2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #32793

Work in Progress: Using Photovoice to Examine the Mental Health Experiences of Engineering Graduate Students During COVID-19

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Using Photovoice to Examine the Mental Health Experiences of Engineering Graduate Students during COVID-19 (Work in Progress)

Abstract

Mental health service utilization and reported mental health problems (e.g., anxiety, depression, and suicidal ideation) have risen nationally. Accessibility to mental health resources is a critical concern for higher education institutions. College and university campus counseling centers are unable to keep pace with students' counseling needs. Furthermore, other resources (e.g., off-campus counseling centers) have a myriad of additional barriers that prevent students from accessing them, including cost, knowledge of services, lack of time, and mental health professional shortages. This is of great concern as students' academic progress has been shown to correlate to their mental state, with undiagnosed and untreated mental health problems affecting students' satisfaction, academic performance, research productivity, and intention to persist. Furthermore, delayed access to care is known to be a factor in increased frequency of relapse and the course of the illness. In studying mental health in higher education, researchers often group together graduate and undergraduate student populations. Yet, these studies may not account for major differences among these groups' degree programs and academic fields of study, including differing academic and social demands. Studies on engineering graduate students are particularly sparse, with most work focusing on the experiences of specific demographic communities (e.g., Black, women, or international graduate students). Work done highlights disparaging results, with engineering students exhibiting higher levels of self-reported measures of mental health problems (e.g., depression, anxiety, PTSD). Research is needed to explore engineering graduate students' mental health experiences, probing more deeply at students' typical behaviors and how these behaviors are informed by expectations of being an engineer.

In this pilot study, we use photovoice, a photograph elicitation and interview process, to explore how eight engineering graduate students at a large public university quantify and describe their mental health experiences. Data is being collected using an initial survey, submitted images and captions, individual interviews, and a focus group. Preliminary findings report results from the initial survey, to include measures on depression, anxiety, flourishing, academic challenges, and perceived work-life balance. These findings may provide vital information on the underlying culture in engineering with respect to mental health. Data will also show how engineering graduate students situate themselves within the engineering environment (e.g., their departments, research labs, and classes), or how they "fit". This study will provide insight into the current state of engineering graduate student mental health and the interactions between engineering graduate students' mental health experiences, their individual expectations, and the culture of mental health in engineering. This information is vital to promote the matriculation of engineering graduate students into the workforce.

Introduction

Reported mental health problems are increasing nationally [1] - [2]. A recent effort by the Healthy Minds Network and ACHA-NCHA collected data during the COVID-19 pandemic (between March and May 2020) from 14 U.S. colleges and universities (the specific breakdown of sites and participants can be seen in [3]. Findings showed decreases in psychological wellbeing and an increased difficulty in accessing mental health care [3]. Accessibility of mental health resources is a critical concern as college and university campus counseling centers are unable to keep pace with students' counseling needs with students' academic progress being tied to their mental health state [4]. Undiagnosed and untreated mental health problems can affect students' satisfaction, academic performance, research productivity, and intention to persist [5] - [9]. Research has shown that confidence in reaching out and developing connections (i.e., social self-efficacy) is associated with significantly lower reported depression and suicidal ideation in science, engineering, and mathematics graduate students [10]. Engineering students have been found to have much lower help-seeking behaviors compared to other disciplines (e.g. humanities and arts), suggesting something about engineering at play [11].

