The Stressors for Doctoral Students Questionnaire: Year 2 of an RFE project on understanding graduate engineering student well-being and retention

Introduction

Doctoral students are experiencing a "mental health crisis" [1], including high rates of mental health concerns and mental health service utilization ([1], [2], [3]) and high rates of attrition. Estimates suggest that the national attrition rate for doctoral students is near 50% (e.g., in [4], [5], [6]). In engineering, the attrition rate is somewhat better compared to other disciplines, however this rate is still high (e.g., no less than 30% [4]). Further, engineering students have been described as pursuing fewer help-seeking opportunities such as counseling services compared with students in other disciplines [3]. While efforts are underway to characterize the culture of undergraduate engineering students regarding stress and mental health (e.g., [7], [8], [9]), little work focuses specifically on the mental health of doctoral students in engineering disciplines [10].

Our study focuses primarily on the experience of stress in doctoral engineering programs. Prior work has linked stress to anxiety symptoms and mental health distress [11]. Further, mental health concerns, particularly including the experience of high stress, have been linked to student retention [12], [13]. We draw upon multiple sources of defining stress (e.g., use ones from qual:[14], [15], [16]) to operationalize the following definition of *stress* across our projects: we define *stress* as a psychological process involving a primarily affective response to a stimulus, which impacts an individual's engagement with the source of stress related to the stimulus. These stress responses can be physical, emotional, cognitive, or motivational and the consequences of these responses can be both positive and/or negative, such as dreading a future interaction or gaining energy to complete a task. We define *stressors* as sources of stress, which can include stress initiated by oneself.

Some studies have explored the nature and effects of stressors specifically for graduate engineering students (e.g., [12], [17] [18]), additional studies have explored stressors more generally for students in STEM disciplines (e.g., [19], [20]). These contributions have generally focused on single phenomena, populations, or stressors; in our work we seek to organize this valuable work by characterizing the nature and effects of the *landscape of stressors* experienced by doctoral engineering students. In Year 1 of this project [21], we employed a longitudinal mixed methods study design to identify the most common and severe stressors experienced by a cohort of students at one institution. Drawing from the results of this study and a review of the literature on graduate student stressors, we developed in Year 2 the Stressors for Doctoral Students Questionnaire for Engineering (SDSQ-E) and administered it twice, in fall 2022 and in spring 2023. The SDSQ-E measures the severity and frequency of stressors including advisor-related stressors, class-taking stressors, research or laboratory stressors, campus life and financial stressors, and identity-related or microaggression-related stressors. We will present a description of our project and updates on its progress in its second year, including preliminary survey results from our fall 2022 data collection.

Project Overview

Understanding graduate engineering student well-being for prediction of retention, is a three-year project with the guiding research question: *What is the nature of and what are consequences of stressors for graduate students?* In the first year of the project, we conducted a longitudinal interview and questionnaire study with a sample of 55 engineering PhD students. Analysis of interviews explored the top-rated (most frequent and most severe) stressors experienced by those students, yielding many familiar stressors and some stressors more or less emphasized compared to the broader stressors literature [21]. In the second year of the study, we developed and validated the SDSQ-E, a measure of stressors in doctoral engineering student experiences. We aim to use the SDSQ-E to predict students' experiences of mental health distress and intention to persist in doctoral programs. In the third year of the study, the developed survey will be applied to a large sample of graduate students.

Developing the SDSQ-E

The development of the SDSQ-E involved a multi-year, multi-phased mixed methods study process with a sequential design for the purposes of triangulation within a constructivist paradigm [22]. In the first phase, we identified themes from coding longitudinal interview data collected in Year 1 [21], many of these themes were well-aligned with the literature on graduate stressors and additional major themes and stressors emerged from this analysis. These themes were categories of stressors, e.g., coursework, advisor relationships, or teaching assistantships. Within each theme, multiple stressors with different natures were represented as codes (e.g., workload, exams, and quality of instruction for classes). We determined a total of eleven themes to use in the construction of the SDSQ-E. Notably, we made the decision to include categories of stressors such as financial stressors which were prevalent in other literature despite not being observed frequently among our own participants, perhaps due to the relatively average cost of living and strong financial support opportunities for engineering graduate students at the focal institution.

