Understanding Stress and Relief: How Engineering Graduate Students Experience and Cope with Stress

Darby Rose Riley, Rowan University

Darby Riley is a student of engineering education at Rowan University. She has a special interest in issues of diversity and inclusion, especially as they relate to disability and accessibility of education. She is a founding member of Rowan University's

Dr. Kaitlin Mallouk, Rowan University

Kaitlin Mallouk is an Associate Professor of Experiential Engineering Education at Rowan University. Prior to beginning that role, she spent five years an Instructor in the Mechanical Engineering and Experiential Engineering Education Departments at Rowan.

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Abstract

The mental health of graduate students, as well as the gap between coping needs and available resources, has recently become of interest in the engineering education community. Graduate students are of two worlds: they retain the student stress of juggling multiple classes, deadlines, and social lives, while also attempting to transition into the adult world where they take on many new responsibilities. As such, it is unsurprising that graduate students experience a significant amount of stress from many different sources. Previous work has demonstrated a correlation between the amount of discrete stressors (including academic and personal) and the quantified stress level of graduate students. However, more qualitative analysis is still needed to more accurately characterize the stressors graduate students face, and the coping mechanisms they use to mitigate the ill effects of stress.

This paper seeks to answer the following research questions: (1) What elements of the engineering graduate student experience cause students stress? And (2) What methods of coping do students depend upon to persist in engineering graduate education? To answer these questions, we surveyed graduate engineering students at a mid-sized Mid-Atlantic institution. The survey consists of three major sections: (1) the Perceived Stress Questionnaire, a validated instrument that assesses an individual's perceived stress level, (2) a section for respondents to identify and rank major sources of stress, and (3) a section for respondents to identify and rank major coping strategies. This work focuses on the three open-ended questions included in the survey: (1) "Please elaborate on your sources of stress if you choose", (2) "Please elaborate on your coping mechanisms if you choose", and (3) "What else would you would like to share with us regarding your sources of stress, coping mechanisms, or success at managing stress?".

Survey responses were analyzed using two-cycle inductive thematic coding. Some overarching themes identified across all responses include a struggle to keep track of responsibilities in many areas (typically classes, research, and personal needs), transitioning from student life to adulthood or feeling "stuck" between student life and adulthood, problematic cultures of stress in departments or in engineering as a field, and a need to dissociate/disconnect from academic responsibilities in order to feel relaxed (referencing anything from time with friends to alcohol). These trends were additionally examined by stress level (low/moderate/high). Results indicate that graduate students with low levels of stress tend to practice self-reflection and disconnection from their academic responsibilities to relax, while students with higher stress levels identify structural problems with their department (problematic professors, unclear or unreasonable expectations, cultures that discourage or penalize making mistakes, etc.) or personal difficulties adjusting/persisting in the program (feelings of isolation, struggles with self-care or organization, creating a liveable routine, etc.).

Introduction and Background

The graduate student experience is often marked by, if not defined by, the amount of stress it places on the student [1, 2]. Even individuals with well-practiced, healthy coping mechanisms feel their process for managing stress begins to fall apart under the full force of their graduate studies [1]. The number of graduate students who have identified as struggling with poor mental health has risen steadily over the past few years [2], with 56% of graduate students considering dropping out of their programs due to struggles with stress, work-life balance, and well-being [3]- [5]. Students in science, technology, engineering, and mathematics (STEM) disciplines typically demonstrate higher stress levels than non-STEM students [2], and previous studies have revealed unique circumstances—cultures of stress [6], [7], heavy research loads [7], [8], and a lack of help-seeking behaviors [4], [5]—which may contribute to the higher stress levels experienced by STEM/these students. However, despite overwhelming evidence that engineering graduate students face unique stressors and higher amounts of stress than the general population, little research has focused purely on engineering graduate students as a population of interest when it comes to stress and mental health.

