Board 405: The Stressors for Doctoral Students Questionnaire (SDSQ): Year 3 of an RFE Project on Understanding graduate Engineering Student Well-Being and Retention

Jennifer Cromley, University of Illinois Urbana-Champaign

Jennifer Cromley is Professor of Educational Psychology at the University of Illinois at Urbana-Champaign. Her research focuses on two broad areas: achievement/retention in STEM and comprehension of illustrated scientific text

Dr. Karin Jensen, University of Michigan

Karin Jensen, Ph.D. (she/her) is an assistant professor in biomedical engineering and engineering education research at the University of Michigan. Her research interests include mental health and wellness, engineering student career pathways, and engagement of engineering faculty in engineering education research.

Dr. Joseph Francis Mirabelli, University of Michigan

Joseph Mirabelli is a postdoctoral fellow in Biomedical Engineering at the University of Michigan Ann Arbor who researches engineering education. He earned his PhD in Educational Psychology at the University of Illinois at Urbana-Champaign with a focus in Engineering Education. His interests are centered around mentorship, mental health, and retention in STEM students and faculty. Additionally, he helps support the development of new engineering education scholars and researches quality in mixed methods research methodologies.

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Introduction

Researchers have recently increased efforts to explore crisis levels of mental health issues [1] and dropout in graduate education [2]. Doctoral student retention rates across disciplines are poor, with ranging estimates suggesting that as many as half of all doctoral students in the United States drop out of their programs [2], [3]. Engineering students have been documented to be less likely to take advantage of mental health services compared to their peers [4]. These issues were recently claimed to be understudied [5], but efforts to explore the mental-health-related and attrition-related experiences of engineering graduate students have become more common (e.g., [6], [7], [8]).

Our work investigates the implications of stressors on student well-being and retention. Stress has been linked to attrition rates for engineering graduate students [8], [9] and stress has been related to mental health challenges in graduate students [10], [11], [12]. Research has suggested that a relationship exists between doctoral student mental health and attrition, particularly for students exhibiting high anxiety symptoms [11], [13], suggesting that the three phenomena of stress, mental health distress, and attrition are all interrelated. Much of the existing engineering graduate literature regarding stress tends to focus 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.

Prior work in the two years of our grant has explored the landscape of stressors experienced by doctoral students in engineering. Synthesizing literature with our qualitative work in Year 1 of this project, we found eleven categories of stressors related to topics common in the literature such as advising relationships, classes, campus life and finances, milestones, and research work. In Year 1 of this project [14], 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 Year 1 of 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 [15] 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. In this update to the final year of our project, we will present a high-level summary of our most recent year of the study.

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 [14]. In the second year of the study, we developed the SDSQ-E, a measure of stressors in doctoral engineering student experiences, we then analyzed a pilot sample of the SDSQ-E to provide evidence of validity, reliability, and fairness. A high-level overview of this evidence is provided below. The purpose of SDSQ-E is twofold: (1) to predict students' experiences of mental health distress and intention to remain (ITR) in doctoral programs and (2) to measure and compare the severity. In the third year of the study, we administered the survey to a large sample of graduate students at two large, Midwestern universities. We also developed a general form of the survey, the SDSQ-G, which was administered at one university to students including, however the results of that survey are not presented here.

SDSQ-E Data Collection in Years 2 and 3

Pilot tests of the SDSQ-E were administered twice in Year 2, and the results of the fall data collection were presented in last years' grantees poster session [15]. In Year 3, data were collected in the fall from two institutions. The research design and instruments were approved by the Institutional Review Boards of both focal sites before data collection began in both Years 2 and 3.

Participants in Year 2 were $N = 104$ doctoral engineering students in the fall survey. $N = 89$ of students participated in the spring distribution of the survey. Participants completed surveys on the Canvas learning management system, where digital consent was also obtained. 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). Within-survey attrition was a serious issue with this study and $n = 14$ respondents who answered fewer than half of the SDSQ-E items were removed from the response pool during analyses.

Figure 1 shows participant demographics aggregated during Year 2. Additionally, participants self-identified with racial identities, including 32% as White or Caucasian, 37% as Asian or Pacific Islander, 12% as Indian subcontinental, 5% as Hispanic or Latinx, 5% as Arab or Middle Eastern, 1% as Black or African American, 1% as American Native, and 39% did not identify with a racial identity. Participants could select multiple races. The demographics form was optional and completed by only 61% of respondents.