Next, we drafted the survey items based on codes within our coding scheme. Fifty codes, the most reported within our analysis of Year 1 data, were selected to be represented by items in the survey. Fifteen additional codes which were not frequently reported in our data corpus but were represented in the literature were additionally selected to be represented by items. To eliminate variance between interpretations of stress across questions, all items were drafted using a common question stem with general phrasing: "I feel stress" followed by a description of an individual code, e.g., "I feel stress about getting writing feedback from my advisor." We also noted in our analysis of interviews that some stressors were reported by participants to only occur once but to cause extremely high stress and rumination; other stressors were described as less severe but more consistently occurring. Thus, each question was accompanied by two Likert-type response prompts: one eight-point Likert-type frequency response (ranging from "This has never happened to me" to "Daily, it bothers me every day") and one six-point Likert-type severity response (ranging from "No stress, I am not bothered at all," to "Extreme stress, it is unbearable and/or debilitating to me"). For validity-checking purposes, an additional option, "Does not apply to me / No basis for judgement," was included with both frequency and severity response options. During the drafting process in summer 2022, our team discussed and refined items in weekly meetings.

This drafting process resulted in a total of 65 items. Our cognitive interview process will be described in more detail in another manuscript submitted to this year's annual conference [23].

However, to summarize the cognitive interviewing process, we conducted $N = 13$ interviews with doctoral students in engineering including some students ($n = 6$) who had participated in Year 1 of the study. In addition to participating in the cognitive interviews, these returning participants were asked additional questions about the accuracy of the items and major stressor topics identified to the stressors identified in their interviews in Year 1 as a means of member checking. Cognitive interview refinements included improving the consistency of language in the survey, removing four and combining two items, and drafting one new item, resulted in a final survey with 61 items. Additionally, 18 demographic items were drafted, drawing from the demographics collected during year 1 of this study. Appendix A includes the full survey and its items, response scales, and the demographics collected.

SDSQ-E Data Collection

The research design and instruments were approved by the focal site's Institutional Review Board before data collection began.

Participants were contacted using targeted emails to student clubs and societies, professional development mailings, TA teacher trainings, and courses with significant engineering doctoral student attendance. $N = 104$ students participated in the fall distribution of the survey. $N = 89$ of students participated in the spring distribution of the survey. Participants self-enrolled into a space on the Canvas learning management system and completed a digital consent form before accessing survey questions. This consent form required participants to confirm that they were engineering doctoral students enrolled at the focal institution and were at least eighteen years old. Participants in each survey offering (fall and spring) were offered remuneration into a drawing for one of five $100 Amazon.com gift cards, which were drawn following the study closure (in November and April).

Table 1 summarizes major participant demographic data from the fall data collection period. Participation in the fall was lower than anticipated by our research team. Evidenced by low participation from large departments, we believe that some departments at the study site published advertisements for the survey in different modalities: e.g., direct emails versus newsletters, where the latter might be accessed less by students.

Table 1. Participant demographics

		Fall Study Sample ($N = 104$)
*Department Size**		
	Small	39
	Medium	35
	Large	9
*Gender***		
	Male	46
	Female	37
*Race***		
	White, Caucasian	33
	Asian or Pacific Islander	38

Black/African American	1
Hispanic/Latinx	5
Indian subcontinental	12
Arab/Middle Eastern	5
American Indian	1

All demographic information collected was optional, thus fewer than the total $N = 104$ participant responses in the fall are included. Options with no responses have been omitted from this table.

*Cutoff values for department size were determined by the team before recruiting participants. The site institutions large departments were considered to be Mechanical Engineering, Electrical and Computer Engineering, and Computer Science; the medium departments were considered to be Civil and Environmental Engineering, Materials Science and Engineering, and Physics; all other departments were considered to be small size.