Existing studies have explored some of the more prevalent stressors that exist for graduate students: research [8], academic performance [9], finances [10], physical health [11] and so on. Many of these studies have utilized a quantitative approach, largely by examining the ratios of students who experience these stressors and occasionally measuring how impactful they perceive the effects of these stressors to be on their mental health. However, previous literature has demonstrated the prevalence of other, less easily-measured stressors that impact the lives of graduate students. Many students struggle to find their place in their department or cite departmental culture as stress-inducing [12]-[15]. Engineering students in particular often push themselves further and harder than other students in the name of common "workaholic" stereotypes about engineers (not sleeping, hardly eating, not going outside, etc.) [6], [7], [16]. It is also common for graduate students to struggle with the "balancing act" of maintaining schoolwork, research deadlines, and personal responsibilities, leaving little space for anything else [8], [12]. Engineering students from traditionally underserved communities cite discrimination and structural racism as a major source of stress [17], [18]—by nature, this stressor does not affect a majority of students, and therefore may not be reflected in more quantitatively-focused studies. Due to the complexities of these interacting factors, it is unlikely that an engineering graduate student experiences stress from only one source (i.e. only grades, only their department's culture, etc.) [19]. These complexities—and students' perception of their impact on mental health—can be best captured using a qualitatively-focused study.

The more frequently-studied coping mechanisms used by students and graduate students are also some of the more easily-defined: therapy and counseling [20], meditation and mindfulness [21],

and substance use such as drugs and alcohol [22], [23]. However, with a purely quantitative approach, the ways in which these mechanisms are used, their relative effectiveness, and the nuances of why these approaches are effective—in other words, the cause-and-effect connection between coping mechanisms and stress reduction—might be lost. Some students perceive hobbies as constructive paths to self-improvement or reflection, while others only view them as possible distractions from stress and frustration [24]. Others see their ability to manage stress (or inability to manage stress) as an innate aspect of their personality, not something that can be changed or improved [7], [25]. Similar to the ways in which multiple stressors are likely to interact with each other, students are also likely to access multiple coping mechanisms to deal with their complex stressors [15], [26].

In this study, we aim to examine the ways in which engineering graduate students experience and manage stress from a qualitative perspective. This study uses engineering graduate students' own words describing their relationship with school, stress, mental health, and coping strategies in an effort to find nuance, as well as bring light to some of the more unique aspects of engineering graduate student life. This study is intended to be exploratory, with the primary goal of guiding future work into areas of potential improvement. To accomplish this, this study investigates the following two research questions: *(1) What elements of the engineering graduate student experience cause students stress?* and *(2) What methods of coping do students depend upon to persist in engineering graduate education?*

Methodology

This study is part of a continuing research project focused on engineering graduate student stress and coping mechanisms. The first part of this research project [27] investigated the interactions between various stressors and coping mechanisms from a quantitative perspective. This work builds on the previous by utilizing responses to open-ended questions posed in the initial survey, constructed through Qualtrics, which gathered data regarding perceived stress levels, stressors, and coping mechanisms used by engineering graduate students. The survey was distributed to all engineering graduate students at a mid-sized Mid-Atlantic University.

The survey collected basic demographic information (engineering discipline, degree program, age, race, ethnicity, gender identity, disability status, and parental status), perceived stress level, sources of stress (chosen from a list), coping mechanisms (chosen from a list), and an overall rating of how well the students believed they managed their stress (one (poorly managed) to five stars (very well managed)). Perceived stress level was measured using a 30-item validated instrument known as the Perceived Stress Questionnaire (PSQ) [28]. The questionnaire generated a score on a scale of 0 to 1, hereafter referred to as the "PSQ score".

In addition to the closed-ended questions, students were prompted to optionally respond to three open-ended questions:

1. [Following the closed-ended question "Which of the following items do you feel contribute to your stress?"] Please elaborate on your sources of stress if you choose:
2. [Following the closed-ended question "Which people / resources do you use to help you cope with your stress?"] Please elaborate on your coping mechanisms if you choose:
3. [At end of survey] What else would you like to share with us regarding your sources of stress, coping mechanisms, or success at managing stress?

Responses to these questions were analyzed using two-cycle inductive coding. Two coders reviewed the responses to all questions to identify prevalent themes, collaboratively developed a codebook based upon said themes, then returned to apply these themes to the responses [29]. Theme applications were discussed until a consensus was reached. Due to the line-by-line nature of the theme-application process, an inter-rater reliability score cannot be calculated. To ensure quality of the data and the analysis, researchers referenced the Q3 framework [30]. Table A1, detailing the use of the quality framework, can be found in the appendix.

