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Board 132: Exploring the Impact of Professors and Peer-Relationships on Undergraduate Mechanical Engineering Students' Well-Being

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Abstract

Student wellness is critical to achieving academic excellence, especially for undergraduate engineering students navigating heavy course loads and the distinct challenges of engineering culture. As a result, the well-being of engineering students is a critical concern, both for prioritizing their wellness and for improving retention in engineering. To cultivate an environment of wellness, retention, and inclusive growth, we must comprehensively understand how to prioritize and protect student well-being. True academic potential is unlocked only when foundational needs are met. Moreover, we know that students from minoritized groups face additional barriers in engineering, and we know from work in engineering design that designing to those on the "margins" results in better solutions for everyone. A preliminary analysis for the larger data set of 21 students found that students felt that professors and their peer community had a significant impact on their overall well-being and feelings of inclusion (removed for review, 2023). This study investigates the experiences of 10 mechanical engineering students at a research-intensive, land-grant university in the mid-west. Specifically, we investigate the following research question: According to mechanical engineering undergraduate students who hold at least one minoritized identity, how do professors and their peer community impact their overall well-being and feelings of inclusion? We use semi-structured, hour-long interviews and thematic analysis to answer this question. By investigating the impact of professors and peer community on mechanical engineering undergraduate students, we can understand how to build an environment that is inclusive and fosters student wellness. Moreover, by identifying the beneficial elements of these academic relationships, we are provided with exemplary practices which can be applied across other disciplines. With this comprehensive understanding, we aim to sculpt an educational environment that is inclusive and nurtures well-being.

Introduction

The high prevalence of mental health issues among U.S. college students continues to pose significant challenges for higher education [1]. In the last decade, rates of depression and anxiety have risen dramatically among students [2], which raises concerns about students' overall well-being and persistence [3]. Notably, research has shown that engineering undergraduates face higher rates of mental health concerns such as depression and anxiety compared to their peers [4], [5]. Furthermore, mental health disparities exist for underrepresented college students. Students with minoritized identities (e.g., students of color, gender and sexual minorities, first-generation college students) experience higher rates of mental health symptoms compared to their peers [2], [6].

The "stress culture" of engineering education, which is rooted in traditional norms of masculinity [7], can create a particularly harsh educational climate for minoritized engineering students [8], [9], [10]. Moreover, engineering students are known to equate "learning with suffering and shared hardship," meaning that students often believe that suffering is a required ingredient in their engineering education [11, p. 12]. This stress culture has also been likened to a "boot camp mentality," [11, p. 12] which harkens the heavy military ties that engineering has held

historically and still holds today. Consequently, research has shown disproportionately higher rates of mental health symptoms in engineering for women-identifying students, first-generation students, and Latinx or Hispanic students [4], [12]. Scholars have also described differences in academic cultures across engineering sub-disciplines, with some data pointing towards more exclusionary climates for underrepresented students in certain disciplines, such as mechanical and electrical engineering [7], [13]. Mechanical engineering, in particular, awarded the most engineering bachelor's degrees of any discipline in 2022 (32,891 compared to electrical engineering's 13,331), yet has one the lowest percentage of degrees awarded to women at 17.6% [14]. Lastly, prior work from this research team has found that, across disciplines, professors and peer community impact engineering undergraduate students' well-being, perceived mental health, and feelings of inclusion [15]. There is a need to understand how students in a discipline with a more exclusionary climate (i.e., mechanical engineering) describe their well-being.

Accordingly, this paper explores the lived experiences of mechanical engineering undergraduate students who hold one or more minoritized identity (race, gender, sexual orientation, first-generation, socioeconomic status) and investigates how their experiences in engineering impact their mental health and overall well-being. We pose the research question: According to mechanical engineering undergraduate students who hold at least one minoritized identity, how do their peer community and professors impact their overall well-being and feelings of inclusion?

Methods

To answer the research question, we employ thematic analysis [16] to explore qualitative, semi-structured interviews with 10 mechanical engineering undergraduate students. These interviews are drawn from a larger data set of 21 undergraduate students of all engineering disciplines offered at the university. All participants were recruited from the same university, which is a research-intensive, land-grant, comprehensive university in the Midwest region of the United States.

Focus on Mechanical Engineering
There are several reasons why we chose to isolate mechanical engineering students for this study. First, mechanical engineering is one of the oldest engineering disciplines and is one of the most common disciplines across universities with engineering programs. Next, mechanical engineering educates the largest share of engineering students compared to other disciplines both nationally and at the university at which the study was conducted [14], [17]. Lastly, in this study, mechanical engineering students were the most represented in the larger study, and isolating the data of one discipline allows us to make consistent comparisons, where courses, workloads, professors, and community are common across participants.