** For *Race* and for *Gender*, multiple options could be selected.

Preliminary Results

We present preliminary results from the fall pilot survey administration. Table 2 summarizes each measure in terms of reliability.

Table 2. Reliability of SDSQ-E Subscales

Subscales	Cronbach's Alpha, Frequency	McDonald's Omega, Frequency	Cronbach's Alpha, Severity	McDonald's Omega, Severity	Number of items in subscale
Advisor-Related Stressors	.87	.92	.87	.91	7
Campus Life Stressors	.86	.90	.88	.91	9
Class-Taking Stressors	.84	.89	.87	.92	8
Identity-Related Stressors	.76	.90	.80	.90	6
Lab and Research Stressors	.81	.86	.87	.92	8
Microaggression-Related Stressors	.88	.90	.93	.95	4
Milestone Stressors	.85	.91	.85	.92	6
Self-Related Stressors	.81	.88	.87	.92	5
TA and Teaching Stressors	.88	.92	.84	.93	4
Work-Life Balance Stressors	.83	.86	.86	.88	3
Writing-Related Stressors	.83	.88	.77	.84	4

Discussion

Initial reliability work on the fall data is promising; all items exhibit good to strong internal consistency of at least 0.7 for Cronbach's alpha and extremely good consistency for McDonald's omega [24]. Preliminary validation work, while not reported here, is also strong, and the structure of latent factors in a preliminary exploratory factor analysis suggests that our categorization of variables is accurate. We found a high correlation (>0.88) between the frequency and severity scores for each subscale, suggesting that measuring either the frequency of stressors or intensity of stressors' impacts may both be reliable ways of measuring the presence and prevalence of stressors.

Future Work

Future work in Year 2 will include completing the analysis and validation of the Year 2 survey, including an analysis of reliability and validity evidence from the spring data collection, an exploratory factor analysis of the two pilot surveys. Additionally, we are developing a user manual for this questionnaire, which we plan to disseminate in Year 3. In Year 3, we will conduct a full administration of this survey beside multiple previously published measures including mental health distress symptoms [25], intention to persist [26], and potentially other constructs such as engineering culture, quality of life, and quality of social relationships. Analysis of Year 3 data will provide further, confirmatory validity evidence and establish the correlative or predictive power of measuring the stressors found in the SDSQ-E with related topics.

Acknowledgments

This material is based upon work supported by the National Science Foundation (grant number 2034800). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. The authors thank our project evaluator Dr. Elizabeth Litzler and advisory board member Diana Gonzalez for their support and guidance on this project. The authors also thank the year 2 participants for supporting this work by sharing their experiences in our survey.

References

[1] T. M. Evans, L. Bira, J. Beltran-Gastelum, L. T. Weiss, and N. L. Vanderford, Evidence for a mental health crisis in graduate education, *The FASEB Journal*, vol. 36, pp. 282-284, 2018.

[2] A. K. Flatt, "A Suffering Generation: Six factors contributing to the mental health crisis in North American higher education," *The College Quarterly*, vol. 16, 2013.

[3] S. K. Lipson, E. G. Lattie, and D. Eisenberg, Increased rates of mental health service utilization by US college students: 10-year population-level trends (2007–2017), *Psychiatric services*, vol. 70, ed. 1, pp. 60-63, 2018.

[4] L. Cassuto, "The Graduate School Mess: What caused it and how we can fix it," *Harvard University* Press, 2015.

[5] J. L. Lott, S. Gardner, and D. A. Powers, Doctoral student attrition in the STEM fields: An exploratory event history analysis. *Journal of College Student Retention: Research, Theory & Practice*, vol. 11, ed. 2, pp. 247–266, 2009.

[6] R. Sowell, "The CGS Ph.D. Completion project: A study of doctoral completion at selected universities in the US and Canada," in *2010 NC State Graduate School Symposium*, 2010.

[7] K. J. Jensen and K. J. Cross, "Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion," *Journal of Engineering Education*, vol. 110, pp. 371– 392, 2021.