When considering why these differences may exist, the role of the culture of engineering is often discussed. Engineering culture has been defined as the cultural expectations, or "shoulds" of being an engineer, which are often taught to students both implicitly and explicitly [12] - [13]. These expectations are experienced differently by undergraduate students and graduate students due to cultural differences in degree programs, with graduate students being exposed to this culture longer given the need for an engineering (or related) undergraduate degree to pursue graduate studies [14] - [15]. Graduate students also experience different demands, with more emphasis being placed on their research, teaching, publishing, unclear advisor expectations as compared to coursework [14] - [15]. However, despite research showing the graduate students are at risk for experiencing severe mental health problems and that there are unique experiences that can factor into these findings (e.g. the importance of the student-advisor relationship), targeted research on engineering graduate students' mental health has been limited [16] – [19]. However, a recent study by [20] was conducted at California Polytechnic State University (Cal Poly) that looked at measures of depression, anxiety, PTSD, and substance use over nine engineering programs with both undergraduate and graduate (master's) students. Results found that engineering students reported much higher levels of risk for serious mental illness (38% compared to 4% of reported U.S. adult population), and over two times more likely than the average college population to self-report some form of depression, anxiety, and PTSD-like symptoms [20]. Recent work by Sanchez-Pena et al. has sought to expand on these findings, using qualitative research to explore experiences of engineers with a diagnosed mental illness [21]; preliminary findings discuss Jack, a late career engineer, and his journey with mental health from college to industry. Preliminary analysis highlights specific aspects of the culture of engineering influencing this journey, such as a lack of information on depression being shared while in college, the de-emphasis on socializing in his first job, and stigmatization faced once employers learned about his illness [21]. These findings, although limited, highlight the importance of studying engineering graduate students' mental health.

In an effort to uncover the landscape of research about engineering graduate student mental health, a scoping literature review was conducted by [22]. Five databases (PubMed, PsycINFO, Scopus, CINAHL, and ERIC) were searched for any articles discussing engineering graduate

students and mental health related topics (e.g. affective responses, coping strategies, etc.). Only 19 of the 4,826 unique articles fit the criteria, suggesting a limited research landscape [22]. Furthermore, most of the papers (18 of 19) focused on understanding the experiences of specific groups (e.g. experiences of female, international, and Black engineers) through observational studies as opposed to studying the effectiveness of a specific intervention or experiences more broadly. Preliminary findings from this review can be seen in [22] with the main findings under review. This study hopes to address this gap in research by answering the following research questions using the participatory action research method, photovoice:

(1) How do engineering graduate students at a large public university describe their mental health experiences?

(2) How does the culture of engineering influence engineering graduate students' mental health experiences, and therefore how they participate in engineering?

Photovoice

Photovoice, also known as photo elicitation or participatory photography, is a research method that uses photographs to empower participants to reflect on, capture, and share their lived experiences [23]. This method is part of a grouping of participatory action research, in which participants in the study are seen as co-investigators of the work [24]. There are three main goals of photovoice: (1) to allow participants to document and reflect on their community and experiences, (2) to initiate and hold conversations about issues central to participants using the photographs, and (3) promote action by reaching policymakers and those who can enact change [25] - [26]. This method can be applied to a variety of settings to answer three types of research questions: descriptive research questions (i.e. what is going on in this context), used to assess the process and outcomes of a photovoice intervention (i.e. how successful was this intervention based on desired outcomes), or be used to assess the applicability of photovoice in specific contexts (i.e. can photovoice be used to study this) [26].

Photovoice has been used to empower participants and promote dialogue about important community issues [25], [27], lending itself to research where linguistic or communication barriers are present. As it can be difficult for individuals to discuss mental health, photovoice will provide a crutch and catalyst for interviewees when discussing this emotionally charged and difficult topic [28] - [29]. Photovoice has been shown to be effective to answer mental health research questions. For example, Weinstein et. al used photovoice to explore the experiences of obese adults on assistance programs and their struggles with access to healthy food options [29]. Ha & Whittaker used photovoice to understand the communication barriers and alienation experienced by children with autism spectrum disorder. In terms of higher education studies, a 2017 study used photovoice to understand the pursuit of leadership experiences by women in STEM [30]. Although the prompt was not directly related to mental health experiences, discussions included conversations about personal and professional costs of these pursuits, the need for resiliency, and reliance on social supports [30]. These studies have shown the applicability of photovoice to answer descriptive research questions about mental health experiences.

Conducting a Photovoice Study

Photovoice projects involve several stages, starting with forming the study team. Central to this team is the facilitator, or the person leading the training, collection, and discussions surrounding

the photographs. Facilitators must be invested in allowing social change to occur while being attuned to any political and power dynamics at play; it is recommended that there be more than one facilitator with at least one being a part of the community of interest [31]. Not only will this be beneficial for the planning stages of the project, but this will help provide buy-in and build rapport with participants. After forming the study team, the next task is to reach out to members of the community to participate in the project. Recruitment of participants can vary with most studies ranging from 8-12 participants given the involved nature of the project and intense data collection [31]. Before data collection begins, it is typical to provide some form of training to participants going over the research methods, the goals of photovoice, and the safety and ethical considerations of photovoice (i.e., not intruding in someone's personal or private space, getting consent of anyone included in a photograph, etc.) [31]. Following this training is when the data collection begins.

