WIP: Introducing thriving in a first-year engineering course

Ms. Alexandra Mary Jackson, Rowan University

Alexandra Jackson is a fourth year PhD student at Rowan University seeking a specialization in Engineering Education. She began her research in Rowan's Experiential Engineering Education Department in the Fall of 2019, and has developed interests in entrepreneurial mindset and student development. In particular, she is interested in assessment of entrepreneurial mindset through both quantitative and qualitative methods, including self-report, concept mapping assessment, and narrative inquiry. She was awarded an NSF Graduate Research Fellowship in April, 2022 for her efforts.

Dr. Justin Charles Major, Rowan University

Dr. Justin C. Major (they/them) is an Assistant Professor of Experiential Engineering Education at Rowan University where they leads ASPIRE Lab (Advancing Student Pathways through Inequality Research in Engineering). Justin's research focuses on low-income students, engineering belonging and marginalization mechanisms, adverse childhood experiences, and feminist approaches to EER, and connects these topics to broader understandings of student success in engineering. Justin completed their Ph.D. in Engineering Education ('22) and M.S. in Aeronautics and Astronautics ('21) at Purdue University, and two B.S. in Mechanical Engineering and Secondary Mathematics Education at the University of Nevada, Reno ('17). Atop their education, Justin is a previous NSF Graduate Research Fellow and has won over a dozen awards for research, service, and activism related to marginalized communities, including the 2020 ASEE ERM Division Best Diversity Paper for their work on test anxiety. As a previous homeless and food-insecure student, Justin is eager to challenge and change engineering engineering education to be a pathway for socioeconomic mobility and broader systemic improvement rather than an additional barrier.

Dr. Rachel Burch, Rowan University

Dr. Rachel Burch is an adjunct instructor at Rowan University in the Department of Experiential Engineering Education. She earned her PhD in civil and environmental engineering from the University of Delaware in 2024. Rachel's research interests include engineering education and sustainability in engineering, and she has engaged in specific projects regarding mental health in engineering students, K-12 engineering education, sustainable technologies for food waste management, and biological waste treatment.

Miss Patricia Lynn Hurley, University of Delaware

Patricia Hurley is a graduate student studying environmental engineering at the University of Delaware.

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Abstract

This work-in-progress research paper describes the implementation and evaluation of mental health topics in a first-year engineering course at a mid-Atlantic institution. Mental health is a critical but understudied issue, with over 75% of college students experiencing moderate to severe psychological distress, and more than 60% meet the criteria for one or more mental health diagnoses. Despite these percentages, mental health is rarely discussed in college classes, especially engineering, where the competitive culture often stigmatizes these discussions. Our half-semester project sought to integrate mental health discussion into a first-year engineering course through three overarching phases: 1) students create a mental health fidget toy that another engineer could use to help them with their mental health, 2) four short-form lessons regarding mental health concepts, and 3) individual reflections those mental health concepts. At four intervals, students took a survey based on an existing mental health survey with strong validity evidence, where we gathered data on students' responses to the intervention.

Quantitative analysis used MANOVA and Multivariate Kruskall-Wallis comparison tests of students' factor scores. We found that student stress slightly decreased and student sense of support slightly increased. The qualitative analysis examined students' reflections thematically and found that although many students expressed having concerns about their mental health at the start of the project, many said that they learned strategies to better their mental health, changed their perspectives about mental health struggles, and realized that engineering students should learn to prioritize their mental health. These findings suggest that integrating short mental health-focused lessons may promote a positive mental health culture in engineering education. Future work will further analyze data and refine the project.

Introduction

Undergraduate students tend to experience poor mental health, including high levels of stress, anxiety, and depression [1], [2], [3]. This problem has been observed even more in engineering undergraduate programs [4], where students report high stress and often do not seek treatment [3]. High levels of stress and anxiety have been shown to negatively impact academic performance, increase the risk of further mental and physical illness, and affect ability to persist in engineering programs [5], [6]. With the urgent need to increase the level of participation, persistence, and retention in engineering programs to keep up with the societal need for more experienced engineers [7], it is crucial that research explores potential methods for bettering engineering student mental health (Jensen et al., 2023). Previous research has examined student perceptions of their experiences with poor mental health (Jensen et al., 2023; Major et al., 2020), confirming that engineering students often struggle with their mental health due to workload, high expectations, and a lack of understanding from professors, advisors, and administrators [10], [11], [12].