[8] K. Beddoes and A. Danowitz, "In their own words: How aspects of engineering education undermine students' mental health," in *2022 ASEE Annual Conference & Exposition, Minneapolis, MN,* 2022.

[9] N. W. Sochacka, J. Walther, J. R. Rich, and M. A. Brewer, "A narrative analysis of stories told about engineering in the public discourse: Implications for equity and inclusion in engineering," *Studies in Engineering Education*, vol. 2, no. 2, 2021.

[10] S. J. Bork and J.-L. Mondisa "Engineering graduate students' mental health: A scoping literature review," *Journal of Engineering Education*, vol. 111, no. 3, pp. 665– 702, 2022.

[11] C. G. P. Berdanier, C. Whitehair, A. Kirn, and D. Satterfield, "Analysis of social media forums to elicit narratives of graduate engineering student attrition," *Journal of Engineering Education*, vol. 109, pp. 125–147, 2020.

[12] N. S. Bekkouche, R. F. Schmid, and S. Carliner, "'Simmering Pressure': How systemic stress impacts graduate student mental health." *Performance Improvement Quarterly*, vol. 34, pp. 547-572, 2022.

[13] S. A. Mackie and G. W. Bates, Contribution of the doctoral education environment to PhD candidates' mental health problems: A scoping review, *Higher Education Research & Development*, vol. 38, ed. 3, pp. 565-578, 2019.

[14] G. Fink, "Stress: definition and history," *Stress Science: Neuroendocrinology*, vol. 3, no. 9, pp. 319-328, 2010.

[15] C. S. Goldman, and E. H. Wong, "Stress and the college student," *Education*, vol. 117, no. 4, pp. 604-611, 1997.

[16] V. H. Rice, "Theories of stress and its relationship to health." In V. H. Rice (Ed.), Handbook of stress, coping, and health: Implications for nursing research, theory, and practice, pp. 22–42. *Sage Publications, Inc*, 2012.

[17] E. Zerbe, G. M. Sallai, K. Shanachilubwa, and C. G. P. Berdanier, "Engineering graduate students' critical events as catalysts of attrition," *Journal of Engineering Education*, vol. 111, no. 4, pp. 868– 888, 2022.

[18] B. A. Burt, Toward a theory of engineering professional intentions: The role of research group experiences, *American Education Research Journal,* vol. 56, ed. 2, pp. 289-332, 2019.

[19] B. N. Böke, D. J. Mills, J. Mettler, and N. L. Heath, Stress and coping patterns of university students, *Journal of College Student Development*, vol. 60, ed. 1, pp. 85-103, 2019.

[20] F. . D., Ampaw and A. J. Jaeger, Completing the three stages of doctoral education: An event history analysis, *Research in Higher Education*, vol. 53, ed. 6, pp. 640-660, 2012

[21] Authors, 2022.

[22] J. C. Greene, V. J. Caracelli, and W. F. Graham, Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, vol. 11, ed. 3, pp. 255–274, 1989.

[23] J. F. Mirabelli, K. Jensen, J. Cromley and S. Vohra, "Conducting the cognitive interview: Sharing experiences and insight from two think aloud studies," *Presented at ASEE Annual Conference and Exposition,* Baltimore, MD 2023.

[24] A. F. Hayes and J. J. Coutts "Use omega rather than Cronbach's alpha for estimating reliability. But…," *Communication Methods and Measures*, vol. 14 no. 1, pp. 1-24, 2020.

[25] S. H. Lovibond and P. F. Lovibond, The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories, *Behavior Research and Therapy*, vol. 33, no. 3, pp. 335-343, 1995.

[26] T. Perez, J. G. Cromley, and A. Kaplan, The role of identity development, values, and costs in college STEM retention, *Journal of Educational Psychology*, vol. 106, ed. 1, pp. 315-329, 2014.

Appendix A

Stressors for Doctoral Students Questionnaire for Engineering (SDSQ–E)

Prompt:

How much do you agree with the following statements about stress? Consider both HOW MUCH (how severe) the stress is, and HOW OFTEN (how frequently) it causes you stress. Please only think about the most recent year of your program when considering how often and how much stress occurred.