Data collection is typically seen as when "participants take photographs and are interviewed to provide their interpretations as a part of the data collection process" [24, p. 170]. That is, participants submit images based on a prompt provided by the study team and then have some form of discussion to follow up on the submitted images with the study team. This process can be iterative depending on the length of the study and level of engagement desired with the community of interest. The prompt provided is intended to guide participants' reflection of their experiences before selecting and submitting images. Captions can be included to provide context as to why an image was included and is helpful when the study team would like to analyze the images independently from the participants or serve as a memory jog after data collection takes place. Interviewing participants can be done in a variety of ways, including one-on-one interviews, group interviews, focus groups, or a combination of them. Discussing the images with participants is a crucial part of the process as researchers need to know the proper context, point of view, and reasoning why the photographs were elected [32, p. 103]. Group discussions are often included as this can serve to identify shared experiences between participants. This can serve as a jumping off point for later analysis as it can be structured so that participants can collectively decide upon representative experiences for the topic at hand, such as through the SHOWeD technique [33] - [34]. Group discussions can also serve as a jumping off point for the action component of research [26]. Here, participants select images and their respective narratives to initiate dialogue with influential community leaders surrounding their concerns and ways to address them; this can be done in in-person meetings or through specific photo galleries or exhibitions [26]. These examples of action can also overlap with the final stage of photovoice, which is to share the findings with the community (e.g., presentations and publications). For studies with higher engagement of study participants, this would be integrated into the group discussions and engagement with study participants.

Applicability

Photovoice was selected for this study for three reasons. Firstly, we desire to capture the lived experiences of engineering graduate students through their personal experiences and perspectives. Photovoice ensures that the study participants are central to every aspect of the research project, from study design to highlighting shared experiences in analysis. Secondly, to study the mental health climate of engineering graduate students, researchers need to be able to navigate and understand all aspects of this engineering culture. Having both an engineering graduate student and faculty member in engineering as part of the study team gives invaluable

insight into that culture and a common ground with participants. Thirdly, photovoice is typically used in situations in which a language barrier exists. We feel this is the case for engineering graduate students given the charged nature of mental health and the wide range of prior mental health experiences participants can bring into the study.

Adapting Photovoice to this Study

In light of the COVID-19 pandemic, this study needed to be adapted from its traditionally in-person format to an online modality. Outside of the transition to online software and interactions, the study team needed to consider how participants would gather images for submission. In traditional photovoice applications participants take photos to try and capture the essence of the prompt. However, in this project, we needed to be more mindful as participants may not have the ability or desire to go in person to capture the experiences that come to mind. As a result, the study team is allowing participants to submit any photograph, image, or graphic they feel best represents the experience they are trying to capture. These can even include online images, so long as the sources are included in the submission. Another important change is the removal of a formal training session. This is partially in part to minimize the effects of zoom fatigue but primarily because the study team felt safe assuming that most graduate students have access to a camera through their smartphone or a digital camera and therefore also have experience taking photographs. In lieu of a formal training, participants will be provided information on the goals of the study, data collection process, goals of photovoice research, and ethical considerations for partaking in a photovoice study via the study informed consent form, a photovoice fact sheet, and virtual instructions.

Theoretical Frameworks Used in the Study

Three theoretical frameworks are leveraged in this work. The first is Ecological Systems Theory (EST). This framework helps to situates individuals within the context of their local environment(s), global environment(s), and social interactions while acknowledging the influences of context, power dynamics, and the stages of development individuals experience [35] - [36]. We use this framework to situate *where* engineering graduate students' mental health experiences take place, and how these may differ from the individual level to their local environment to the larger engineering culture. The second is Sociocultural Theory (SCT). This theory states that individuals interact in their world through tools (e.g., language or artifacts) which serve to mediate and regulate relationships with others and ourselves [37]. These interactions do not exist within a bubble, but are instead informed by cultural and societal norms, which are dependent on the role they are serving when an interaction takes place [38]. In this work we will use this theory to describe *how* engineering graduate students interact and engage within their different environments. The third and final theory being leveraged is Eccles' expectancy value theory (EVT) with emphasis on Eccles' concept of subjective task-value (STV). Eccles explains how educational choices are driven by one's outcome expectancy and motives for achievement; that is, outcome expectancies are driven by the options an individual sees and what they perceive those respective outcomes to be whereas achievement-based choices are driven by a range of factors (e.g. expectations for success, core identities, relation to short and long term goals) [39]. These achievement-based choices are broken down into four categories: attainment value, interest value, utility value, and perceived cost [39] - [41]. In this work, I will use this framework to explore *why* engineering graduate students interact and engage in their environments by exploring their motivations.