Results and Discussion

18 of the total 43 survey participants responded to at least one of the open-ended survey questions. The first cycle of coding revealed five major themes, listed and defined in Table 1.

Table 1. Major themes identified during the first coding cycle

THEME	DEFINITION
Escapism	Dealing with stress from school/work primarily through disconnecting, detachment, or dissociation from responsibilities.
External Pressures	The influence of departmental expectations (advisors, professors, administrators, or department culture) on stress levels
Internalized Pressures	The influence of turning societal expectations or stereotypes of students' position / job title inward on stress levels
Work-Life Balance - Positive	Managing stress by maintaining a healthy work-life balance
Work-Life Balance - Negative	Overwhelming deadlines or lack of personal time being a significant source of stress

These themes were then applied to the responses, typically in units of a sentence or more. Following the second-cycle coding, the responses were sorted both by PSQ Score and by stress management star rating. To respond to the research questions, students having low-to-moderate stress management star rating (1–3 stars) were examined to understand the most intense stressors for engineering graduate students. These students had an average PSQ score of 0.61, considered "high" (greater than 0.46) [31], and are collectively referred to as "high-stress students". Similarly, students having a high stress management star rating (4–5 stars) were analyzed to understand the most effective coping mechanisms of engineering graduate students. These students had an average PSQ score of 0.38, considered "moderate" (between 0.34 and 0.46) [31], and are collectively referred to as "low-stress students".

RQ 1: What elements of the engineering graduate student experience cause students stress?

The most frequent themes applied to high-stress students' responses (*n* = 10) were *Work-Life Balance - Negative*, *External Pressures*, and *Internalized Pressures* (Table 2). These three codes often appeared together in combinations of two or three, with *External Pressure* and *Internalized Pressures* being the most common pair (*n* = 3).

Table 2. Theme applications for participant subgroup "high-stress students"

THEME	HIGH-STRESS STUDENTS
Work-Life Balance - Negative	7
External Pressure	5
Internalized Pressures	4
Escapism	2
Work-Life Balance - Positive	0

Sections coded with *Work-Life Balance - Negative* tended to reference the more commonly understood and discussed aspects of work-life balance: overwhelming work responsibilities, conflicting deadlines, and a lack of time to care for oneself [32], [33]. Participant 15 describes their stress simply as "*Maintaining deadlines between multiple different sources is exhausting*," while participant 21 noted that they "*work full-time, do research, and care for my family. It's a lot.*" However, relationships to other themes appear to illuminate that the struggle to maintain a healthy work-life balance is tied to other factors.

External pressures are common in graduate studies and often more acute and intense than in undergraduate studies [7], [12]. The theme *External Pressure* captures this phenomenon, whether

these pressures originate from an advisor, a department, or the university as a whole [34], [35]. For example, participant 15 states that they feel "*like I'm constantly needing to raise the bar when it comes to research and work harder to maintain my relationship with my PI*," while participant 38 shared that they "*probably will have to leave the program because there doesn't seem to be a "learning" culture at [University]. Professors only care about their research and don't focus on being better teachers*." The *External Pressures* theme was applied with the *Work-Life Balance - Negative* theme for two participants. Participant 22 describes the struggle to reconcile work-life balance with external pressures as follows: "*Finding the balance of taking care of myself and completing all my work is often hard when I feel there is more pressure and more to accomplish then [sic] making sure I can rest*."

These external pressures can quickly turn inward, along with societal expectations and stereotypes about "workaholic" engineers [6]. The theme *Internalized Pressures* describes the ways in which engineering graduate students tend to neglect their own needs or otherwise struggle to cope with stress due to assumptions about the amount of work they feel they "should be" completing [7], [36]. Participant 17 described one of their sources of stress being "*this mentality that if you are sleeping you arent [sic] working hard enough. And especially in graduate studies, this is incredibly unhealthy*." Despite their self-awareness that this is an unhealthy attitude, participant 17 still cites this mentality as a pillar of their identity as a student: "*My entire life I have thrived on stress and my life has basically never been without something to do*." This internalized connection between productivity and self-worth does appear to be connected to external factors; *External Pressure* and *Internalized Pressures* appeared together in four participants. As participant 17 notes, "*There are as far as I can see zero attempts by the college or university to even bring to light the legitimacy of stress*."

