setting. Furthermore, engineering identity significantly declined ($t(68) = -5.75$, $p < .001$, $MD = -2.62$), and engineering belonging also showed a significant reduction ($t(68) = -5.56$, $p < .001$, $MD = -1.53$). These findings highlight the experiences of students based on their parental education background, particularly in their perceptions of prejudice, social distance, and identity in engineering context.

*Table 12: Paired t-test results (US East) Parents with College Degrees (n=69)*

| Variables | Mean Diff. | t-value | P-value | 95% CI | Cohen's d |
|---|---|---|---|---|---|
| General Prejudice | -0.18 | -0.44 | 0.66 | [-1.04, 0.66] | -0.05 |
| College Specific Prejudice | -1.33 | -2.59 | 0.01* | [-2.35, -0.30] | -0.31 |
| College Specific Social Distance | 1 | 1.93 | 0.05 | [-0.03, 2.03] | 0.23 |
| Eng. Specific Social distance (in person) | 0.34 | 0.88 | 0.37 | [-0.43, 1.13] | 0.10 |
| Eng Specific Social Distance (Online) | 0.13 | 0.44 | 0.65 | [-0.48, 0.75] | 0.05 |
| Help Seeking Attitude | 0.15 | 0.27 | 0.78 | [-0.98, 1.30] | 0.03 |
| Engineering Identity | -2.62 | -5.75 | 0.00** | [-3.53, -1.71] | -0.69 |
| Engineering Belonging | -1.53 | -5.56 | 0.00** | [-2.08, -0.98] | -0.66 |

*+p<0.10, *p<0.05, **p<0.01*

## 5. Discussion

The results of the paired t-test analyses revealed consistent trends across the overall sample and the demographic groups, highlighting important temporal changes in college specific prejudice, engineering identity, and belonging. Across all groups, college specific prejudice generally declined which suggests that the experiences of prejudice within the academic environment declined over time across the whole group, and trends were the same within different demographic groups. A moderate decline in engineering specific social distance in online context was also observed but only for those experiencing mental health conditions. However, a decrease in engineering identity and engineering belonging were evident across gender, race, sexual orientation, and parental education level, suggesting a weak connection to the engineering field and its community over time. These patterns were particularly less pronounced or absent among international students, likely due to a smaller sample size, nonetheless suggesting variability in experiences tied to demographic factors. These findings indicate critical challenges in fostering a sense of identity and inclusion within an engineering academic environment while indicating modest progress in reducing prejudiced perceptions within college environment.

In interpreting the results, it is notable that the decline in college-specific prejudice observed in this study was not accompanied by changes in help-seeking behaviors. This finding aligns partially with prior research by Lipson et al [27], which highlights a significant reduction in stigma over the past decade, with personal stigma decreasing to a greater extent compared to perceived stigma and being closely associated with treatment-seeking behaviors. The absence of significant differences in help-seeking behavior over time suggests that a decline in college-specific prejudice, while important on its own, is insufficient to increase utilization of formal mental health resources. These findings underscore the need for targeted interventions that address personal stigma directly to encourage help-seeking among engineering students. Nevertheless, we acknowledge that the tool we are using only refers to attitudes towards formal help seeking. It is also important to consider alternatives, such as informal help seeking strategies that might be part of the repertoire of students in engineering.

The observed increase in college-specific social distance could be attributed to the lingering effects of the social distancing policies adopted during the COVID-19 pandemic, which significantly altered social interactions within academic settings. The transition to remote learning and the enforcement of social distancing measures disrupted traditional avenues for peer engagement and community building which led to feelings of isolation and reduced connectedness among students [28]. We expect that despite the institution's transition back to in-

person learning, the impacts of the disruptions experienced not so long ago could still have influenced students' perceptions of social distance.

The significant decline in engineering identity and belonging across all demographic groups may be an indicator of the known persisting challenges within the engineering culture. The results point to the existence of broader issues with diversity and inclusion, as students from diverse backgrounds often encounter systemic barriers that hinder their sense of connection and identification with the field [29]. We found that students with mental health conditions had the largest drops in engineering identity and belonging, which is an area of valuable further inquiry. Moreover, the competitive culture and high stress academic environment within engineering programs not only leads to mental health conditions [30] like stress, anxiety, and depression but also may exacerbate feelings of exclusion and disconnection [31]. Over time, a weak engineering identity and low sense of belonging could have repercussions for engineering student retention [32] which could in turn lead to wider institutional problems for engineering and the economy. Our findings highlight the need for fostering a more inclusive and supportive engineering culture, with targeted initiatives to strengthen belonging and identity, particularly for marginalized groups.

## 6. Limitations

This study has some limitations that should be considered when interpreting the findings. While we have examined changes over time, we have used on only two data points collected one year apart, which limits the ability to establish long-term trends. The small sample size (N = 91) although appropriate for the procedures performed may restrict generalizability, particularly for subgroup analyses, as smaller representation of international students and those with mental health conditions may have contributed to the lack of significant findings in certain areas. Additionally, external factors, such as the lingering effects of the COVID-19 pandemic, may have influenced students' experiences of social distance, belonging, and identity in ways that were not directly measured. Despite these limitations, this study provides valuable insights into changes in stigma, help-seeking attitudes, and engineering identity. The findings of the study also highlight key areas for intervention and lay the foundations for future research to explore these dynamics over a longer periods of time.

## 7. Conclusion and Future Work

This study focused on gauging the changes in stigma of MHC and help-seeking attitudes among engineering students between two consecutive years in their engineering education. Using a sample of 91 students that provided valid responses to established instruments in years 1 and 2 of the project we conducted paired t-tests comparisons of all stigma and help-seeking related sub-constructs as well as those related to engineering identity and belonging. Analyses included those among subgroups of students according to critical demographic variables such as gender, sexual orientation, race, international status, family education level, and MHC status. Results showed a consistent decrease only in one stigma sub-construct, the one related to *College Specific Prejudice*, but no significant difference in any other stigma or in help seeking attitude sub-construct. However, a significant decline was observed for engineering specific social distance in online setting for those with mental health conditions despite the limited sample size. Therefore, no other stigma was reduced, nor help seeking attitudes were increased. Notwithstanding, there was a consistent decrease shown in general and among all subgroups studied in engineering

identity and engineering belonging. Given the hypothesized relationships held by the larger project where this study belongs, it will be critical to unpack such decreased engineering identity and belonging and how that might be affecting students' mental health and wellbeing, which in turn might have important implications to further understand retention in the field.

Upcoming work with this data will involve the addition of the third wave of data collected for the project, which will support confirming the observed trends in a longer period. Furthermore, a more complex understanding of the relationships between engineering identity and perceived culture with stigma and help-seeking attitudes will be pursued using longitudinal structural equation models.

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