Study Design

The goal of this study is to answer two descriptive research questions with regards to engineering graduate students: *(1) How do engineering graduate students at a large public university describe their mental health experiences?* and *(2) How does the culture of engineering influence engineering graduate students' mental health experiences, and therefore how they participate in engineering?* There are four major points of data collected in this study: (1) an initial survey, participants' submitted images and captions, an individual interview, and a focus group.

Research Site

The research site is a large midwestern PWI with an emphasis on research. The main facilitator is a white, female, first-generation engineering graduate student with a background in electrical engineering and engineering education research. Eight engineering graduate students were recruited using convenience sampling. This is within the typical size of a photovoice project, with recent studies including 8-12 participants [23], [28], [34], [42]. Being driven by qualitative research methods, the goal was not to seek generalizable results but rather asking questions and probing in depth to get detailed responses to understand their experiences [24]. Participants will then complete one round of data collection over April – June, 2021.

Initial Survey

The initial survey began by providing participants with the informed consent form, intended to provide information about the study aims, compensation, timeline, and potential risks and discomforts. After signaling they agreed to participate in the study, the survey collected information on participants' background, demographics, engineering climate, academic performance, and high-level mental health measures. These measures are still being flushed out; currently, most questions being asked are some form of multiple choice with a few open response questions. For this paper, the results section will report on findings from five survey

Table 1. Initial Survey Questions Reported on in Results

Name	Description	Composite Response Categories
Patient Health Questionnaire (PHQ-9)	self-reported measure for severity of depression; 9 items (8 in this study)	0-4: minimal depression 5-9: mild depression 10-14: moderate depression 15-19: moderately severe depression 20-27: severe depression
Beck Anxiety Inventory (BAI)	self-report measure of anxiety; 21 items	0-21: low anxiety 22-35: moderate anxiety 36(+): potentially concerning levels of anxiety
Psychological Well-Being (PWB; Flourishing)	self-reported views on areas including relationships, self-esteem, purpose/meaning, and optimism; 8 items	Scores range from 8 (lowest) to 56 (highest); A higher score indicates a person with many psychological resources and strengths
Academic Challenges	self-reported challenges preventing participants from completing their degree; 12 items	N/A
Work-Life Balance	open-text response question: *"How would you describe your work life balance? Please be as descriptive as able."*	N/A

items. Specifically, we will present results from items that correspond to depression, anxiety, flourishing, academic challenges, and work-life balance. Table 1 above and the following paragraph overviews these items. Detailed information on survey questions and scaling options for measuring depression, anxiety, flourishing, and academic challenges can also be seen in Appendix A.

Depression is measured using the Raw Patient Health Questionnaire score (0-27) from the Patient Health Questionnaire (PHQ) [43] [44]. This score can be grouped based on depressive symptom severity: 0-4 minimal depression, 5-9 mild depression, 10-14 moderate depression, 15-19 moderately severe depression, and 20-27 severe depression [44]. All items from the PHQ-9 questionnaire were included except for the ninth and last question, phrased "Thoughts that you would be better off dead, or of hurting yourself." This is due to the high level of depression believed to be needed to endorse this item as it relates to suicidal thoughts and ideation. Participants' were still scored using the recommended categories despite this question being removed. Anxiety was measured using self-reported responses to the Beck Anxiety Inventory [45] [46]. This scale was elected as it leans into physiological experiences as diagnostic items for anxiety. Flourishing was assessed using the Psychological Well-Being scale given the intent to measure positive mental health [47]. Unlike the previous instruments, this scale does not have categories; simply, the higher the reported composite number, the higher demonstrated positive mental health. Perceptions of academic challenges were assessed using a multi-option response question: *"Which of the following challenges would most likely prevent you from finishing your degree? Select all that apply."* The survey was modified from the Healthy Minds Network 2020-21 survey [48]. An additional option was added, specifically, "COVID-19 related delays or changes to degree progress." Last, work-life balance was measured using responses to an open-ended question: *"How would you describe your work life balance? Please be as descriptive as able."*

