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Stigma of mental health conditions within engineering culture and its relation to help-seeking attitudes: Insights from the first year of a longitudinal study

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Stigma of mental health conditions within engineering culture and its relation to help-seeking attitudes: Insights from the first year of a longitudinal study

1. Introduction

Colleges and universities are trying to keep pace with the increasing mental health needs of students. However, it has been documented that students' attitudes towards seeking help are still a barrier to the use of available resources, and such attitudes vary across student subpopulations, with engineering students being less likely to seek help for mental health conditions (MHCs) than students in other fields when they need it [1]. Given the high-stress culture that has been promoted in the engineering field, it is important to explore the barriers that exist to our students' help-seeking attitudes and the behaviors that would support their mental health and, consequently, their academic success. In addition, it is unknown how these barriers prevail as engineering students graduate and transition to their first professional engineering experiences.

The central hypothesis of our larger project is that general and engineering-specific elements of stigma towards MHCs are negatively correlated with help-seeking attitudes of students and that such correlations vary by elements of their personal background. With our study we aim *(1) to quantitatively measure the relationship between stigma of MHCs and help-seeking attitudes of engineering students and early professionals, how this relationship evolves over time, and how it is influenced by potential mediating effects related to the students' characteristics and their engineering educational and professional environments*, and *(2) to generate a qualitative understanding of the elements of engineering identity and culture that influence students' and early professionals' experiences with MHCs, their willingness to seek help or support others' help-seeking attitudes when necessary, and the strategies that are demonstrated to be effective in addressing MHCs concerns.*

This paper presents the longitudinal research design of our multi-institutional study and the results and lessons learned from the first year of its execution. We present quantitative results from the analysis of survey data that was collected using established instruments measuring stigma of MHCs and help-seeking attitudes. We also present preliminary qualitative results from students' interviews at an institution in the eastern U.S.. The research questions that guide this paper are:

RQ1. *What is the relationship between the stigma of MHCs and the help-seeking attitudes of engineering students?*

    RQ1.1. *How does this relationship vary across different student identities?*

RQ2. *What are the relationships between elements of the engineering experience and help-seeking attitudes?*

    RQ2.1. *How do these relationships vary across different student identities?*

RQ3. *Which elements of the engineering culture do students report as intersecting with their mental health and their help-seeking attitudes?*

Following this (1) introduction, we present (2) a review of the literature that locates this research project within the current body of knowledge on the topic, (3) the study design for the larger, longitudinal project, (4) the methods used for collecting and analyzing the data during the first year of the project as well as the identified challenges to its execution, (5) the results from the analysis of data from one institution during the first year, (6) a discussion, and (7) conclusions and suggested future work.

2. Literature Review

The mental health needs of students in higher education have been on the rise for the last decade [2]. Recent U.S. estimates show that one-third of undergraduate students experience significant clinical symptoms for a MHC, including depression, panic disorder, and generalized anxiety. In this population, MHCs impact women, sexual and gender minorities, ethnic minorities, and other marginalized groups more seriously [2], [3]. A number of current confounding issues have increased students' stressors, such as the COVID-19 pandemic [4], [5], with its consequential economic recession [6], and the racial reckoning happening in the U.S. [15]. These issues have only exacerbated the mental health challenges of college students, especially those of marginalized groups [7].

2.1 Engineering students' MHCs and help-seeking attitudes

Engineering-specific studies about students' prevalence of and experiences with MHCs are scarce but insightful. A multi-institutional study conducted in the western U.S. gauged the prevalence of MHCs among engineering students in their first and second academic years and found that almost 30% of respondents potentially suffered from a diagnosable MHC [8]. In addition, one-third of students were suffering from major distress, while more than 80% had at least moderate levels of stress. Furthermore, they found that female students and those from historically excluded ethnic and racial groups showed higher rates of Panic disorder and Post Traumatic Stress Disorder (PTSD) than majority groups [8]. Larger scale studies based on national surveys have shown that while engineering students have comparable prevalence of MHCs compared to students in other fields, engineering students experiencing such conditions have lower utilization of available resources to address their challenges [1].

Ongoing work is being conducted to generate a better understanding of engineering students help-seeking attitudes. In their current project, Wilson and colleagues are developing an instrument to specifically explore engineering students help-seeking beliefs [9]. Similarly, valuable efforts are now taking place to understand more deeply the challenges of undergraduate [10] and graduate students [9] within the stressful culture of engineering. However, society-wide barriers to help-seeking attitudes, such as stigma, and the role it plays in important transition points such as the first years of professional life, are largely understudied, especially at their intersection with the engineering academic and professional culture.

2.2 Stigma of MHCs

Stigma refers to a strong feeling of disapproval about a particular characteristic [11] and can be targeted at a variety of someone's voluntary or involuntary traits [12]. In the case of MHCs, stigma is perpetuated by negative portrayals in media of people with MHCs as dangerous or intellectually limited [13]. These perpetuated misconceptions of people with MHCs hinder efforts to reduce stigma surrounding MHCs and instead these misconceptions support the continued stigma prevalence in society. Another challenge to reducing stigma is the multi-dimensional nature of MHC stigma. Two levels of stigma need to be acknowledged: *social stigma* (i.e. public stigma), the stigma held by society in general, and *self-stigma*, the disapproval of the condition by those that have it [14]. It has been shown the two levels are interrelated, with social stigma directly influencing the development of self-stigma, but not the other way [15]. Substantive evidence identifies the prevalence of MHC stigma as a barrier to seeking help for MHCs in the general population [14]–[17]. Such stigma-derived avoidance attitudes vary across groups such as those with different age distributions [18], ethnic backgrounds [19]–[21], and professions [22]. As college students, and engineering students in particular [1], have a higher prevalence of help-seeking avoidance than the general population [23], [24], it is important to explore how stigma interacts with such attitudes in this population. Further, with the increasing prevalence of MHCs among the college-aged population [25]–[27] it is important to identify elements that continue to promote stigma around MHCs that could negatively affect student help-seeking attitudes.

