Work in Progress: Understanding Student Perceptions of Stress as Part of Engineering Culture

Dr. Karin Jensen, University of Illinois, Urbana-Champaign

Karin Jensen is a Teaching Assistant Professor in bioengineering at the University of Illinois at Urbana-Champaign. Before joining UIUC she completed a post-doctoral fellowship at Sanofi Oncology in Cambridge, MA. She earned a bachelor's degree in biological engineering from Cornell University and a Ph.D. in biomedical engineering from the University of Virginia.

Dr. Kelly J. Cross, University of Illinois, Urbana-Champaign

Dr. Cross completed her doctoral program in the Engineering Education department at Virginia Tech in 2015 and worked as a post-doctoral researcher with the Illinois Foundry for Innovation in Engineering Education at the University of Illinois at Urbana-Champaign. At UIUC she has collaborated with multiple teams of engineering faculty on implementing and assessing instructional innovation. Dr. Cross is currently a Research Scientist in the Department of Bioengineering working to redesign the curriculum through the NSF funded Revolutionizing Engineering Departments (RED) grant. She is a member of the ASEE Leadership Virtual Community of Practice that organizes and facilitates Safe Zone Training workshops. Dr. Cross has conducted multiple workshops on managing personal bias in STEM, both online and in-person. Dr. Cross' scholarship investigated student teams in engineering, faculty communities of practice, and the intersectionality of multiple identity dimensions. Her research interests include diversity and inclusion in STEM, intersectionality, teamwork and communication skills, assessment, and identity construction. Her teaching philosophy focuses on student centered approaches such as problem-based learning and culturally relevant pedagogy. Dr. Cross' complimentary professional activities promote inclusive excellence through collaboration.

©American Society for Engineering Education, 2018

Work in Progress: Understanding Student Perceptions of Stress as part of Engineering Culture

Introduction

High levels of stress and anxiety are common amongst college students, particularly engineering students. Students report lack of sleep, grades, competition, change in lifestyle, and other significant stressors throughout their undergraduate education [1,2]. Stress and anxiety have been shown to negatively impact student experience [3-6], academic performance [6-8], and retention [9]. High levels of stress and anxiety can further contribute to mental health disorders that are prevalent for college students [5,10]. Mental health disorders have been rising in prevalence and severity for college students and are a major concern in higher education [11]. Previous studies have shown that while some intervention methods can be beneficial for students experiencing significant stress and/or suicidal thoughts, the majority of students do take advantage of these resources [12,13]. Previous studies have focused on identifying factors that cause individual students stress while completing undergraduate engineering degree programs [1]. However, it not well-understood how a *culture of stress* is perceived and is propagated in engineering programs and how this impacts student levels of identification with engineering. Further, it is has not been explicitly studied how a culture of stress impacts student recruitment, retention, and success in engineering programs.

Students attribute different characteristics to their programs and disciplines, both before and after entering a degree program [14]. Peer interactions can have significant impact on student experiences in engineering [15] such as team interactions [16,17]. Students are socialized into the engineering culture and propagate this culture to incoming students through their interactions and the specific advice that they provide about courses, instructors, and the departmental norms. Culture and perceived norms for programs are important for students to feel a sense of belonging. In a 2012 study of engineering students, feeling a "lack of belonging" in engineering was cited as a top reason for students to leave the program [18]. Students can develop and promote a culture of stress within the student body by attributing stress as a group characteristic ("we work hard" or "we are always stressed out—that's just the way we are") or social norm. Describing stress as a norm for the group has numerous detrimental effects to student recruitment, retention, and success. Students describing engineering or particular engineering majors as a "high stress" group gives the false impression that only a certain student profile or personality is accepted, valued, or successful in engineering or a specific engineering disciplines. This false narrative and exaggerated impression risks discouraging participation or creates a barrier to student engineering identity development which may vary by engineering disciplines, irrespective of student ability.

The engineering program at the institution of study has a notorious national reputation of being competitive and rigorous (see institutional context below). In this intense environment, the perception that high levels of stress and anxiety are part of the culture in engineering academics may discourage students from pursuing engineering degrees at the undergraduate and graduate levels. Attributing stress to be characteristic of engineering students may negatively impact the success of students currently enrolled in engineering programs and deter them from continuing to pursue engineering in graduate school or from entering engineering careers. Feeling overwhelmed due to pace and workload in coursework was a top reason cited by students for leaving STEM programs[19]. Stress and anxiety portrayed as a norm within the program culture

may cause students to feel the need to adopt additional feelings of stress and anxiety in an effort to feel included in the group. In other words, accepting the stress culture may be an "ingroup norm" that current students pass on to incoming students. In a 2012 study of college students, belief that stress is the norm was the second most commonly cited reason for students to not seek treatment for mental health disorders [13]. Students who feel that the levels of stress and anxiety are unmanageable may assume coping strategies they are not fit for the program and could choose to leave engineering instead of seeking support to manage their stress and anxiety.