We sought to present a potential stepping stone to solving the engineering student mental health crisis, specifically by incorporating mental health awareness and discussion into the classroom. In this work-in-progress research, we developed a project where students design fidget toys with the goal of marketing them as use for mental health help for other engineering students. Throughout this project, students experienced brainstorming, design, and manufacturing while

also completing activities about various mental health challenges such as belonging, stress, and purpose. Students not only learned about the poor mental health experiences of other engineering students like them and sought to design with them in mind, they also had the opportunity to reflect on themselves and their own experiences. The following sections will address the background and motivation for this work, describe our intervention in detail, and provide some preliminary quantitative and qualitative results from four sections of the fidget toy project.

Background

Engineering is perceived to be one of the most challenging undergraduate programs a student can undertake [13], [14], often having a heavier course load and an unforgiving culture of competition [15], [16]. In fact, many engineering students expect that poor mental health as a result of these elements is inevitable, often refusing to seek help or treatment (Jensen & Cross, 2019; Lipson et al., 2019).

To combat this crisis and encourage a help-seeking mindset in engineering students, some research has begun to implement mental health-focused interventions designed to shift the mindset and encourage persistence in engineering programs [18]. In Tait et al. (2024)'s review of well-being interventions, they found that the most common type of intervention was educational, in which a curriculum is updated to feature considerations for mental health awareness. Some interventions have included reflections surrounding mental health [19], in-class discussion [20], watching videos or consuming media [21], or designing products that promote mental health [22]. These interventions often led to positive outcomes, with students often reporting lower stress [22], greater motivation [23], and better academic performance [24]. In Miller et al.'s (2021) intervention, students explored biological reactions to stress by studying medical devices. Students were exposed to mindfulness activities as a coping mechanism for this stress, where they reported that they were beginning to understand the benefits of mindfulness practices to reduce bodily reactions to mental stress.

Though studies exist in recent years that have reported these positive mental health outcomes [21], [22], most of these studies are quantitative, pointing to a need for qualitative research that may provide further explanation of the positive quantitative results [18]. This study utilizes both quantitative and qualitative methods to explore the Fidget Toy project intervention, taking both self-report survey results and qualitative reflections to understand the impacts of this curricular intervention.

The Mental Health Fidget Toy Project

We developed a project for first-year engineering students that focuses on incorporating mental health awareness and reflection into the curriculum. This project was piloted in Spring 2024 in five sections of a second-semester, first-year course at a mid-Atlantic institution, a general engineering course focused on basic engineering concepts and interdisciplinary design. In this half-semester project, students designed and manufactured a fidget toy for use by engineering students like them who might be experiencing a mental health challenge. The project was also divided into five phases focused on different aspects of ideation, design, and dissemination.

Throughout multiple phases, students researched fidget toys, designed, 3D printed, exchanged with other students for feedback, and reported on their final products.

Throughout the project, students engaged with five mental health topics through in class lectures and activities. These topics included gratitude, stress, mindfulness, belonging & identity, and meaning & purpose. After introduction to each topic, students answered reflection questions as a homework assignment (refer to Table 1 in the appendix).

Students also responded to a survey at 2-4 time points during the project, depending on the class, answering questions adapted from [25], [26]. These questions were chosen given their past validity evidence, and evidence of construct malleability (that constructs could be influenced/changed through intervention). Survey questions measured perceived gratitude, stress, mindfulness, belonging, and meaning & purpose. The survey was used to track student mental health and to determine how students developed throughout the course of activities The total timeline we followed in each of the five sections is presented in Table 2 in the Appendix.

Data Analysis

The entirety of this work was approved by our local Institutional Review Board. To analyze our findings, we first quantitatively assessed differences in constructs, and across groups, using analysis of variance and multivariate analysis of variance (ANOVA/MANOVA). Appropriate alternate tests were used when normality assumptions, assessed by QQ-Plot, were violated. Second, for the reflections, we used thematic coding to review each students' reflection and determine the major themes. Some of our broad findings are reported below.

Preliminary Findings

The following sections will discuss the preliminary quantitative and qualitative findings from one semester of this project and the interpretations of these findings.

Quantitative Findings

Surprisingly, very few constructs were affected. In our preliminary statistical analysis, we found that student stress decreased non-significantly by 0.123, $F(2, 249) = 0.556$, $p=0.519$, throughout the semester, their sense of support for stress also increased by 0.518, $F(2, 249) = 5.128$, $p=0.006$. However, these changes were very slight, and of small effect size. These findings indicate to us that student stress decreased because of students' changing perceptions that they felt supported in the course. We believe the size of the change is simply because of the small timescale of which this intervention took place.