2.3 Engineering Culture

A culture of high stress and endurance has been traditionally endorsed in the field of engineering as a synonym for the rigor required to succeed [28]. In engineering education spaces, it is not uncommon for a lack of sleep and deprivation from social and leisure time to become honor badges that unconsciously measure belonginess [29]. While many of these features are common for other STEM fields, few areas have explored the wellbeing challenges of their professionalizing cultures, e.g. medical school [30]. The relationship between stress and mental health has been theorized extensively [31], [32]; empirical evidence has shown a negative relationship between stress, mental wellbeing, and student academic success and retention [33], [34]. However, little is known about the relationship between stress and other discipline specific factors and how this relationship may affect students' mental health and related success.

One early attempt to understand the role of stress in the engineering culture was conducted by Jensen and Cross [35]. Their survey of 1,203 students captured perceived levels of engineering identity, departmental inclusion, stress, and anxiety through a variety of established instruments. They found that higher perceptions of engineering identity and departmental inclusion of students were correlated with lower depression levels. Similarly, lower perceptions of department inclusion were correlated with high levels of stress and anxiety. While these correlations may or may not be causal, they warrant further study since low perceived inclusion or lack of belonging have been identified as barriers for engineering students, particularly affecting their retention and success [36]–[38].

To contribute to the understanding of the intersection of MHCs within engineering spaces, our team conducted a qualitative exploration of the experiences of three engineering students and professionals living with a diagnosed MHC [39]. Our results indicated that social stigma and self-stigma limited their help-seeking attitudes and successful treatment. In addition, self-stigma was strongly related to the conflict between their engineering and MHC identities [39]. Important transition time points, such as graduating and starting their professional career, added additional strain on understanding and managing their MHC [31]. Elements of the engineering culture at their academic and professional spaces such as the "down-to-business" mindset were also identified as influencing the expression and feasible management of their MHC. This was particularly impactful for the one female in our study, who cited the additional challenges of navigating teamwork within a male-dominated engineering department as damaging her mental health [manuscript under preparation]. These results inform the space of inquiry guiding this research project.

Other recent qualitative studies have shed additional light into which elements of the engineering culture influence undergraduate students' mental health and their help-seeking attitudes. Wright et al. [40] found that an unsupportive engineering training environment, the difficulty of work, limited time for tasks, a suck-it-up mentality, and public shame were the major stressors for engineering students. Similarly, Beddoes and Danowitz [41] identified seven features of engineering education that contribute to student's worsening mental health: the ubiquity of stress, professors not being sympathetic, certain exam formats, 5-year degree programs sold as 4-year programs, ties to the military and government, a culture of silence, and an environment dominated by men.

Our own quantitative exploration of the relationship between engineering culture and help-seeking attitudes started with a pilot study of engineering undergraduates at two institutions (n=79) which helped frame the study discussed in this paper [42]. We found evidence of a negative correlation between student stigma about MHCs and help-seeking attitudes [42]. Elements of self-stigma did not correlate significantly with help-seeking attitudes, confirming that social-stigma represents the most limiting type of stigma [15]. In addition, when exploring the relationship of students' perception of their engineering departments with their help-seeking attitudes, we found that there was a general positive correlation between the perception of their department diversity orientation (i.e. the perception of their department openness and support to diverse students) and help-seeking attitudes amongst all the students. However, when splitting the analysis by MHCs status, the correlation remained positive among students without MHCs, but it was inverted among those with MHCs, with department diversity orientation having a negative correlation with help-seeking attitudes [40], which could indicate that a student's MHC status influences their conceptions of diversity. Through our larger project [43] we aim to unpack such conflicting results. Here we present the project at large, and the insights we have gained during the first year of the project execution.

3. Study Design

3.1 Theoretical framework

The theoretical framework guiding this work is composed of multiple theories that acknowledge the complexity of engineering as a disciplinary culture and its theorized interaction with MHCs. Figure 1 represents the multiple agents playing a role in promoting and perpetuating cultural elements related to attitudes towards MHCs within engineering in and out of academia, including administration/management and faculty/supervisors. Our study focuses exclusively on students and early professionals, although it has the potential to shed light on other elements of the engineering culture that affect students' and early professionals' wellbeing.

Social identity theory [44] provides a general framework for further understanding engineering culture and its interaction with stigma towards MHCs. The tenets of social identity theory assume that individuals constantly strive to obtain or preserve a positive social identity. However, social identities can also be negative depending on the social consensus existing around certain categories. Negative identities tend to reflect elements that do not comply with societal expectations. Because of the multiple spaces where we develop identities, we have multiple social identities and they differ in their nature and strength [70]. An engineering identity can be considered a positive identity due to its prestige in U.S. society [45] and experiencing a MHC can be considered a negative identity due to the societal stigma still present around MHCs [24]. From these characteristics, we derive two assumptions for our study: (1) engineering identity takes precedence over the MHC status identity, and (2) there will be some conflict derived from the interaction between these two identities.