Image and Prompt Collection

For this study, five images and captions will be collected from each participant using an online survey platform. As stated above, as opposed to solely using images captured by individuals for the purpose of this study, participants will have the option of using any form of visuals for their submissions. The following prompt will be used to solicit these images:

> *Reflect on five impactful emotional experiences of any type that you have had as an engineering graduate student here at the [BLINDED]. Please try to capture the range of emotional experiences you've had. With these in mind, please select an image to represent each of those experiences. These images can be ones you have taken, ones you take or create specifically for this project, or find online. Please submit each image with a 3-5 sentence caption explaining why the image was included, and if necessary, the URL from where you found the image.*

These images and respective captions will be analyzed prior to conducting individual interviews as discussed in the Data Analysis Strategies section.

Individual Interviews

60-minute semi-structured interviews will occur with each participant after the collection and analysis of their respective images and captions. Interviews are structured to provide space for interviewees to expand upon the images selected and captions provided. Questions asked in the interview will go over the participants' background, their perceptions of the culture of engineering, and their perceptions of mental health in engineering. All interviews will be conducted online using a video and audio software platform before being transcribed.

Focus Group

A 90-minute focus group will be conducted after completion of each of the eight individual virtual interviews. Not all interviews will have been fully analyzed at the point of the focus group. It is intentional that no larger group analysis takes place until the end of the image, caption, and interview data collection to center on each participants' experiences. The goal of this focus group is to bring together participants to discuss the images they have collected to find commonalities, themes, or concepts shared across images and individual experiences. The specific task of the focus group is to collectively agree on five to ten images that best represent participants shared emotional experiences as engineering graduate students at the same institution. This will be done by leveraging the SHOWeD strategy [33] [34] [49]. SHOWeD, an acronym, represents a list of five questions facilitators can pose to help participants talk about the images they include: "What do you *s*ee here? What is really *h*appening here? How does this relate to *o*ur lives? *W*hy does this problem, concern, or strength exist? What can we *d*o about it?" [33, p. 84]. These questions will be used to facilitate the focus group dialogue surrounding each participants' images to help sift down to the final group of five to ten images.

Data Analysis

Data analysis will focus on the images, captions, interview transcripts, and focus group transcript. This analysis will be done in two distinct phases with the overarching goal of understanding the groups' collective mental health experiences as engineering graduate students. The first phase will leverage an inductive, open coding format guided by thematic analysis [50]. The second phase will use more of a deductive coding strategy leveraging the three theoretical frameworks guiding this study as a basis for the codes, such as seen in [41]. That is, in the first phase data will be analyzed by assigning a word or short phrase to summarize a portion of qualitative data, with the objective of creating categorical codes to capture specific themes discussed across the data with the second phase using pre-defined, theory-driven codes [41] [50]. In the first phase, an emphasis will be placed on the qualitative findings from the focus groups, using individual images, captions, and interviews to fill out findings. The second phase is expected to be more targeted, with emphasis on exploring the role of the culture of engineering as it pertains to engineering graduate students' mental health. It is likely that findings from these two phases of coding will overlap; however, we anticipate that these coding strategies will reveal different highlights of information from the data. Finally, the data analysis done here will be triangulated with the researcher notes and initial survey responses once completed.

Preliminary Results

As mentioned, eight engineering graduate students were actively recruited using convenience sampling at a large midwestern PWI with an emphasis on research. At this time, only data collected in the preliminary survey will be reported on.