Participants
The participants in this study were undergraduate mechanical engineering students with at least one minoritized identity (racial, ethnic, sexual, and gender minorities, along with low-income and first-generation college students) at a large, public, land-grant university in the Midwest. We included students with identities commonly discussed in the literature as being minoritized in engineering [8]. We focus on students with a spectrum of minoritized identities to understand

broadly what experiences and challenges are common among non-majority students. Participants were recruited via flyers posted around the engineering buildings on campus along with a recruitment email distributed by the engineering departments. Students were invited to participate in an interview and were compensated with a $30 Visa E-Gift Card for their time. The identities of interest, along with the representation of each identity within the participants, are shown in Table 1. A high-level summary of participant demographics is shared to avoid any potential identification of individual participants.

Table 1. Identities of 10 Mechanical Engineering Undergraduate Student Participants

First-Gen	Gender Identity	Sexual Identity	Racial Identity	Low-Income	Year in School			
	(not cisgender man)	(not heterosexual)	(not white)	(<$70,000)	1st	2nd	3rd	4th
3	6	3	4	4	0	4	3	3

Data Collection and Analysis
Hour-long semi-structured interviews were conducted with each participant. Questions (see Table 2) were designed to understand their experiences in engineering, with respect to their self-perceived mental health. Participants were prompted to share their experiences in engineering, both positive and negative, and reflect on how those experiences impacted their mental health, both positively and negatively. Participants were asked to define what mental health means to them and to relate their experiences and perspectives to their own definition.

Table 2. Participant Interview Questions

Interview Questions and Prompts
1. What (if anything) have you found to be particularly challenging about being an engineering student?
2. What have you found to be particularly easy or rewarding about being an engineering student?
3. Have you had any experiences throughout your engineering degree where you either felt like you were the only person who looked like you or had a similar background to you?
4. Can you recall any instances where you felt like being an engineering student negatively impacted your mental health?
5. Can you recall any instances where you felt like being an engineering student positively impacted your mental health?
6. Have you ever thought about changing your major? If so, what were the reasons behind your consideration?
7. Can you explain how your experiences at UNL have shaped you as a cultural being?
8. Is there anything you'd like faculty and administrators at UNL to know about the impact of being an engineering student on your mental health? Are there any changes you'd like to see?
9. Is there anything that I didn't ask you that you think is important for me to capture?

From each participants' interview, the research team worked together to identify what factors significantly impacted the participants' mental health. During the first round of coding, the team used emergent open coding to generate an initial list of codes. In the second round of coding, the team discussed the codes from each interview and coalesced these codes into themes. It was in this second round of coding that the author team noticed that peer community and professors were two areas which impacted students' overall feelings of well-being and inclusion. We scoped our next round of coding accordingly to look specifically for these two areas in each interview. In this final round, each transcript was reviewed by two coders, and final themes within each category were identified (Table 3).

Positionality of Authors
This specific research project was conceptualized by authors Fitzpatrick and Deters. The broader research project was conceptualized by Drs. Chin and Deters, whose respective research aims to examine the impact of socioeconomic status on student experiences (Chin) and broaden participation in engineering (Deters). Chin is an Assistant Professor of Counseling Psychology and Deters is an Assistant Professor of Mechanical Engineering, with a Ph.D. in Engineering Education. Investigating mental health in engineering emerged as a natural intersection of Chin and Deters' research and meets a need to better understand and support the mental of underrepresented engineering students. Chin and Deters conducted the interviews for this project; to the extent that it was possible, interviewers and participants were matched with shared identities. In cases where a match was not possible, we understand that participants may have felt uncomfortable sharing all their experiences and identities. Interviewers did their best to make participants feel comfortable while sharing their experiences, but we understand this is a limitation. At the time that data analysis was conducted, Fitzpatrick and Adams were engineering undergraduate students and Baldwin was a psychology undergraduate student. The data analysis was primarily conducted by Fitzpatrick, Adams, and Baldwin, who all identify as women. Fitzpatrick developed the final categories and themes shown in Table 3 and developed the findings.

Findings

Table 3 captures the themes within each category of inquiry: professors and peer community. We discuss the findings by category below.