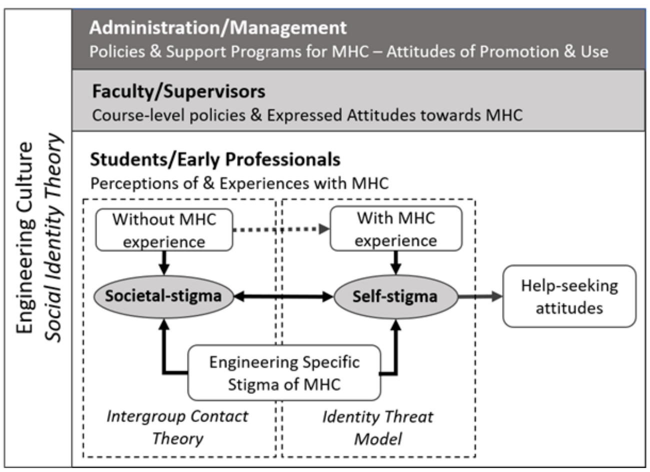

Figure 1. Graphical representation of the theoretical framing of this study

The figure 1 also denotes additional theoretical elements to study regarding the identity of experiencing a MHC. First, when focusing on individuals without MHC experiences, we expect that social stigma will be the main type of stigma influencing their attitudes and interactions. Therefore, their understanding of MHCs will be led by their willingness for intergroup learning. Hence, we use the lens of *intergroup contact theory* [46], [47] to understand the influence of campus-based initiatives and other available learning resources about MHCs and the role of close contact with people with MHCs in the evolution of their stigma of MHCs. Second, when focusing on those with MHCs, we recognize self-stigma taking place through the internalization of the social stigma [18]. Internalized stigma usually results in neglecting the MHC and avoiding treatment all together [15]. Consequently, those with high self-stigma also miss the opportunity to build a community of support [48], which are now often promoted in college campuses. Because of the assumed interaction with the engineering identity, we analyze the presence of self-stigma using the *identity* *threat model*, which states that having a stigmatized identity increases exposure to stressful situations that threatens one's main positive identity.

We focus on how an MHC identity interacts and acts as a threat to an engineering identity. The theoretical model considers collective representations, situational cues, and personal characteristics as affecting an individual's appraisal of identity threat and determining the type of response that somebody experiencing this conflict will act upon. Our framework is composed of elements of the interactions between engineering culture and identity and between students/early professionals with and without MHCs, aims to uncover the nuances of such dynamics. In addition, by recognizing that MHCs can have an onset at any point in life, which is denoted by the dotted arrow between both groups, the study of these dynamics in a time-evolving setting, such as this multi-year study, will allow us to unpack the important transition from college to engineering professional spaces and variations of the experience of MHCs over time.

3.2 Longitudinal research design

The ***research hypothesis*** of this study is that general and engineering-specific elements of stigma towards MHCs are negatively correlated with help-seeking attitudes and are influenced in different ways by personal and sociocultural elements (e.g. gender, race/ethnicity, gender identity, socioeconomic status). In addition, based on the theoretical framings the tensions between stigma towards MHCs and help-seeking attitudes, we hypothesize that help-seeking attitudes might change through time during the preparation of engineering undergraduates, with a potential reduction in stigma due to time and exposure to knowledge of MHCs.

Our 3-year longitudinal explanatory sequential mixed methods study allows for the quantitative measurement of students' and early professionals' attitudes towards MHCs and help-seeking attitudes and the qualitative exploration of their experiences with and attitudes towards MHCs at three different points of time. In the first year, all engineering students at two institutions were invited to participate in the quantitative survey. Only participants of the first year will be invited to participate in the following years of this longitudinal study. We envision that this longitudinal approach will allow us to capture how the challenges of engineering students and professionals evolve through time and how the challenges related to their engineering accomplishments interact with their mental health challenges. Table 1 denotes the spread of students' levels through the years of this longitudinal study for both the quantitative and qualitative data collection processes. As mentioned, this paper focuses on the preliminary results obtained from the first year of execution of this project at one institution.

Table 1. Spread of study participants' academic/professional years across the longitudinal deployment of this project.

Time	First-Year	Sophomores	Juniors	Seniors	5th year or recent graduate	6th year or recent graduate
2022-2023 (Y1)						
2023-2024 (Y2)						
2024-2025 (Y3)						

4. Methods

4.1 Data Collection

Quantitative data is collected through a yearly survey using established instruments, some of which were modified for the engineering context. The quantitative results inform the qualitative data collection using the maximum variance principle in which we use the respondent's stigma and help-seeking scores to selectively invite participants to the qualitative part of the study. Qualitative data is collected through yearly interviews. All study procedures were approved by the Institutional Review Board at University at Buffalo.

We collect data from two institutions in the continental U.S. Based in their location, in the remaining of this paper we refer to them as U.S. East and U.S. Midwest. This paper refers to the preliminary results derived from data collected at U.S. East in the first year of this project.

4.1.1 Survey Data

A series of established instruments were selected to capture data on undergraduate engineering students' stigma of MHCs, self-stigma, help-seeking attitudes, and other opinions. All these instruments were previously validated. The survey was administered through Qualtrics. Essential details of each instrument are presented next.

The *College Toolbox Project* (CTP) [49] was used to measure ***stigma constructs***. The three constructs considered by CTP are: *general prejudice* (8 items), *college-specific prejudice* (9 items), and *college-specific social distance* (11 items). Only a subsection of the third subscale (5 items) was adapted for the engineering context, considering the use of in-person and online spaces for engineering students' interactions. The other scales were not altered due to the results of our pilot (n=79, and described in [42]) that showed no significant difference between the college-specific and the engineering-specific prejudice.

The *stigma scale* [50] was used to measure ***self-stigma among those that have MHCs***. This validated scale has 28 items measuring three main factors: *perceived discrimination from others* (13 items), issues of *disclosure* of their condition (10 items), and *positive aspects of having a mental illness* (e.g., becoming a more understanding or accepting person) (5 items). The self-stigma scale is only offered to students that provide evidence of having a MHC.

Help-seeking attitudes were measured using the *Attitudes Towards Seeking Professional Psychological Help instrument*. This reduced instrument was proposed and validated by [51] and uses 10-items to explore willingness to seek professional help when needed. Recent explorations of this scale have found that the instrument holds a three-dimensional structure [52] capable of capturing different aspects of help-seeking attitudes, including: (1) openness to seeking professional help (3 items), (2) value in seeking professional help (4 items), and (3) preference to cope on one's own (3 items).

Elements of the Engineering Experience were measured through a modification of the *Engineering Department Inclusion Level (EDIL) survey* [53]. For our purposes, we combined elements of department care (6 items) and department diversity (7 items), and we also included items related to experiences of people with MHCs that aligned with the instrument. ***Engineering identity and belonginess*** was measured through five questions used by [54].

In addition, we created 5 new items that mapped elements of ***engineering culture related to competition and meritocracy beliefs*** (5 items) in a 6-points Likert scale. These proposed items were informed by literature [55], [56] and are listed in Table 2.

Table 2. Proposed items for Engineering culture.