Stress associated with engineering or attributed as being part of a culture may discourage students from seeking coping support to alleviate stress and anxiety by making them feel it is normal or even necessary for success within the discipline or major. Since many college students experiencing suicidal thoughts typically do not seek interventions [13,20] this could be particularly problematic for engineering. Perceptions of a stress culture in engineering may exacerbate individual student feelings of stress and anxiety, especially for students susceptible to anxiety disorders and those who lack social support or confidence in their abilities to perform in the program. This is particularly concerning for students who already experience higher levels of stress than their peers due to confounding and interrelated factors, such as racial microaggressions. Stress similar to microaggressions, have cumulative effects that are not simply additive. For example, being a female student of color at a predominantly white institution has also been linked to increased stress levels [21,22], which implies that stress may impact or interact with multiple dimensions of students' identity simultaneously.

Methods

Conceptual Framework

The proposed study is grounded in social identity theory as defined by Henri Tajfel. Social identity is the individual's sense of self based on their membership in certain groups [23]. Importantly, student engineering identity has been shown to be positively correlated with persistence and success in engineering [24]. Conversely, stress and identity have been shown to be negatively correlated for undergraduates (outcomes, performance, academic success, retention, achievement) [6]. Given the importance of student formation of engineering identity, we seek to understand how stress is part of the socialization process of engineering education and how this impacts student perceptions of identity and inclusion. We use social identity theory to understand this group dynamic and individual self-perceptions.

Social Identity Theory (SIT) is a broad social psychology theory of the role of self and identity within group and intergroup interactions. SIT was originally developed by Henri Tajfel based on his work and passion to understand societal conflict including prejudice, discrimination, and intergroup conflict. In fact Tajfel defined social identity as both cognitive and evaluative terms where group knowledge and behaviors directly impact the value and emotional significance of the group membership [25] or group norms [26]. Another component of social identities is the context dependence where different dimensions of self and identity become more salient in varying interpersonal interactions. Finally, SIT clarifies the differences between ingroup behaviors compared to outgroup behaviors through social comparison. The social comparison between groups is evidenced by the value placed on one's own group (i.e. ingroup bias) and the positive values derived from that group membership. For example, ingroup behaviors are seen as more desirable or socially acceptable than outgroup member behaviors. The combination of the components of SIT has been an analytical tool of the process responsible

for the recognition, construction, and internalization of group norms which has been applied in a wide range of social and psychological research studies [27].

SIT has been used to study both group relations and self-categorization to understand intergroup behaviors such as conflict, cooperation, and social change. For example, Hogg &Reid articulated the role of social identity in communicative group norms [26]. The authors conclude that group norms are not fixed phenomenon, but they are fluid and context dependent [26]. Other SIT studies include the group behavior of trust and found that group membership was a strong predictor of trusting behaviors [28]. SIT has also been related to intergroup conflict [27] and intergroup discrimination [25]. Also, social identity has been used to study student interactions on a college campus [29]. In the current study, we differentiate ingroup and outgroup behaviors where ingroup members include engineering students with high levels of identification with engineering. Also, the level of stress and perceptions of inclusion will identify emergent clusters of ingroup and outgroup members. Overall, SIT provides an insightful approach to investigate the role self-concepts and engineering identity development that may be influenced by stress or other social features of the engineering culture.

The **objectives** of the current study are to 1) understand how students perceive and experience engineering stress culture (ESC) and how this differs across engineering disciplines and 2) illuminate the relationships between anxieties, stress, perceptions of inclusion, and identification with their engineering major. Towards the goal of understanding the ESC and its impact on students, our study will investigate how ESC emerges at the intersection of academic and social identities. We postulate that ESC develops when stress permeates both academic (e.g., unspoken curriculum challenges) and social normative contexts in engineering (e.g. peer interactions and perception of competitiveness). Our study will address the overall research question: **How does the ESC impact students' perception of their engineering discipline or their level of identification with engineering?**

The study described here is part of a sequential mixed methods study that will use quantitative surveys to inform qualitative interviews. In the current paper we describe our quantitative survey results to answer the following question: **What is the relationship between engineering students' level of identification with their major and their perceptions of anxiety, stress, and inclusion?** Student experience of ESC will be measured with three existing surveys to capture stress and anxiety, engineering identity, and inclusion (Figure 1). Data collected from these surveys will be analyzed to define the relationships between stress and anxiety, engineering identity, and perception of inclusion for engineering students. Additionally, demographic data from the surveys will be used to identify factors that modify these relationships (e.g. major, gender, class, first-generation).

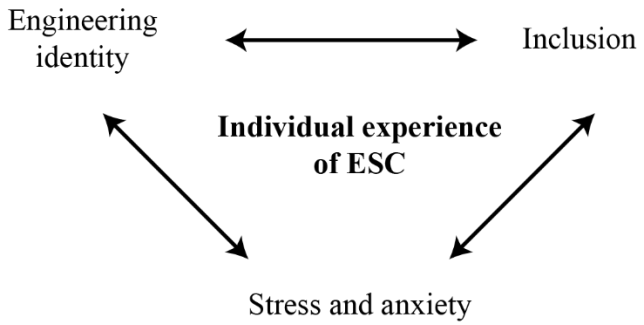

Figure 1. Students' individual experience of ESC was measured by surveying self-reported levels of engineering identity, sense of inclusion, and stress and anxiety.