Simultaneously, we saw students' perceptions of connectedness of goals decrease by 0.423, $F(2, 249) = 4.440$, $p=0.031$ (they saw their present self less connected to their future self in terms of relevance) and that sense of empathetic faculty understanding increased by 0.403, $F(3, 246) = 3.248$, $p=0.009$ (my faculty is empathetic to my needs) increased. Changes in connectedness and empathetic faculty understanding had additional increases for women leading to overall positive increases (+0.136), $F(2, 249) = 4.440$, $p=0.008$, (+0.666), $F(3, 246) = 3.248$, $p=0.011$, respectively. We were surprised by students' changing perceptions of their goals, but not

surprised by the change in empathetic faculty understanding given the aforementioned change in stress support. Together, with the above results, we initially hypothesized from our quantitative findings that student stress decreased because students felt supported by faculty's conversations about mental health in the classroom. Our qualitative findings add context to this finding.

Qualitative Findings

Preliminary qualitative analysis revealed multiple themes throughout the first three reflections: Mental Health and Coping, Gratitude, and Stress & Mindfulness. More detail about these themes is included in Table 3 in the appendix.

It is likely that these themes were prominent due to the reflection questions themselves, which were focused on mental health, coping mechanisms, gratitude, stress management, and mindfulness. However, it is promising that students provided personal examples and reflected on adjusting their coping strategies as a result of the class intervention. Engineering students traditionally point out similar areas of stress: academics, social problems, and worries for the future [2], [8], [27], as well as similar coping mechanisms for dealing with said stress: socializing, exercising and participating in hobbies [11]. However, not much research re-evaluates coping mechanisms after an intervention [10], so it is promising that students in this study are willing to adopt mindfulness strategies like meditation after being exposed to them.

The most striking preliminary findings appeared in the final reflection, where students were asked to discuss their identity and experiences learning about mental health over the course of the project. The major themes were as follows: students discussed a variety of identities, if students reflected their perspective did not change, it was because they were already prioritizing their mental health, students reflected their perspectives changed due to not having realized the importance of mental health in engineering, and students reflected that their perspectives changed due to exposure to strategies. Further details on these themes are depicted in Table 4 in the appendix.

These early results lead to the promising inference that engineering students' perspectives about mental health became more positive post-intervention. According to Asghar et al.'s [10] literature review, engineering education research has begun to adopt a more positive perspective about engineering student mental health, which has often positively influenced the students' responses to interventions. It is possible that the presentation of mental health in a positive light through this project encouraged these perspective shifts.

In terms of identity, students' reflections indicated that post-intervention, they have a strong sense of personal identity, including engineering identity, racial identity, gender identity, and multiple other personal identities related and unrelated to engineering. Existing research indicates that a stronger sense of engineering identity often leads to a greater sense of belonging within engineering culture [28], [29], which is promising for the students in this study.

Conclusion & Future Work

Based on these findings, our project helped students acknowledge the importance of mental health, reflect on themselves and their identities, and appreciated the discussion around mental

health in an engineering class. These results indicate that students' perspectives and perceptions of their own mental health may be changing as a result of this intervention. Considering that engineering culture is traditionally perceived to be extremely competitive and fosters an unforgiving environment, this project is a promising step in refining these thoughts around engineering culture and mental health.

Though the results of this study may be used to inform interventions concerning engineering student mental health, our analysis contained missing data due to some sections only requiring two of the surveys to be answered. Future work will utilize statistical techniques to mitigate the effects of these missing data. Additionally, the surveys will be shortened significantly for our future iterations, as many students reported that the length of the survey caused them to struggle to complete it.

Our future work will also include further quantitative and qualitative analysis that goes further in depth on each of the mental health categories included in the survey and comparisons across year, section of the course, instructor, and demographic information.

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WIP: Introducing thriving in a first-year engineering course

Appendix

Table 1. Reflection Questions

Reflection	Prompt
1 - Introduction	Have you ever been concerned with your mental health? How about one of your friends? How did you feel? What did you see or hear? What coping mechanisms have you used to manage your mental health? Would you suggest these coping mechanisms to someone else? Why or why not?
2 - Gratitude	What and who are you grateful for? Why? What have those things and people done for you in your life that makes you grateful for them? How can you bring more gratitude into your life and the lives of others around you?
3 - Stress & Mindfulness	What types of things make you stressed? Why? Be detailed. Have you used mindfulness strategies in the past? Which ones? What are some mindfulness strategies you plan to use moving forward? How do you think these strategies will help you manage your stress?
4 - Belonging, Identity, Meaning, & Purpose	Part 1: What identities are important to you? What do you feel is the most important part of your identities? How about the least? How does this identity contribute to meaning & purpose you have for your life? Part 2: Has this semester's focus on mental health in engineering shifted your perspective? In what ways? How will you approach mental health moving forward in your engineering program?