Item	Statements
1	Engineering is a more difficult major than other non-engineering fields
2	Engineering students are expected to put their schoolwork before everything else
3	Engineering students are expected to compete against each other
4	Those that cannot keep up with the demands of the engineering training do not deserve to be engineers.
5	All sacrifices as an engineering student are worth the future benefits of becoming an engineer.

We also used the *Depression, Anxiety, and Stress Scale* (DASS-12) (12 items) [57] to have a real-time measurement of students' ***mental health status***, students' ***knowledge of MHCs*** and ***awareness of campus resources about MHCs***, although such results are not presented here.

Finally, ***demographic*** variables were collected, including gender, race/ethnicity, sexual orientation and identity, and international status, among others. Demographic variables were used for grouping in this first analysis. The Qualtrics survey containing all these instruments had a total of 120 items and took participants an average of 14 minutes to complete. Students were compensated with $10 for their time.

4.1.2 Interview Data

Considering our theoretical framework, our interviews are guided by students' (1) perceptions of MHCs, (2) experiences with MHCs, and (3) interactions related to MHCs, all framed within the engineering context. In practice, students are asked first about their beliefs about engineering culture and their engineering identity, then their knowledge about mental health and stigma. The final section of the interview asks questions about the intersection of these two elements in order to explore participants' beliefs about how dealing with MHCs is different and/or unique within engineering. Our protocols will follow the same structure and flow between years. However, additional details will be modified or added to acknowledge student academic/professional year. In our interviews for years 2 and 3, we will also add guided questions focused on the new knowledge and experiences around MHCs within the participants' engineering spaces, with specific attention to transitions and changes happening during the last year. Interviews were professionally transcribed. The transcripts were validated for accuracy and used for our qualitative analysis.

Our complete research design involves collecting 24 interviews per institution in the study each year. While the totality of interviews were conducted at U.S. East by the time of this writing, only the analysis of four interviews is presented here as an exploratory analysis to address research question 3.

4.1.3 Contextual Challenges

We originally expected to collect responses to our survey in parallel at both institutions (U.S. East, and U.S. Midwest) at the beginning of Fall 2022 (i.e. late August/early September). However, due to the additional time it took the team to finalize IRB approval, the quantitative survey had to be launched in mid-October 2022. By that time, one tragic event involving the death of a student had taken place at U.S. Midwest. Due to this context, the team agreed to halt data collection at that institution. In an odd coincidence, the death of a non-student then took place at the U.S. East campus a couple of weeks later. The survey was launched at U.S. East on October 24, which the team believes affected response rates at the sites as well (~5%). The launch of the survey at U.S. Midwest was re-scheduled to the beginning of the Spring 2023 semester, and was launched on January 23, 2023 with more satisfactory response rates (>10%). For Year 2 of our data collection, we plan to maintain the different timing for data collection between institutions, but we will ensure that for both data collection periods (Fall 2023 for U.S. East, and Spring 2024 for U.S. Midwest) we offer the survey as early in the semester as possible to maximize response rates.

4.2 Data Analysis

We present preliminary quantitative and qualitative results derived from data collected at one of the two participating institutions, U.S. East. The sample obtained for this first wave of data collection at U.S. East had 211 valid and complete observations. The demographic distribution is presented in Table 3. While females represented only 35.5% of the total sample, they made up a higher proportion of the participants with MHC experience (50.8%) than males (39.0%). Similarly, those identifying as non-heterosexual (18.4% of the total sample) had a higher proportion (39%) of experience with MHCs (39.0%). Those identifying as Latinx, also showed a higher proportion of experience with MHCs (15.3%) than their sample representation (7.6%). With respect to socioeconomic status growing up, those in the lower levels had higher rates of experiences (49.2%) with MHC than their sample representation (35.6%). International students were the group with the largest differences from their representation of the total sample (21.3%) and the proportion of MHC experience that they made up (81.4%).

Table 3. Demographics distribution of data collected during Year 1 of the study at U.S. East.

Demographic Dimension	***All***		***With MHC Experiences***		***Without MHC Experiences***	
	n	***%***	***n***	***%***	***n***	***%***
Gender						
Men	126	59.7	23	39.0	103	67.8
Women	75	35.5	30	50.8	45	29.6
Transgender Men	4	1.9	3	5.1	1	0.7
Transgender Women	1	0.5	1	1.7	0	0.0
Other	2	0.9	1	1.7	1	0.7
Prefer not to answer	3	1.4	1	1.7	2	1.3
Sexual Orientation						
Heterosexual	166	78.7	36	61.0	130	85.5
Gay/Lesbian	6	2.8	4	6.8	2	1.3
Uncertain	6	2.8	4	6.8	2	1.3
Other	27	12.8	15	25.4	12	7.9
Prefer not to answer	6	2.8	0	0.0	6	3.9
Hispanic/Latinx						
Yes	16	7.6	9	15.3	7	4.6
No	192	91.0	47	79.7	145	95.4
prefer not to answer	3	1.4	3	5.1	0	0.0
Race/Ethnicity						
Two or more races	29	13.7	13	22.0	17	11.2
American Indian	12	5.7	4	6.8	8	5.3
Pacific Islander	1	0.5	0	0.0	1	0.7
White	125	59.2	32	54.2	93	61.2
Other	44	20.9	10	16.9	33	21.7
Socioeconomic status growing up						
Very poor	9	4.3	3	5.1	6	3.9
Had enough to get by but not many extras	66	31.3	26	44.1	40	36.3
Comfortable	105	49.8	23	39.0	82	53.9
Well to do	25	11.8	6	10.2	19	12.5
Prefer not to answer	6	2.8	1	1.7	5	3.3
International status						
International Student	45	21.3	11	81.4	34	22.4
Non-international	166	78.7	48	18.6	118	77.6
Engineering Major						
Aerospace	29	13.7	5	8.5	24	15.8
Biomedical	20	9.5	5	8.5	15	9.9
Chemical	8	3.8	3	5.1	5	3.3
Civil	18	8.5	5	8.5	13	8.6
Computer Eng & Comp Science	9	4.3	4	6.8	5	3.3
Electrical	53	25.1	16	27.1	37	24.3
Engineering Physics	22	10.4	8	13.6	14	9.2
Environmental	1	0.5	0	0.0	1	0.7
Industrial	7	3.3	4	6.8	3	2.0
Materials Science & Eng	6	2.8	2	3.4	4	2.6
Undecided	38	18.0	7	11.9	31	20.4
Academic Year						
First-Year	52	24.6	12	20.3	40	26.3
Sophomore	37	17.5	8	13.6	29	19.1
Junior	49	23.2	11	18.6	38	25.0
Senior or more	59	28.0	20	33.9	39	25.7
Fifth year or more	9	4.3	4	6.8	5	3.3
Other	5	2.4	4	6.8	1	0.7
Education level in family						