Figure 1: Year 2 Demographics

First-Generation Student Status		Gender Identification		Enrollment Status		Department Size*		Stage in Program**	
First-Generation Student	23%	Female	41%	Domestic Student	44%	Small	43%	Early	34%
First-Generation Graduate Student Only	29%	Male	59%	International Student	56%	Medium	44%	Middle	40%
Not First-Generation Student	48%	Nonbinary	0%			Large	13%	Late	26%

The SDSQ-E consisted of a list of 65 items related to 11 categories of stressors determined by qualitative results in Year 1 and a review of the literature. For each item, participants responded twice on Likert-type scales to indicate the frequency of a stressors' occurrence and the severity of stress caused by each stressor. Additionally, Year 2 participants responded to a psychometric

measure of stress and anxiety [16] and a previously-validated measure of intention to remain in a program [17], modified for doctoral engineering programs.

Full analyses of Year 2 data included descriptive analyses, classical test theory analyses, exploratory factor analyses, and tests of fairness (mean score differences, measurement invariance testing, and tests of differential item functioning). We present a high-level overview of results here to prelude future publications of our full results. Analyses were conducted in R, Version 4.2.1 [18]. Factors in the SDSQ-E are scored by summing the responses to each Item (severity and frequency treated separately) and then by dividing by the number of items in each factor. Our team has published a manual for using and interpreting the SDSQ-E to an online repository (https://www.ideals.illinois.edu/items/128147). This manual also includes the specific items in the SDSQ-E.

In Year 3, $N = 100$ doctoral engineering students from the first focal university and $N = 172$ doctoral engineering students from a second university participated in a larger survey distribution including the SDSQ-E, a general form of the SDSQ, called the SDSQ-G (results not presented here), and several pre-existing psychometrics. Analysis of the Year 3 data is still in progress and not presented in this update.

Preliminary Results

We present preliminary results from the combined fall and spring pilot survey administration in Year 2. Table 1 summarizes each measure in terms of reliability evidence. Given the large factor structure of the data, McDonald's omega reliability scores, using SEM [19] were calculated, along with the more commonly used Cronbach's alpha.

Table 1. 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	.90	.94	.89	.92	7
Campus Life Stressors	.91	.93	.91	.93	9
Class-Taking Stressors	.90	.94	.89	.93	8
Identity-Related Stressors	.87	.94	.84	.91	6
Lab and Research Stressors	.90	.93	.90	.93	8
Microaggression-Related Stressors	.89	.93	.94	.96	4
Milestone Stressors	.90	.94	.87	.91	6
Self-Related Stressors	.88	.93	.89	.93	5
TA and Teaching Stressors	.91	.93	.89	.95	4

Work-Life Balance Stressors	.91	.91	.90	.91	3
Writing-Related Stressors	.89	.93	.85	.88	4

To investigate the behavior of the SDSQ-E subscales, table 2 provides correlations of the SDSQ-E subscales. Table 3 provides correlations of the SDSQ-E subscales with the DASS 21 Stress and Anxiety psychometric subscales and the ITR subscale administered.

Table 2: Correlations between SDSQ-E subscale scores (severity scores used)

	Adv	Camp	Class	Ident	Micro	Lab	Writ	Mile	Self	TA	WLB
Advisor	–	*	*	*	*	*	*	*	*	*	*
Camp	.467	–	*	*	*	*	*	*	*	*	*
Classes	.577	.645	–	*	*	*	*	*	*	*	*
Identity	.275	.484	.306	–	*	*	*	*	*	*	*
Micro	.350	.522	.367	.384	–	*	*	*	*	*	*
Lab/ Research	.737	.568	.605	.380	.405	–	*	*	*	*	*
Writing	.481	.593	.587	.510	.495	.629	–	*	*	*	*
Mile	.547	.476	.569	.420	.462	.576	.672	–	*	*	*
Self	.569	.596	.640	.333	.373	.700	.618	.476	–	*	*
TA	.618	.615	.730	.285	.452	.678	.688	.584	.634	–	*
WLB	.565	.698	.659	.378	.390	.746	.510	.445	.723	.674	–

Note: Correlation between Stress and Anxiety was .640, with Stress and ITR was -.099, and with Anxiety and ITR was -.067.