Table 2. Fidget Toy Project Phases

Mental Health Topic	Project Phase	Project Topics	Survey
Gratitude	Search	Literature Search, Market Assessment	Pre Survey
Stress	Alternatives	Brainstorming, Design Alternatives	
Mindfulness	Final Design	Task Analysis, Final Design choice	Survey 2
Belonging	Prototype	3D print and evaluate prototype	Survey 3
Meaning & Purpose	Communicate	Design Report and Video Commercial	Post Survey

Table 3. Major Themes Noted in Reflections 1-3

Reflection	Theme	Example Quote
Mental Health and Coping	Most students indicated having had a concern about their mental health at some point.	"I have been concerned with my mental health. When I got to college in September I was stressing myself out and telling myself how I wanted to transfer out and go back home. I had to constantly call my mom to talk about things." - Participant 5
	The most common coping mechanisms mentioned include: socializing or relying on friends, exercising, participating in hobbies or sports, and taking time to reflect	"One coping mechanism I have used is talking it out to my friends. Not all, but some of my friends are STEM majors…they are always there for me whenever I need to rant to them, need their help in any form possible, or even want to go and cry off my stress." - Participant 14
Gratitude	Students commonly mention family, friends, and their health when they discuss things they are thankful for	"I'm mostly grateful for my family, more specifically my parents as they helped me become the person I am today. Whenever I had to make an important decision or was dealing with a tough situation I always looked to them for advice. They encouraged me to do well in high school and pursue college for a higher education." Participant 24
Stress, Mindfulness	Most students discuss academic stressors, but some also discuss finances, social problems, their future, and their health	"Things that make me stressed are primarily related to security in my future. Having a good career, pursuing what I want to, and being financially stable are big factors that give me anxiety. Doing well in school is certainly a big pressure that gives me stress too." Participant 15
	Students name similar coping mechanisms that they mentioned in the first reflection, more students start to mention mindfulness strategies they've started using or would like to try.	"Recently, I have been trying to get better at meditation and deep breathing when I feel stressed out. After meditation I often feel refreshed and my head almost feels lighter in a way. I also practice mindfulness through exercise. I feel as though exercise is the best way to release stress." Participant 20

Table 4. Major Themes Noted in Reflection 4 (Final Reflection)

Theme	Example Quote
Students discuss a variety of identities. Some common ones include engineering identity or identity as a student, cultural identity, identities associated with personal hobbies, and racial identities.	"My identity as an engineer is the most important to me, as the requirements to be an engineer are how I would describe myself. I am intelligent with the ability to use the knowledge base I've acquired to face the problems in my life, and I have the creativity to come up with a couple of ways to solve a single problem." - Participant 4
	"Identities that are important to me are my ways of expressing myself. My identity as a black woman in Engineering allows me to pave the way for many other black women who plan to go and thrive in an engineering setting. This identity also puts pressure on me as I feel the lack of women in STEM majors and minorities in STEM settings as well." Participant 11
When students reflected that the semester didn't change their perspective on mental health, they also often clarified by saying they already felt very reflective and already took mental health seriously	"I think that the mental health assignments throughout this semester have done nothing for me personally. I have always been very introspective so I have already thought about who I am plenty. I plan to approach mental health in the future the same as I have in the past." - Participant 22
Some students said their perspectives changed because they didn't realize other engineering students were going through similar struggles, or they didn't realize engineers should prioritize their mental health.	"With this semester's focus on mental health, my perspective shifted because at the beginning I felt that it was not my purpose to become an engineer because of how challenging all of my classes were looking. But as we discussed mental health in class and throughout our project, I realized that I do belong in engineering."- Participant 25
	"This semester's focus on mental health has indeed shifted my perspective. I often heard of how tough engineering courses are…on its students and [they] often overlook the mental impacts it has on its students. However focus[ing] on mental health in the engineering program made me realize that, yes the course is tough and rigorous, but my mental health needs to be on top of my worries…I think the incorporation into the engineering program itself also shows that the program also wants to be able to provide the time and space for one to look after their mental health and rethink about their mental state which I loved." - Participant 14

Some students said their perspectives changed because they learned strategies to help better their mental health	"The consistent discussion regarding mental health has caused me to routinely reflect on myself and how I am feeling. This has helped me in regards to being able to more easily calm myself down in stressful situations as well as for help when I need it. The constant discussion has also helped me feel comfortable enough to utilize the counseling services offered by Rowan." - Participant 35