First generation college student	55	26.1	17	28.8	38	25.0
One parent with college degree	61	28.9	15	25.4	46	30.3
More than one parent with college degree	95	45.0	27	45.8	68	44.7
Total	211	100.0	59	28.0	152	72.0

4.2.1 Confirmatory Factor Analysis

The performance of all established instruments was evaluated through appropriate tools. Confirmatory Factor Analysis (CFA), was used to evaluate the performance for those tools that had an appropriate sample size according to [58]. Since the self-stigma scale was offered only to those mentioning having experience with MHCs, the sample size was smaller (n=59) and only Chronbach alphas [59] were calculated. In Table 4 we summarize the main results from these analyses, showing the Confirmatory Factor Index (CFI), Tucker Lewis Index (TLI) and RMSEA (Root Mean Square Error of Approximation). Literature refers the range for CFI and TLI to be between 0 and 1, with values over 0.90 indicating a good fit for these two measures [60]. For RMSEA, values below 0.05 indicate good fit, between 0.08 and 0.1 indicate a marginal fit and values greater than 0.1 indicate a poor fit [60]. Finally, Chronbach's alpha values are considered good above 0.7 [59].

All subscales from the College Toolbox were evaluated as independent single factors, while the help-seeking attitudes and engineering identity/belonging instruments were evaluated as multifactor structures. The engineering culture elements were not assessed, as they were newly proposed, and an Exploratory Factor Analysis [60] is necessary. The validation of College Toolbox elements resulted in limited performance of the college-specific prejudice and the college-specific social distance scales. Similar limited performance took place for the structure of the help-seeking attitudes instrument and some elements of engineering. While the RMSEA fit was marginal for many of these instruments, due to the limited sample size of this preliminary analysis (n=211), we executed our analyses with all results, knowing that some of the conclusions might not hold. However, an increased sample size will likely improve our results. We expect that the inclusion of the data being collected at the second institution (U.S. Midwest) will improve these performance measures.

Table 4. Main Results of Confirmatory Factor Analysis of survey elements

Instrument or section	Subscale	Items	CFI	TLI	RMSEA
College Toolbox	General Prejudice	8	0.94	0.91	0.08
	College-Specific Prejudice	9	0.76	0.68	0.18
	College-Specific Social Distance	6	0.89	0.82	0.22
	Engineering-Specific Social Distance (In person)	5	0.98	0.96	0.12
	Engineering-Specific Social Distance (Online)	5	0.99	0.98	0.08
Self-stigma	Discrimination	12		α = 0.87	
	Disclosure	11		α = 0.82	
	Positive Aspects	5		α = 0.43	
Help-Seeking Attitudes	Openness to seeking professional help	3			
	Value seeking professional help	4	0.85	0.79	0.11
	Preference to cope on one's own	3			
Engineering Experiences	Department Respect and Care	6	0.91	0.89	0.12
	Diversity and Inclusion	7			
	Engineering Belonginess	5	0.98	0.97	0.09
	Engineering Identity	1			
	Engineering Culture	5		NA	
DASS-12		12	0.85	0.82	0.13
Demographics		13			
Total		**120**			

4.2.2 Quantitative Analysis

Our quantitative analyses included parametric correlation analyses to identify raw relations between the scales being explored. The correlation analysis compares against the null hypothesis that there is no correlation between the variables. The variables used to perform the correlation were the totals for each scale. Totals were calculated for each participant after scale values were standardized in direction (i.e. greater values reflected higher values of the construct), which required the recoding of some items with inverse wording. In addition, non-parametric group comparisons (i.e. Wilcoxon tests) in the scales totals between different groups were conducted (null hypothesis: there is no difference between groups). If significant differences were found, additional grouped correlation analyses were conducted to see if the relations identified changed in any way. All statistical tests were conducted considering a 0.05 significance level, however, modest significance (i.e. between 0.05 and 0.1) was also tracked and presented in our results because of the exploratory nature of our analyses.

4.2.3 Qualitative Analysis

Our qualitative analyses were performed through thematic analysis [61]. One researcher used inductive or open coding to identify themes in the experiences and knowledge of MHCs and perceptions of engineering culture that students reported in their interviews. This paper only reports on the themes identified around the perceptions of engineering culture interacting with mental health. In addition, to expand the analysis to the totality of the sample, our results will be strengthened through coding by additional researchers to establish inter rater reliability and strengthen the validity of our findings [62], [63].

4.2.4 Limitations

A limitation of this early-stage study is the small sample size for both the quantitative analysis (n=211) and the qualitative analysis (n=4). The validation of the established instruments used in our survey had limited performance, and we expect such performance to increase with a larger sample size. Similarly, the themes we present from our qualitative analysis can be considered only exploratory in nature due to the small sample size, yet it reflects just the preliminary results from our project.

5. Results

5.1 Quantitative Results

Results of the parametric correlations using the complete sample (n=211) are summarized in Table 5. Not surprisingly, all elements of the College Toolbox were significantly negatively correlated to help-seeking attitudes. Therefore, students with higher general prejudice, college-specific prejudice, and college-specific and engineering-specific (in person and online) social distance attitudes generally had lower help-seeking attitudes. Correlations between these elements were also significantly positive between each other, so a more thorough analysis of these relationships is necessary through other analytical strategies. These first results confirm that social-stigma and its negative relationship with help-seeking attitudes are present within this sample of engineering students.