Table 3. Summary of Categories and Themes

Category	Theme	Definition (Participants mentioned …)	No. of Participants
Professors	Empathy and Flexibility	… instructors demonstrating empathy and flexibility in difficult situations.	7
	Lack of Adaptability and Understanding	… instructors' inability to be adaptable and understanding of their students' needs.	8
	Overwhelming Workload	… the burden of an excessive workload from their engineering courses.	8

Peer Community	Making Friends in Engineering	… the community amongst their peers enhancing their engineering education experience.	10
	Overwhelming Workload Enables and Impairs Friendships	... the excessive workload from engineering courses can constrain or enable friendships.	8

Professors

According to participants, professors have a significant impact on students' mental health, whether that be positive or negative. Students discussed the difference between receiving empathy and flexibility from their professors, which helped their mental health, and not receiving adaptability and understanding from professors, which challenged their mental health.

Empathy and Flexibility Compared to Lack of Adaptability and Understanding from Professors

Students shared stories of empathy and flexibility from their professors, which contrasted with stories of a lack of adaptability and understanding. Students felt that professors were empathetic and flexible when they showed understanding of student's circumstances and granted extensions. A non-traditional student shared that when a challenge arose that prevented them from meeting a deadline, their professor was flexible and met their needs:

> I have found that a lot of professors, at least with non-trad[itional students], tend to be pretty flexible. If you're like, "Hey, stuff happened and this isn't getting done right now, but it will get done and here's my plan for getting it done." They're like "Cool, whatever. Just get it done." Instead of really rigidly adhering to the unnecessary difficulty model. [Participant 6]

Empathy also looked like professors using class time to center students' well-being. For example, Participant 3 discussed a time that their professor brought in a therapy dog for the class to interact with:

> Today in class, my professor brought in this lady who had a therapy dog with her—I was not expecting that at all. She brought the dog around, and everybody's petting a dog, you know? Everybody's having a good time. That was cool. I've never seen it before. That was great of him to show that he actually cares to take time out [of class], to actually bring somebody in. [Participant 3]

On the other hand, students noted instances where professors lacked adaptability and understanding. Participant 6 discussed how, if they did not have accommodations, they would not be able to process all the new content during lectures with the more traditional professors. This difference between flexible and inflexible professors illuminates a stark contrast present in this Mechanical Engineering department:

> There are also these things where having [course] information digitized, like possibly having a recorded lecture is super helpful. What I've noticed is there are some instructors in the Mechanical Engineering department that do that, just because it's more efficient,

right? The students learn better, they have less work to do, everything is better. They do that and they've figured that out and they're on it. And then we have some instructors who insist on lecturing about very complex topics, from memory or from handwritten notes by writing on a whiteboard. If I didn't have accommodations, I wouldn't be able to get all of that down essentially, because they refuse to make it easy. These are often the same instructors whose tests have very little to do with what they lectured about, or very little do with the textbook. And that's another level of difficulty that just doesn't need to be there because it's not serving any educational purpose. [Participant 6]

Overall, participants wished that professors had more instances of showing empathy and flexibility. As one participant noted, engineering is stressful, and professors should check in on their students:

You know, everybody is stressed out; everybody is kind of, you know, tense. I don't think there's anything I can think of that specifically applies to me, that doesn't apply to everybody. So, I don't know, just check on everybody and make sure everybody is alright. [Participant 3]

Overwhelming Workload Impairs Personal Time

When participants were asked to share what has been challenging being an engineering student, many shared their difficulty balancing such an overwhelming workload. The workload for individual courses is determined by professors, so we've opted to nest this theme under the "professors" category. However, importantly, the overwhelming nature of workload can be a cumulative effect as students take multiple engineering courses at once. Participant 2 shared the difficult cycle that would often be the result of an overwhelming workload, affecting their sleep schedule and attendance:

I'd have homework late at night, you know, and it affected my sleep schedule. I had classes at like 8:30 in the morning and I just couldn't wake up for those classes because of the homework from the night before. And so, I'd skip those classes because I was just way too exhausted to even get out of bed.

Despite the impacts of the workload on Participant 2, they shared that "the amount of work that needs to be put into engineering" has been challenging as an engineering student. At the same time, they also discussed how the rigorous courses with heavy workloads have made them think about leaving the discipline. But, when reflecting on what they would ask the university to change, they described wanting a lighter workload as a "personal thing" and not a common theme amongst students:

I really cannot think of anything [that faculty and administrators need to know or change] right now apart from my own personal thing, which is a [lighter] workload to help me relax, but apart from that, [there is] really not much else because they're doing a fantastic job right now. [Participant 2]

Along with Participant 2, Participant 9 shared their challenges with their workload and how it restricts their ability to make the seven-hour drive home to see their family on a weekend:

I have one class specifically where our homework isn't even graded, but we have about eight problems every week. It probably takes you like six hours, more or less, to do and they are not even graded. You're doing all of that and it's still not contributing to your growth, like it's contributing to your grade in the way that you'll do better on your quizzes and exams … It's just so much time you have to put in that the reward doesn't seem [worth it]. But that's like every week, so you could never just take a weekend off. … I can't just go home for a weekend because that 14 hours spent in the car could be used for homework and I just don't have time to not take advantage of that time. [Participant 9]

These stories describe how participants were often missing out on practices that contribute to their personal well-being – like sleep and spending time with family – because they needed to spend their time working on their courses. These stories implore us to consider how to design educational experiences that can allow students to find balance between their well-being and their work.