Overall, the engineering graduate students struggling the most to manage stress do not identify a single source of stress. As was found in previous studies, these students often cannot maintain a healthy work-life balance due to the overwhelming nature of their stress coming from many angles [8]. These results further indicate that high-stress engineering graduate students deal with substantial external and internal pressures to maintain high performance by neglecting basic tenets of self-care, such as consistent sleep schedules or time off from work.As participant 5 summarizes, "*Getting a minimum grade of a B is a ridiculous ask of master's [sic] students*."

RQ2 - What methods of coping do students depend upon to persist in engineering graduate education?

The most frequent themes applied to low-stress students' responses (*n* = 8) were *Escapism* and *Work-Life Balance - Positive* (Table 3). These codes appeared together in two cases.

Table 3. Theme applications for participant subgroups "low-stress students".

THEME	LOW-STRESS STUDENTS
Escapism	4
Work-Life Balance - Positive	3
External Pressure	1
Work-Life Balance - Negative	0
Internalized Pressures	0

Sections coded *Escapism* focused on detachment as a coping mechanism. These students placed an emphasis on getting away from their stressors as much as possible; for example, participant 25 recommended "*Just actively taking time to get away from it all, whatever it may be, and doing just what you enjoy for a moment*" as a healthy way of managing stress. Multiple participants mentioned detaching from sources of stress or disconnecting from responsibilities as a method of coping, with participant 8 explaining their primary coping mechanism—art—as follows: "*Doing something completely different from engineering can be so relaxing because it's entirely different.*" Detachment and escapism, while common, are most often viewed as a negative means of dealing with stress; many individuals use alcohol or drugs to escape [37], or choose to escape a situation rather than attempt to solve a problem [38]. However, these results, paired with those from above, indicate that we should perhaps be examining escapism from a different perspective: as a means of maintaining a healthy work-life balance.

The *Escapism* theme's connection to the *Work-Life Balance - Positive* theme is made explicit through several student responses. For example, participant 44 stresses the importance of "*Controlling the ability to transfer the "work mindset" to "having fun mindset"*" and adds that "*Setting deadlines and progress [sic] steadily (not always at peak performance) is good enough!*" Similar to the recent phenomenon of "quiet quitting" [39], this approach suggests that graduate students might find work-related stressors easier to cope with if they can detach emotionally from their work responsibilities and focus on maintaining a life and identity outside of work [15], [31], [32]. Participant 8 states that "*Balance is key for me: I try to care enough to do a good job but care little enough that a loss will not wreck my mentality.*" Additionally, participant 8 explains their use of religion as a coping mechanism in the following way:

> "*Religion category: I know there's so much more to life than school and work... I don't need to be disappointed if I don't feel a sense of identity from school or work because that's not where purpose comes from. While it's important to do a good job in school or work, I don't get my identity from that. A bad job or academic semester doesn't seem so bad when you know there's so much more to life.*"

These results reinforce the idea that engineering graduate students who struggle to cope with stress should focus primarily on improving their emotional relationship with their position [7], [15], [34]. In this study, students who developed a healthy work-life balance and found time to detach completely from academic responsibilities both had lower levels of stress and a greater self-reported ability to manage their stress. However, as previous studies have found, it is likely that a student's identity as an engineering graduate student, and the environment they live and work in, might stand between them and more effective coping strategies [6], [15], [34], [40].

The engineering student "boot camp mentality"—the belief that an experience of shared suffering and hardship can bring people closer together—can make some students feel as if struggling is necessary [40]. At the graduate level, this can combine with expectations from advisors to abandon personal lives in favor of complete dedication to class and research [14], [15], [34], [35], [41], [42]. In an environment where workaholism is expected, taking time for oneself to rest and heal might feel like a failure in and of itself, even if the quality of work does not suffer in the end [34]. As participant 17 stated, "*When I do try to make time for myself I regret wasting it and not getting done work instead.*" Additionally, the prevalence of the *External Pressure* theme—and particularly its relationship to the *Internalized Pressures* theme—imply that these tensions might be reinforced by advisors, mentors, departmental culture, and other external pressures or expectations [7], [11], [14], [15], [34], [35].