Table 5. Pearson Correlations between Help-seeking and elements of social and engineering-stigma across the full sample.

Scales	0	1	2	3	4	5
0. Help-seeking attitudes	1					
1. General Prejudice	-0.29**	1				
2. College-Specific Prejudice	-0.25**	0.80**	1			
3. College-Specific Social Distance	-0.28**	0.44**	0.50**	1		
4a. Engineering-Specific Social Distance (in person)	-0.23**	0.39**	0.51**	0.67**	1	
4b. Engineering-Specific Social Distance (online)	-0.25**	0.37**	0.49**	0.66**	0.85**	1

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

Table 6 summarizes the results of the correlations between help-seeking attitudes and the measures that we considered reflecting engineering elements, including perceptions of department care and respect, department diversity, engineering identity and belonging, and the proposed exploratory elements of engineering culture. In general, most elements had a negative correlation, however only the elements of engineering culture were significantly negatively correlated with help-seeking attitudes, i.e. the more a student agreed with such statements the less likely they were to seek-help.

Table 6. Pearson correlations between help-seeking and the considered engineering elements across the full sample

Scales	0	1	2	3	4	5
0. Help-seeking attitudes	1					
1. Department Care and Respect	0.03	1				
2. Department Diversity	-0.06	0.73**	1			
3. Engineering Identity	-0.02	0.48**	0.41**	1		
4. Engineering Belonginess	-0.03	0.54**	0.45**	0.85**	1	
5. Engineering Culture	-0.25**	0.05	0.07	0.07	0.05	1
*+p<0.10, *p<0.05, **p<0.01*						

Knowing the differences in the prevalence of MHCs among certain groups, we conducted group comparisons in the measures across gender and experience with MHCs. The gender comparison was performed between men and women because the sample size for other groups was not big enough for statistical reliability. We look forward to having richer data that will allow for a more granular comparison that includes other minority groups when including data collected at our second institution. When comparing the stigma measures and help-seeking attitudes of men and women, we found that women had statistically lower stigma measures ($p<0.05$) in all but one measure (college-specific social distance), and statistically higher help-seeking attitudes ($HS_w=27.8$ vs $HS_m=25.9$, $p=0.01$). With regard to comparisons in the measures across experience with MHCs, students that had experience with MHCs had statistically lower stigma measures in all stigma measures ($p<0.05$) and higher help-seeking attitudes ($HS_{MHCexp}=28.4$ vs $HS_{noMHCexp}=26.0$, $p=0.01$) than those without such experience. We then conducted the correlation analysis within each of these subgroups to explore if any difference was evident from the results obtained for the larger group.

Tables 7 and 8 summarize the results of the correlations among women only (n=75). When comparing to the results obtained from analyzing the totality of the sample, there are some differences in the results. In particular, the negative correlation of the engineering-specific social distance measures with help-seeking attitudes was not statistically significant among this group (Table 7). Similarly, the correlation between engineering culture items and help-seeking was also weaker (Table 8).

Table 7. Pearson Correlations between Help-seeking and general and engineering specific elements of stigma among Women only (n=75)

Scales	0	1	2	3	4	5
0. Help-seeking attitudes	1					
1. General Prejudice	-0.33**	1				
2. College-Specific Prejudice	-0.25*	0.72**	1			
3. College-Specific Social Distance	-0.39**	0.48**	0.51**	1		
4a. Engineering-Specific Social Distance (in person)	-0.13	0.37**	0.54**	0.67**	1	
4b. Engineering-Specific Social Distance (online)	-0.21	0.34**	0.53**	0.69**	0.91**	1
*+p<0.10, *p<0.05, **p<0.01*						

Table 8. Pearson correlations between help-seeking and the considered engineering elements among Women only (n=75)

Scales	0	1	2	3	4	5
0. Help-seeking attitudes	1					
1. Department Care and Respect	0.01	1				
2. Department Diversity	-0.03	0.85**	1			
3. Engineering Identity	0.02	0.55**	0.44**	1		
4. Engineering Belonginess	-0.03	0.61**	0.51**	0.92	1	

5. Engineering Culture	-0.27+	-0.21+	-0.12	-0.16	-0.16	1

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

Tables 9 and 10 summarize the results of the correlations among participants with MHC experience (n=59). For this group the correlations with help-seeking attitudes observed across all stigma measures were larger than those found for the general sample (Table 9). In addition, the correlation between engineering culture and help-seeking attitudes was also weaker (Table 10). Finally, in Table 11 we present the results of the self-stigma scale, only taken by those with MHC experience, in which the only significant negative correlation between elements of self-stigma and help-seeking attitudes was that of positive aspects of having a MHC.

Table 9. Pearson Correlations between Help-seeking and general and engineering specific elements of stigma among those with MHC experience (n=59)

Scales	0	1	2	3	4	5
0. Help-seeking attitudes	1					
1. General Prejudice	-0.36**	1				
2. College-Specific Prejudice	-0.33*	0.75**	1			
3. College-Specific Social Distance	-0.47**	0.35**	0.35**	1		
4a. Engineering-Specific Social Distance (in person)	-0.48**	0.19	0.35**	0.52**	1	
4b. Engineering-Specific Social Distance (online)	-0.39**	0.18	0.42**	0.57**	0.69**	1

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

Table 10. Pearson correlations between help-seeking and the considered engineering elements among those with MHC experience (n=59)

Scales	0	1	2	3	4
0. Help-seeking attitudes	1				
1. Department Care and Respect	0.17	1			
2. Department Diversity	0.09	0.81**	1		
3. Engineering Identity	0.03	0.48**	0.40**	1	
4. Engineering Belonginess	-0.02	0.51**	0.46**	0.88**	1
5. Engineering Culture	-0.25+	0.05	0.04	0.05	0.03

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

Table 11. Pearson correlations between help-seeking and elements of self-stigma among those with MHC experience (n=59)

Scales	0	1	2	3
0. Help-seeking attitudes	1			
1. Discrimination	0.14	1		
2. Disclosure	-0.18	0.42**	1	
3. Positive Aspects	-0.39**	-0.12	0.39**	1

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

5.2 Qualitative Results

While our initial qualitative data contains information about the perceptions and experiences of mental health, as well as aspects of mental health that intersected within the engineering culture, we are just reporting on the perceptions of engineering culture interacting with mental health reported by our four participants. In Table 12, we present the gender, year and major of our four participants, together with the pseudonym assigned to each of them. We use these pseudonyms to report our results.