Peer Community

Peers and the community that participants found with their peers impacted participant's mental health, both positively and negatively. One participant spoke about finding "their people" and building a community of engineering students:

I feel like engineering is so unique with the way it challenges you that you have this specific community of [people] taking the same classes and doing the same things. I feel like one of the positive things [about being an engineering student] has been finding my community within the engineering department. I feel like I've seen that with other people too; there's not a ton of people that I've seen that don't have a core group of friends that are engineer[ing students]. I think one of the easy things is finding your people, which is kind of surprising to say as someone [who is] one of like seven or eight women graduating in the mechanical engineering department this semester. [Participant 10]

Overwhelming Workload Enables and Impairs Friendships
However, while students made great friends, the friendships were often foraged in the culture of overwork and stress of engineering. Participant 20 reflected:

I feel like because I do too many things, I don't have a ton of time to be around my family anymore. It feels like I'm never at home because I'll be in the aerospace lab either doing homework or working on projects… sometimes I don't get home until like 4am. … On the other hand, I [have] made a lot of friends through all the clubs I am in and so I have a lot of different groups of friends and they're all really cool people to be around. … Just getting to be a part of different club dynamics…I don't know, it's just a lot of fun to get to talk to so many different people. [Participant 20]

On the other hand, some participants noted that it was challenging to maintain friendships because of how time-consuming their engineering coursework was. For example, Participant 9 discussed how time spent hanging out with friends or taking care of themselves can result in an academic setback, yet those are key things that contribute to improving their mental health:

Any self-care time or time with your friends you take just sets you back, which is just more stress and more things on your plate later. It really just seems like a lose-lose situation. … I texted one of my friends in engineering and I was like 'do you ever think about how not okay it is that we just do homework all of the time?' Like, we don't take any self-care time, we don't have time to hang out with each other; we are really not okay and there's not much we can do about it. We just wait for the summer to come. [Participant 9]

From these excerpts, we see that engineering and its workload could facilitate community for students but could also constrain students' ability to remain connected to anyone that they were not seeing because of their courses.

Conclusion and Implications

Universities strive to form supportive environments for their students that foster community, well-being, and academic excellence. The findings of this paper illuminate the lived experiences of mechanical engineering undergraduate students with minoritized identities with respect to their mental health and well-being. By exploring the experiences and perspectives of students, especially those with minoritized identities, we can learn how to better support the student body as a whole. This paper shares key experiences that had a significant impact on participants in order to highlight what should be considered when shaping policy and practices. In order to protect the mental health of engineering students, we provide recommendations for universities that are aligned with the findings of this paper.

First, professor-student interactions can have a significant impact on student mental health, either positively or negatively. To ensure that professors are equipped to proactively safeguard student well-being, universities should invest in faculty training programs. These programs can help faculty develop a deeper understanding of the unique challenges faced by engineering students, especially those from minoritized groups who may face additional barriers. Building awareness about the importance of flexibility and empathy in teaching, along with providing tools to adapt existing practices, will cultivate a supportive educational environment. Professors should not only be encouraged but also supported in adapting to the evolving needs of their students, offering reasonable accommodations when needed. Furthermore, urging professors to promote open communication with students fosters trust and respect in both directions. Equipping professors with tools to empathize with students and adjust to their needs will positively impact students' mental health.

Fostering a sense of peer community is another way that universities can enhance students' well-being. Particularly within engineering programs, acknowledging the impact of student friendships and connections is imperative for a positive learning environment. Integrating peer support into course curriculum through group projects and facilitating mentorship programs within the college are effective methods to authentically increase peer community for students. Additionally, supporting student organizations, communities, and clubs is essential to generate teams of students outside of coursework. Especially for students with minoritized identities, mentorship programs and student groups can alleviate feelings of isolation and contribute to

identity fulfillment. Prioritizing these initiatives to grow student communities will have a lasting impact on students as they seek belonging and support throughout their academic career.

Universities are responsible for understanding and addressing the mental health concerns that arise from student experiences. By considering these recommendations to support professors to empathize with students and invest in fostering a nurturing engineering community, academic institutions can develop more inclusive learning environments that prioritize student well-being.

Acknowledgements

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