Demographic and Background Information

Information about participants' background and demographics can be seen in Table 2. This table includes information about participants' degree program, race/ethnicity, gender (male, female, non-binary), age (per census age brackets), international student status, and their primary and secondary parent (or caregiver's) highest level of education. As shown, participants included only one master's students and seven joint master's and doctoral students. Four of the participants identified as White / Non-Hispanic with two participants identifying as Black / African American, one participant identifying as Asian or Asian American, and one participant identifying as both Hispanic or Latino and White / Non-Hispanic. One participant identified as non-binary, two participants identified as male, and five participants identified as female. Using the United States census categories for age [51], two of the participants fell into the 18-24 category with six participants in the 25-44 category. Only one of the participants identified as an international student. All but one student had at least one parent/caregiver with a graduate degree. Overall, only one parent/caregiver has a high school degree, four parents/caregivers have a bachelor's degree, six parents/caregivers have a master's degree, and five parents/caregivers have a doctoral degree (disciplines unknown).

Table 2. Participant Background and Demographic Information

Participant	Degree Program	Race / Ethnicity	Gender	Age	International Student	Parents' Highest Level of Education
Adrian	MS/PhD	Hispanic or Latino; White / Non-Hispanic	Non-Binary	25-44	No	MS & HS
Aiden	MS/PhD	White / Non-Hispanic	Male	18-24	No	MS & PhD
Alex	MS/PhD	White / Non-Hispanic	Female	18-24	No	BS & BS
Diana	MS/PhD	Black / African American	Female	25-44	No	PhD & PhD
Erik	MS/PhD	White / Non-Hispanic	Male	25-44	No	MS & MS
Naomi	MS/PhD	Black / African American	Female	25-44	No	PhD & PhD
Nitya	MS	Asian or Asian American	Female	25-44	Yes	MS & BS
Zoey	MS/PhD	White / Non-Hispanic	Female	25-44	No	MS & BS
Notes: HS = high school, BS = bachelor's degree, MS = master's degree, PhD = doctoral degree						

Participants also provided their engineering disciplines using the National Science Foundation reported categories [52]. However, at risk of participants being identified, this will only be presented in aggregate form. The eight participants came from seven engineering disciplines: bioengineering and biomedical; chemical; electrical, electronic, and communications; environmental health; materials science; mechanical; and other engineering.

Mental Health and Academic Measures

Table 3 on the following page details individual scores for each participants' self-reported responses to the discussed mental health metrics. The PHQ-9 self-reported responses indicated three participants with minimal depression, three participants with mild depression, and two participants with moderate depression. As for the Beck Anxiety Inventory, one participant was

Table 3. Initial Survey Responses to Mental Health and Academic Challenge Questions

Participant	PHQ-9	BAI	PWB	Perceived Academic Challenges
Adrian	Minimal Depression	Low Anxiety	44/56*	Mental or emotional health problem
Aiden	Minimal Depression	Low Anxiety	54/56	Lack of motivation or desire; Career Opportunities; Other
Alex	Mild Depression	Low Anxiety	50/56	Mental or emotional health problem; Lack of motivation or desire; Other
Diana	Mild Depression	Low Anxiety	38/56	Mental or emotional health problems; Family obligations; Academic challenges (struggling to pass classes); Lack of motivation or desire; COVID-19 related delays or changes to degree programs
Erik	Minimal Depression	Low Anxiety	56/56	-
Naomi	Mild Depression	Low Anxiety	31/56	Mental or emotional health problem; Academic challenges (struggling to pass classes)
Nitya	Moderate Depression	Moderate Anxiety	49/56	Visa or other challenges related to being a non-U.S. citizen; COVID-19 related delays or changes to degree programs
Zoey	Moderate Depression	Low Anxiety	37/56	Mental or emotional health problems; Family obligations; Lack of motivation or desire; Career opportunities; COVID-19 related delays or changes to degree programs

Note: *omitted an item on this scale; "-" indicates question not answered

classified as having moderate anxiety with the other seven participants being classified with low anxiety. In terms of Flourishing, responses ranged from a score of 31/56 to a score of 56/56, with an average score of 44.9. Table 3 also notes that Adrian indicated one item was not applicable, and therefore was recorded as a zero on that item when tallying the composite score. In terms of Perceived Academic Barriers, the most selected responses were mental or emotional health problems (62.5%), the lack of motivation or desire [to complete their degree] (50%), and COVID-19 related delays or changes to degree progress (37.5%). Two individuals selected the other option for this question; Alex wrote in "if [my degree] is something I truly want or not" and Aiden wrote in "change of career path." Erik left this question unanswered.