Table 12. Characteristics of the four participants in the Qualitative analysis

Pseudonym	Gender	Year	Major
Jenn	F	Grad	Mechanical
Asher	M	3	Electrical

Lauren	F	3	Chemical
Matthew	M	3	Electrical

The four themes identified from the qualitative evidence were: that (1) engineering is harder than other majors, that (2) engineering is your "whole life;" also that there was (3) no time to consider mental health in engineering, and (4) an absence of discussions about mental health in engineering spaces.

(1) Engineering is "harder" (than other majors). Participants shared the perception that engineering is hard work as compared to many other fields of study, and many of them associated the challenges of engineering with mathematics. For example, Asher said, "there's a lot of work, but a lot of the work is also really difficult. It is a lot of math upfront and that can be kind of daunting." Similarly, Matthew said, "we learn a lot of abstract math, mathematical concepts, and our professors really push us." Jenn pointed out that the hard work required of engineers is a point of pride for many people. She said,

> a lot of engineers take pride in the fact that college is so hard. And it's definitely something to be proud of. When you get an engineering degree, it does mean something. It means you put in significant amounts of work.

However, other participants point out the ways that the challenges of engineering have negatively impacted their mental health by making them feel stressed or bad about themselves. For example, Lauren said,

> professors have made me feel really bad about myself for not, I guess, meeting their standards. As I said, a lot of them are high achievers themselves, and I felt like my professors kind of rolled their eyes at me or thought I wasn't one of their worthy students.

In another example, Asher said,

> It's also pretty easy to go into an exam, see that you got a 40 on it and think that you did really badly, which can be pretty stressful. And then later you find out that you actually got an A because everyone else got a 20.

Thus, there is the perception that engineering is challenging, and several participants point out the ways that the challenges can negatively impact their mental health.

(2) Engineering is your "whole life." There was also a shared perception that engineering becomes your whole life when you are an engineering student. For example, Jenn said, "I think part of the engineering culture is always focusing on school." For Lauren, the hard work required of engineering is what makes it so all-consuming in her life. She said,

> the workload, and even on top of that, just doing your assignments, just doing the bare minimum, you're not going to pass with that. You need to put in those extra hours to do well, and then even, you could be doing that and getting good grades, but it's still not quite enough because you want internships or you want research experience. So it really has to be your whole life. […] All of our entire minds, everything that we do even outside of school really comes back into what we do in our classes. That's kind of the most important part of our lives. We have to make it a priority in order to do well.

Asher expressed how the workload led to his lack of free time, saying, "I have heard a lot of my friends have free time. I don't. It's usually like, I wake up and then I do homework until I go to bed." Together, these quotes demonstrate that our participants felt like in order to succeed at the hard work required of engineering students, they had to make engineering their whole life and were left with little free time.

(3) No time to consider mental health in engineering. Participants described the perception that, due to the challenging workload and the time-consuming nature of being in engineering, there is not time for engineering students to care for their mental health. For example, Jenn described an "engineering mindset" of approaching mental health by saying, "I don't have time to worry about that right now. I'm just going to put that off, focus on this thing that needs to get done. Prioritize, but not actually prioritize something that's important, which is your mental health." Lauren said nearly the same thing,

> for an engineering student specifically, I think they would just say, 'I don't have time to deal with my mental issue. I have a test coming up,' or, 'I have projects due.' I do genuinely think that this is a problem that a lot of engineering students feel and go through.

Jenn described the way that striving for efficiency in engineering has led to stigmas in engineering around taking time to take care of mental health. She said,

> engineering [is] always striving for efficiency. I think that's so dangerous when it comes to mental health. […] it's like, okay, me struggling with my mental health, that's not very efficient. That couldn't be me. I can't go get help for it or whatever. But I feel like you definitely see it more in almost artsy fields where it's like mental health is something that's way more accepted and it's like, okay, maybe you do need to take some time off. Maybe this will be better for your mental health or your health in general, whereas with engineering, I don't think that people wouldn't say it.

The participants perceive that the culture of engineering does not allow for time to care for mental health, which contributes to a stigmatized view of taking time away from engineering to care for your mental health.

(4) Absence of discussion about mental health in engineering spaces. Further contributing to perception that there is no time to consider mental health, mental health is not prioritized or discussed within engineering spaces. For example, Jenn said that, within engineering, "I can't recall a time where someone actually sat down and was like, 'mental health is important, let's talk about it.'" She went on to describe how discussions of mental health in engineering spaces are so foreign that they would be uncomfortable. She said,

> if you had grabbed one of my engineering classes this semester and been like, 'we're going to talk about mental health,' I probably would've been way more uncomfortable than I am talking about it with the soccer team and way less likely to share anything.

Conversations about mental health are not happening in engineering spaces, but engineering students are stressed and dealing with a plethora of mental health conditions.

6. Discussion and future work

In our sample we found that 28% of all students had first-hand experiences with MHCs, which is just slightly below the 31.6% found among engineering undergraduates by Lipson et al. [1]. The prevalence of MHC was higher among women (40%) and other gender minorities (80%, n=5) aligning with previous studies within the context of engineering [8], [64]. When exploring differences in help-seeking attitudes and stigma measures among women and those with MHC experience, both sub-groups had higher help-seeking attitudes and lower stigma measures, which aligns with existing literature [65]. We expect that our analysis of the larger data being collected for this project will shed more nuances among the groups with low representation in this paper.