Example Question	Frequency Response Options	Severity Response Options
I experience stress trying to balance coursework, research work, teaching or service work, or other graduate-school related responsibilities.	This has never happened to me (coded 1) This has happened but does not bother me (coded 2) Rarely, once per semester or less (coded 3) Monthly, or a few times per semester (coded 4) Sometimes, a few times a month (coded 5) Weekly (coded 6) Multiple times per week (coded 7) Daily (coded 8) Does not apply to me / No basis for judgment (coded NA)	No stress, not bothered at all (coded 1) Low stress, barely bothered or bothered in a minor way (coded 2) Mild stress, being bothered by it has some impact on me (coded 3) Medium stress, I am troubled or bothered in a more considerable way (coded 4) High stress, it bothers me very strongly and interferes with life (coded 5) Extreme stress, unbearable and/or debilitating (coded 6) Does not apply to me / No basis for judgment (coded NA)
I experience stress when it comes to interpersonal interactions with my current advisor (s).	This has never happened to me or has happened but does not bother me Rarely, once per semester or less Monthly, or a few times per semester Sometimes, a few times a month Weekly Multiple times per week Daily Does not apply to me / No basis for judgment	No stress, not bothered at all Low stress, barely bothered or bothered in a minor way Mild stress, being bothered by it has some impact on me Medium stress, troubled or bothered in a more considerable way High stress, it bothers me very strongly and interferes with life Extreme stress, unbearable and/or debilitating Does not apply to me / No basis for judgment

Questions by Theme – Additional Instruction text provided with some themes

Theme: Advisor

1) I feel stress when I have to communicate (e.g., in a meeting, via email/Slack) with my advisor.

2) I feel stress about getting writing feedback from my advisor.

3) I feel stress about the number of hours my advisor expects me to work.

4) I feel stress asking my advisor for vacation time or to take long weekends.

5) I feel stress because of my advisor's mentoring style, (e.g., how hands-on or hands-off they are, or how often they are available to meet with me).

6) I feel stress asking my advisor for help with research problems (e.g., to learn a research technique, or approaching my advisor because an experiment isn't working).

7) I feel stress when I think about whether I have chosen (or if I am choosing) an advisor who is right for me.

Theme: Campus and Personal Life

1) I feel stress finding my preferred groceries on/near campus.

2) I feel stress because of my finances.

3) I feel stress because of the size of my graduate stipend.

4) I feel stress searching for sources of funding on campus.

5) I feel stress when it comes to managing my household (e.g., cleaning, cooking, utilities).

6) I feel stress because I don't feel safe on or around my campus.

7) I feel stress from balancing spending time with my family, friends, or partner with doing work for my doctoral engineering program.

8) I feel stress from conflicts or expectations from family, friends, or partners during my doctoral program.

9) I feel stress from getting around (e.g., driving, walking, taking public transportation) in my local community (e.g., to go shopping, to go to work).

Theme: Classes

In this section, if you have already completed your coursework during your graduate work in your current program, please answer these questions to best describe how you felt while taking classes.

1) I feel stress preparing for tests such as midterms and final exams.

2) I feel stress completing assignments (e.g., presentations, papers, reports) for class.

3) I feel stress balancing coursework with other responsibilities from my graduate program.

4) I feel stress when selecting coursework or navigating my program requirements and curriculum.

5) I feel stress from completing coursework online (e.g., summer online coursework, classes online as a result of COVID-19).

6) I feel stress because of the quality of my professors/instructors.

7) I feel stress when the topic and content of my coursework does not benefit me (e.g., is too specific, not relevant to my research).

8) I feel stress by being unprepared for doing well (e.g., having prerequisite knowledge, having enough knowledge to perform well) in my classes.

Theme – Identity-Related Experiences

If any of these items do not apply to you, please select "Does not apply to me / No basis for judgement".

1) I feel stress by being so far away from my family.

2) I feel stress to have to renew or obtain my visa as an international student.