Work Life Balance

As stated before, participants responded to an open-ended question asking them to describe their work-life balance. Two participants indicated a positive work-life balance. Nitya said, "*It's pretty good right now*," and Erik initially stated it was "*good.*" However, other participants shared not feeling like there was enough time to do both academic work and other activities. Diana wrote:

> Not too much free time for life enjoyment. When I am tired, I relax by watching movies, but this feels as if it is at the sacrifice of my academics.

Diana justified relaxing via her fatigue. However, choosing to relax was at a direct sacrifice to her academics. Whereas Diana discusses needing to separate and choose something over work, others described feeling not being able to truly separate their work and academics from other aspects of their lives. Although Erik described his work-life balance as "good," he also shared:

> [T]he boundaries between my work and life are very porous. For instance, it's rare that I am unable to hang out with someone because I am too busy with work. At the same time, it's also rare for me to take genuine breaks from work (I probably genuinely unplug at most one to two weeks out of the year).

This porous boundary between work and life seems to be a common theme across participants. That is, many individuals communicated a desire to prioritize a work-life balance but inferred that they had difficulty doing so. Naomi shared that this is due in part to her peers. She wrote,

> I am able to set better boundaries when I have solo work, but with group projects I feel like the lines between work and life blur a bit more, especially when my group is particularly demanding and/or do not have good work/life balance in their lives.

Although Erik explained this porosity between work and life being due to his interest and motivation in his work, Naomi shared how this porosity can be experienced by those who wish to keep the space between work and life more defined. Alex also discussed how she struggled with setting boundaries in her response.

> I think I have some boundaries, but struggle at times saying no to things and so my efforts and work always take longer than I imagine which gives me immense guilt at the end of the week when I haven't accomplished as much as I should have, but really did a lot more than I think, even though my to-do list says otherwise.

Alex highlighted feelings of not being able to say no to additional work, which in turn fueled immense guilt at the end of each week when looking at the tasks still yet to be done. Alex feel unproductive despite continuously working as there was also more for her to do. Zoey, on the other hand, emphasized a desire for work-life balance, but difficulty when comparing herself to others:

> I try to prioritize work-life balance as much as possible. I work 2 hr or less on the weekends. However, I often feel guilty because I know that other graduate students work more hours than me.

These pervasive feelings of guilt when trying to maintain a desired work-life balance were found through other responses. Rather than from directly comparing one-self to others as Zoey described, Aiden talked about expectations he feels are in place for working:

> [F]airly balanced; I often feel like I "should" be working more eg on weekends. Some self-imposed stress, some due to a sense of what grad school ought to be.

This response highlights an important aspect of what Aiden perceived to be the norms about engineering graduate school to be. Feeling that there is always more work to do and you should consider working on weekends to get it done seems to be expected. Adrian expanded on these expectations:

> [F]rom what I've experienced and also heard from others, grad student (engineering) culture normalizes burnout, self-blame through meritocracy, and feeling like you need to work all the time in order to make progress, reinforced by folks with more institutional power than you emphasizing research work over well being. After realizing that work won't love me back, it helped me see that it doesn't really help to bring about the world I want to live in if I'm doing psychological damage to myself by continuing to try and adapt to engineering culture as I've experienced.

As Adrian discussed, their work-life balance has improved as they have progressed through graduate school. This progression seems to come from them making conscious choices to operate outside of their perceptions of the culture of engineering, in which they prioritize their mental health over their research productivity.

Study Limitations

One major limitation of this study is the use of convenience sampling to solicit participants. This has two impacts. One, the researchers' identity as a female influences the pool of potential participants recruited into the study as the researcher knows more individuals closer to this identity group. Secondly, there is a selection bias for participants' opting into the study. Given that the nature of the study is about mental health, individuals opting into the study are more likely to have mental health experiences and a desire to discuss them. Finally, recruitment for this study took place in the last two weeks in April during the ongoing COVID-19 pandemic and during pervasive racial injustices to Black and Asian communities. Given the increased levels of exhaustion, zoom fatigue, and overall rise in emotional distress, students in the U.S. are exhibiting increased mental health problems [3]. This could both alter participant demographics as well as present increased levels of mental health problems reported by participants in the initial survey.