Table 3: Correlations between SDSQ-E severity subscales and stress, anxiety, and ITR

	Stress	Anxiety	ITR
Advisor	.359	.483	-.206
Camp	.313	.382	-.095
Classes	.417	.359	-.228
Identity	.147	.312	-.138
Micro	.284	.424	-.058
Lab/ Research	.427	.508	-.175
Writing	.222	.329	-.060
Mile	.220	.330	.030
Self	.486	.451	-.189
TA	.440	.512	-.138
WLB	.525	.496	-.141

Note: Correlation between Stress and Anxiety was .640, between Stress and ITR was -.099, and between Anxiety and ITR was -.067.

Exploratory factor analysis results are not presented here, but to summarize, given the lower-than optimal participant count, factor analysis techniques will not be fully reliable until incorporating the Year 3 data. Doing an exploratory factor analysis on the limited Year 2 sample yielded an adequate KMO criterion and six latent factors, in which several of the SDSQ-E subscales, while theoretically distinct under different categories of stressors, loaded together. For example, one category of the SDSQ-E is writing-related stressors, this subscale loaded onto the lab/research stressors and the class stressors, potentially because of which environments participants were doing writing projects in.

Finally, differential item functioning (DIF) and mean difference testing suggested the following differences between participants between demographics we had the statistical power to analyze:

For men and women, two items significantly differed in terms of DIF: Campus #5 and Identity #2. Additionally, the means for microaggression stressors were significantly different, 1.96 for women and 1.08 for men. Generally, the mean stress was higher for women, however this was rarely a significant difference. For example, women reported a mean severity score of 3.26 for milestones against a mean score of 2.68 for men, an increase of over half a point. However, a Wilcoxon rank sum test shows that those means are not significantly different ($p = 0.126$).

For historically racially marginalized (HM) vs. non-HM participants, DIF testing suggested that Campus #5, Identity #2-4 and 6, and all Microaggression items significantly differed. Additionally, the identity and microaggression means were significantly different for both subscales. Similar to trends for gender, HM/non-HM mean differences generally suggested that there was higher stress for the HM population, however the mean differences were generally non-significant.

Using Kruskal-Wallis tests, we found no difference in means between groups based on aggregated department sizes and found stage in program (early being before qualifying exams and late being after preliminary exams) only to be significant for late-stage students' teaching assistant experiences.

For international students, the mean identity score was approximately double that of the typical domestic student, while for other subscales, the two were generally comparable. Interestingly, international students scored lower (e.g., reported less severe stress) for microaggressions compared to domestic students.

Discussion

As presented above, completed analyses of the Year 2 data suggests that all scales exhibit good to strong internal consistency of at least 0.7 for Cronbach's alpha and extremely good consistency for McDonald's omega [19]. These stressors are mostly moderately correlated, with a few weaker correlations (e.g., advisor with identity) and a few strong correlations (e.g., advisor with lab/research stressors, class stressors with TA stressors). One interesting note is that a student's overall stress or anxiety symptoms as measured by the DASS 21 psychometric test was more weakly associated with intention to remain than many of the SDSQ-E subscales, suggesting that measuring stressors impacting students' doctoral working environments may be more important to predicting student wellness and retention.

Preliminary work into investigating Year 3 stressors has suggested that these trends hold.

Future Work and Products

Future work will include dissemination of the results of our full study and the conclusion of analyses from data gathered in Year 3. Two book chapters are currently in press regarding qualitatively-measured stressors related to the advising relationship [20] and stressors that arose due to the COVID-19 pandemic [21]. Two journal articles are currently in revision regarding the Year 1 data and results, and a qualitative case study of bioengineering students within our sample. Two additional papers drawing from our qualitative results related to participant retention and perceptions of student roles such as teaching versus research assistantships are

planned. We are currently preparing a manuscript that describe the analysis and validation of the survey work in Years 2-3, including an analysis of reliability, fairness, and validity evidence from the spring data collection, an exploratory and confirmatory factor analyses of the two pilot surveys, and demonstrations of the predictive and correlative power of the SDSQ with other previously validated measures, including mental health psychometrics [16], a scale of intention to remain in programs [17], and other constructs such as engineering culture [22], and quality of social relationships. Additionally, we have made our qualitative coding scheme and interviews publicly available for researchers to replicate or extend our work at the following link:

https://www.ideals.illinois.edu/items/126312 [23].

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