3) I feel stress from differences between American culture and my own culture.

4) I feel stress from living far away from my home.

5) I feel stress from speaking English as a second language.

6) I feel stress from technical writing in English, as it is not my first language.

Theme: Microaggressions

If any of these items do not apply to you, please select "Does not apply to me / No basis for judgement".

1) I feel stress from being a person of my identity (e.g., my gender, race, culture, sexual orientation, country of origin, etc.) in my doctoral engineering program.

2) I feel stressed from experiencing microaggressions (defined as comments or actions which discriminate subtly, unintentionally, or indirectly) based on my identity in my doctoral engineering program.

3) I feel stress from witnessing or hearing about microaggressions in my doctoral engineering program.

4) I feel stress because I worry about experiencing microaggressions based on my identity in my doctoral engineering program.

Theme: Research/Lab

1) I feel stress from figuring out where my research is going or what direction I want my research to take.

2) I feel stress because my experiments do not work or have unexpected or null results or other challenges (e.g., inability to access required materials, limited lab personnel due to COVID or another reason, etc.).

3) I feel stress interacting with other students in my research group.

4) I feel stress from receiving or needing to receive training on techniques, coding skills, or the use of equipment/apparatuses used in my research group.

5) I feel stress when I am presenting research to my research group (e.g., in weekly group meetings).

6) I feel stress balancing research work with other responsibilities for my graduate program.

7) I feel stress when mentoring or training other students (e.g., graduate students, undergraduate students) in my research group.

8) I feel stress keeping up with weekly research progress.

Theme: Writing

1) I feel stress getting formal, external feedback on my writing from reviewers, editors, journals, conferences, etc.

2) I feel stress having collaborators (e.g., other authors, research group members) edit my writing.

3) I feel stress getting started on writing projects.

4) I feel stress about how the quality of my writing will be perceived.

Theme: Milestones

If you have completed or prepared for any of the milestones in this section, answer these questions to best describe how you felt during the semester or period during which you completed the milestone. If you have not completed these milestones, please select “Does not apply to me / No basis for judgement”.

1) I feel stress from preparing for my qualifying exam.

2) I feel stress from choosing a topic for my thesis/dissertation.

3) I feel stress when I think about interacting with or forming committees for milestones (e.g., qualifying exams, preliminary exam/dissertation proposal, final thesis/dissertation defense) towards my doctoral degree.

4) I feel stress finishing all the classes and credit hours required for me to complete my PhD.

5) I feel stress from preparing for my preliminary exam/dissertation proposal.

6) I feel stress from preparing for my thesis/dissertation defense.

Theme: Work-Life Balance

1) I feel stress balancing my personal life (e.g., time with friends/family/partners, recreation and hobbies, health, cleaning/cooking, and exercise) with other responsibilities from my graduate program.

2) I feel stress due to poor balance between my work and aspects of my personal life, such as hobbies, time with friends/family/partners, health, cleaning/cooking, and exercise.

3) I feel stress when it comes to prioritizing how I spend time on tasks related to my doctoral program (e.g., grading vs homework vs research progress vs writing).

Theme: Self

1) I feel stress from my need to complete every project with the highest quality as I possibly can.

2) I feel stress because I feel like I don't deserve to be in my PhD program.

3) I feel stress because of my sense of perfectionism.

4) I feel stress from trying to accomplish all of my professional goals as a PhD student.

5) I feel stress because I worry about being an imposter or that I don't belong in my PhD program.

Theme: TA

In this section, if you have TA experience from your graduate work in your current program but are not currently teaching, answer these questions to best describe how you felt while being a TA. If any of these items do not apply to you, please select "Does not apply to me / No basis for judgement".

1) I feel stress balancing teaching and grading with my other responsibilities.

2) I feel stress preparing to teach courses (e.g., preparing lecture materials or lab experiments).

3) I feel stress interacting with other instructors (e.g., other TAs, course coordinators) in courses I TA for.

4) I feel stress keeping up with grading based on expectations laid out for my TA assignment.