Limitations and Future Work

This study is limited by its small sample size ($n = 18$) and its restriction to a single institution in the United States. Due to this small sample size, the analysis of the subgroups (high-stress and low-stress) might not be generalizable to larger populations. This work also lacks responses from marginalized groups, and therefore cannot examine the ways in which stress and coping might be different for members of these groups. Future work might continue to investigate the effect of engineering student workaholism and boot camp mentality on stress and coping, and the ways in which departmental culture might reinforce these mindsets.

Conclusions and Recommendations

The mental health and wellbeing of engineering graduate students is steadily declining, yet there is little research on why this is and what can be done to support these students. This work aims to fill this gap by presenting a qualitative analysis of engineering graduate students' stressors and coping mechanisms. The results presented herein indicate that engineering graduate students with high stress levels generally do not report a single source of stress, but rather describe a culture (both external and internalized) that discourages or actively inhibits a healthy work-life balance. For many participants, the ability to disconnect emotionally from academic

responsibilities was critical to maintaining a healthy work-life balance and managing stress appropriately. While students may be able to tackle some of these problems alone, these results also imply a more systemic issue at play: advisors with unrealistic expectations, departments with too great a focus on research, and universities that refuse to acknowledge the mental health epidemic their graduate students are struggling with. If these students need to disengage from work to stay mentally healthy, the structures they work within must be willing to grant time away from academic responsibilities—both physically and emotionally. The results from this study can guide future work in understanding and addressing the unique mental health needs of engineering graduate students, as well as help faculty more adequately support graduate students struggling to cope with stress.

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Appendix

Table A1. Research Quality Considerations

	Making the Data	**Handling the Data**
Theoretical Validation Do the concepts and relationships of the theory appropriately correspond to their social reality under investigation?	*The research process needs to be able to capture the full extent of the social reality studied.* ● Approach firmly grounded in review of relevant literature regarding stress, particularly as experienced by graduate students	*Interpretations need to reflect the coherence and complexity of the social reality under investigation.* ● Analysis of the data aligns with existing literature on graduate student mental health ● The analysis responds to gaps in existing literature
Procedural Validation Which features of the research design improve the fit between reality and the theory generated?	*Strategies need to be implemented in the research design to mitigate threats to contextual validation.* ● Participants responded to a voluntary survey regarding stress and coping mechanisms ● Open-ended questions were also voluntary as part of the survey	*Processes need to be implemented to mitigate risks of mis-constructing the participants' reality in the researcher's interpretations.* ● All responses were coded by two researchers through a two-cycle coding process ● Each stage of the coding process was recorded to capture changes in theme definitions
Communicative Validation Is the knowledge socially constructed within the relevant communication community?	*The data gathering needs to capture the respondents' inter-subjective reality.* ● Student responses were completely anonymous ● Questions were phrased to be as open-ended as possible, allowing participants to drive the focus of the study	*Interpretations need to be grounded in the accounts of the participants. The knowledge produced needs to be represented in accordance with the meaning conventions of the research community.* ● Researchers continually consulted existing literature to align emergent themes with existing patterns ● Changes to theme applications were discussed with all coders until a consensus was reached

Pragmatic Validation Do the concepts and knowledge claims withstand exposure to the reality investigated?	*The concepts underlying the research design need to be compatible with reality in the field.* ● Only graduate students in engineering were considered for this study to ensure alignment with the study's focus	*The knowledge produced needs to be meaningful in the social context under investigation.* ● The data was examined for emergent themes which would be relevant to engineering graduate students and those who work with engineering graduate students.
Process Reliability How can the research process be made as independent as possible from random influences?	*The data needs to be collected and recorded in a dependable way.* ● Surveys were sent via university listservs to ensure that only students in the population of interest were invited to respond ● All survey responses were anonymized prior to coding ● Changes to themes and theme definitions were tracked in a shared database	*Procedures for generating and representing knowledge need to be established and documented.* ● Final code applications were agreed upon by both coders ● Coders avoided over-interpretation of student responses, instead focusing on what was explicitly stated