RQ1. *What is the relationship between the stigma of MHCs and the help-seeking attitudes of engineering students?*

RQ1.1. *How does this relationship vary across different student identities?*

We found negative correlations between stigma measures and help-seeking attitudes across the whole sample which were all statistically significant. This confirms that the engineering context does not escape the well-known societal dynamics between these two elements [48]. Therefore, it is important to account for stigma when trying to increase help-seeking attitudes within engineering. Given that large-scale interventions have been proved effective for reducing stigma in higher education [49], engineering-specific interventions to tackle such stigmas could have potential to reduce stigma among engineering students and may increase their help-seeking attitudes as a result.

When considering different groups, our correlation analyses among women and participants with MHC experience showed that the negative correlations among these groups were stronger than those found within the general group, with the strongest correlations among those with MHC experience. When exploring the self-stigma measures among those with MHC experience, there was no correlation between the discrimination and disclosure elements of self-stigma but there was a negative correlation between the positive aspects of self-stigma and help-seeking attitudes. This might indicate a positive outlook of their condition among those with MHC experience. In our previous work, we found that those living with MHCs might find empowerment in advancing their knowledge about their conditions [39], and education is a common approach to reduce stigma used by large scale organizations like the National Alliance of Mental Illness [66]. However, since it is known that many factors are intertwined with stigma [11], additional explorations at the intersection of the identities of those with MHC experience is necessary.

The engineering-specific measures of social distance that were deemed context-specific measurements of stigma had a significant negative correlation with help-seeking attitudes among the full sample. However, when performing the analysis among women and those with MHC experience such relationships changed. Among women such correlation disappeared while it was a stronger negative correlation among those with MHC experience. It is important to explore if these differences prevail within our larger sample and to unpack further why these differences may exist.

RQ2. *What are the relationships between elements of the engineering experience and help seeking attitudes?*

RQ2.1. *How do these relationships vary across different student identities?*

Among the explored elements of the engineering experience, we found that perceptions of the engineering department (care & diversity) and elements of engineering identity and belonging were not directly related to help-seeking attitudes. Previous work has found relationships between these measures and the prevalence of mental health conditions. When exploring the relationship between these elements we confirmed the relationship between engineering identity and belonging with department care and diversity previously identified by Jensen & Cross [35]. Jensen & Cross also found a negative correlation between these elements of department caring and diversity and the depression levels among engineering students (i.e. the more caring and diverse the department was perceived the less depressed students were). Due to these previous findings, we expected some correlation between department care and diversity with help-seeking attitudes (e.g. the higher the perceptions of department care and diversity the higher the help-seeking attitudes), but there was none among this sample. Therefore, while previous research identifies the perceived departmental care and diversity and engineering identity as impacting the levels of depression among students [35], such elements does not necessarily hinder or help the help-seeking attitudes of students. It will be critical to explore these results further with the expanded sample of this study.

The elements we proposed to gauge the presence of competition and meritocracy in engineering culture [55], [56] were the only ones showing a strong negative correlation with help-seeking attitudes. Among women and those with MHC experience, the identified relationships were weaker. While discussion of the description of engineering culture has been going for a while [35], [67] we believe we are offering a first attempt to gauge it quantitatively and measure its effect on other aspects of engineering education. In our results we interpret that while *internal beliefs* related to students' identity and belonging and their perceptions of their engineering departments' orientation to diversity and level of care were not related to help-seeking attitudes, perceptions of *group beliefs* about what engineering is as a field negatively correlate with help-seeking attitudes. Further exploration of the potential of these items is necessary, starting by a formal Exploratory Factor Analysis of its structure and further validation [60].

RQ3. *Which elements of the engineering culture do students report as intersecting with their mental health and their help-seeking attitudes?*

Qualitative findings related to students' perceptions of engineering and how engineering intersects with their help-seeking attitudes for mental health confirmed some of our quantitative results. Some elements of participants' reasoning for why engineering is harder than other majors, in particular their comments on how they need to be competitive and work harder, and the pride they are cultured in for succeeding in engineering aligns with what is known as the meritocracy of difficulty in engineering [55]. The themes related to the need to make engineering your whole life, leaving no time for mental health or self-care in general aligns with previous literature relating the high-stress culture of engineering with the prevalence of some mental health conditions [35].

Students' identification of the lack of discussion of mental health in engineering spaces offers a clear opportunity for a cultural change within engineering and might represent the greatest opportunity to directly tackle the help-seeking attitudes of engineering students. Faculty are key players in the design of engineering education environments in which discussions about mental health take place or not. Some of our research is also exploring faculty attitudes about wellbeing and how they are reflected in their classroom practices and how they support students wellbeing for their academic success [68]. Similarly, our qualitative data is pointing to additional barriers related to students' experience with available resources. Additional exploration of this data will be reported in other venues soon.

7. Conclusion

This paper reports on the initial findings from our longitudinal study exploring the relationships between stigma and help-seeking attitudes of engineering undergraduates and professionals. We presented exploratory quantitative and qualitative results from the data collected at one of our two institutions in Fall 2022, and the immediate next steps in our planned analysis. We summarize some of the contextual challenges we faced in the first year of execution of this multi-institutional project.

We found a negative correlation between general social and college-specific measures of stigma and help-seeking attitudes, as well as between engineering-specific measures of stigma and help-seeking attitudes. Only those that were engineering-specific changed in strength among women and students with MHC experience. When considering elements of engineering, we found that perceptions of department diversity and care were not related to help-seeking attitudes, nor were the engineering identity or belonging measures. However, our newly proposed items to measure beliefs of engineering culture based on competition and meritocracy showed a negative correlation with help-seeking attitudes. This aligned with our qualitative results in which students shared how they perceived engineering to be harder than other majors and their engineering experiences and duties becoming their "whole life," while leaving no time for mental health. In addition, they also identified the lack of mental health conversations in engineering spaces.

Future work includes expansion of this analysis with more data and methods and a further integration of quantitative and qualitative results. Our overall project results will contribute to a better understanding of the unique challenges of tackling the mental health crisis within educational and professional environments in engineering.

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