Discussion and Future Work

The study team is currently in the participant recruitment and data collection stages. Up until this point, the study team has primarily been working on refining the research design and methods and preliminary data collection. Given the centrality of the prompt in the data collection process and overall study results, the team spent considerable time refining and soliciting feedback on it. This includes soliciting feedback on four separate occasions from current STEM and engineering graduate students (two one-on-one discussions and two group discussions). In addition, the first author conducted a focus group with two individuals to discuss the data collection procedures of this study (i.e. photovoice prompt, individual interview questions, and focus group questions). One individual had expertise in conducting interviews with STEM students on related affective topics with the second participant being a mental health expert at the institution who has worked with STEM graduate students on mental health related topics. Their insight helped refine the prompt in several ways, most notably to monitor the tone to ensure a range of experiences is captured, not just negative.

The initial survey data shows a diverse range of study participants, covering seven engineering disciplines with a variety of mental health experiences. In terms of perceived academic challenges, participants allude to concerns of motivations and mental health concerns as prominent factors that could lead them to not complete their degrees. The open-ended responses

with regards to work-life balance began alluding to larger cultural factors. Future work will compare students' mental health experiences (photovoice) with self-reported scores on known markers for mental health conditions (survey responses) to provide insights into what engineering graduate students expect with regards to their mental health experiences. This will be done by probing experiences shared in the image and caption collection, individual interviews, and focus group data collection stages. Saturation of themes across data will show what internal and external factors students attribute to their self-reported mental health status, such as the advisee-advisor relationship, coping mechanisms, social supports, or self-efficacy.

Results from this pilot study will be used in two ways. First, it will be used to refine the study design for a larger multi-institutional study. Second, the preliminary results will be presented within the institution's administration as well as the larger engineering education research community to bring awareness to engineering graduate students' mental health concerns as well as provide suggestions for ways to address these concerns going forward.

Acknowledgments
The authors would like to thank the Engineering Education Research community at the University of Michigan for their invaluable feedback and guidance. This work is supported by a University of Michigan Rackham Predoctoral Candidate Grant.

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Appendix A

Detailed Survey Items for Measures of Depression, Flourishing, Anxiety, and Academic Challenges

Over the *last 2 weeks*, how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

(For office coding: Total Score _____ = _____ + _____ + _____)

If you checked off *any* problems, how *difficult* have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

Figure A1: Screenshot of full PHQ-9 from [43] pp. 613.

Below are 8 statements with which you may agree or disagree. Using the 1–7 scale below, indicate your agreement with each item by indicating that response for each statement.

7 Strongly agree
6 Agree
5 Slightly agree
4 Mixed or neither agree nor disagree
3 Slightly disagree
2 Disagree
1 Strongly disagree

I lead a purposeful and meaningful life.
My social relationships are supportive and rewarding.
I am engaged and interested in my daily activities
I actively contribute to the happiness and well-being of others
I am competent and capable in the activities that are important to me
I am a good person and live a good life
I am optimistic about my future
People respect me

Scoring: Add the responses, varying from 1 to 7, for all eight items. The possible range of scores is from 8 (lowest possible) to 56 (highest PWB possible). A high score represents a person with many psychological resources and strengths.

Figure A2: Screenshot of full Psychological Well-Being Scale (PWB) from [47] pp. 263.

	Not at all	Mildly, but it didn't bother me much	Moderately – it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding / racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky / unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint / lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot / cold sweats	0	1	2	3

Figure A3: Screenshot of full Beck Anxiety Inventory from [46], generated from [45].

Which of the following challenges would most likely prevent you from finishing your degree? Select all that apply.

1. Financial challenges
2. Mental or emotional health problems
3. Other health problems (not directly related to mental or emotional health)
4. Family obligations
5. Family or relationship difficulties
6. Academic challenges (struggling to pass classes)
7. Visa or other challenges related to being a non-U.S. citizen
8. Lack of motivation or desire
9. Work or professional commitments
10. Career opportunities
11. COVID-19 related delays or changes to degree progress
12. Other challenge(s) (please specify)

Figure A4: Survey questions on Academic Challenges adapted from [48].