Data Collection

Institutional context

The study was conducted at a large, public university. The admission criteria for each department varies but overall the college of engineering is highly competitive (the average ACT score of admitted students is 32).

Participants

We employed convenience sampling to survey undergraduate students enrolled in the college of engineering (N = 1203). All students enrolled in engineering were contacted by email and were invited to participate in the survey. Requirements for participating in the survey were undergraduate student status in engineering. The response rate was approximately 16% of the total student body. The identity of the participants was protected according to IRB requirements. Participants were offered a $5 Amazon.com gift card for participating. Over 75% of the sample population reported that English as their first language. Approximately 85% of the sample population reported that they are first generation college students. Participant demographics is shown in Tables 1-4.

Table 1. Self-Selected Racial/Ethnic Background

	Frequency	Percent
American Indian or Alaskan Native	3	0.3
Asian	144	13.7
Black or African American	15	1.4
Hispanic American	48	4.6
Multiple ethnicity/Other	322	30.7
White/Caucasian	516	49.2

Table 2. Self-Selected Socioeconomic Status (SES)

	Frequency	Percent
Upper class	49	4.7
Upper middle class	439	41.8
Middle class	428	40.8
Lower middle class	99	9.4
Below middle class	35	3.3

Table 3. Self-Reported Gender

	Frequency	Percent
Female	335	31.9
Male	709	67.6
Other	5	0.5

Table 4. Self-Reported Student Majors

		Frequency	**Percent**
Aerospace Engineering		79	7.5
Agricultural and Biological Engineering		24	2.3
Bioengineering		66	6.3
Chemical and Biomolecular Engineering		3	0.3
Civil and Environmental Engineering		105	10.0
Computer Engineering		159	15.1
Computer Science		139	13.2
Electrical Engineering		127	12.1
Engineering Physics		29	2.8
Industrial Engineering		48	4.6
Materials Science and Engineering		53	5.0
Mechanical Engineering/Engineering Mechanics		140	13.3
Nuclear, Plasma, and Radiological Engineering (NPRE)		24	2.3
Other		22	2.1
Systems Engineering and Design (formerly General Engineering)		33	3.1
	Total	1051	100.0

Instruments

Quantitative surveys captured demographic data (e.g. gender, major, first-generation status) in addition to measures of student identification, perceptions of inclusion, and stress and anxiety levels. By surveying students across all classes (freshman, sophomores, juniors, and seniors) and majors we will be able to identify relationships between identity dimensions, inclusion, and stress for engineering students and also investigate if these relationships vary for certain disciplines. Student identity levels with engineering and their specific engineering discipline was

measured by the Identification with Academics subscale translated to engineering. Sample items include “Being good at engineering is an important part of who I am” and “It matters to me how I do in engineering school”. Each item is rated on a Likert scale from (1) Strongly disagree to (7) Strongly agree [30]. Student perceptions of inclusion was measured using the Engineering Department Inclusion Level (EDIL) Survey. Sample items include “I belong in this department” and “I like being an engineering student in this department”. Each item is rated on a Likert scale from (1) Strongly disagree to (6) Strongly agree [31]. Stress, anxiety, and depression levels experienced by students was assessed with the Depression Anxiety Stress Scales (DASS21). Sample items include “I found it hard to wind down” and “I felt that I was using a lot of nervous energy”. Each item is rated on a Likert scale from (0) “Did not apply to me at all” to (3) “Applied to me very much, or most of the time” [32].

Data Analysis

Cronbach’s alpha scores were calculated to validate the subscales and compare to previously published work. Pearson correlations between constructs to test the relationship between subscales. All analyses were conducted using SPSS software.

Results

Reliability of the quantitative survey subscales was tested by calculating Cronbach’s alpha scores for each subscale in the survey (Table 7). Based on these values, we determined the survey subscales were valid for our sample. The results were also consistent with previous research studies.[30,31,33]

The survey indicated high levels of stress, anxiety, and depression for engineering students with 22.4% of students reporting moderate to severe stress, 29.9% reporting moderate to severe anxiety, and 29.9% moderate to severe depression. Concerningly, 12.8% of participants reported depression categorized as severe or extremely severe. Further, 9.9% of the participants reported stress levels categorized as severe or extremely severe and 14.1% of the participants reported anxiety levels categorized as severe or extremely severe.

Table 5. Descriptive Statistics Summary of Instrument Subscales[1]

	N	Minimum	Maximum	Mean	Std. Deviation	Cronbach's alpha
Eng_Idty	1018	1.00	7.00	5.7677	1.25957	0.889
DeptCaring	1020	1.00	6.00	4.3076	0.90196	0.947
DeptDiversity	1019	1.00	6.00	4.6806	0.97552	0.769
DeptPride	1020	1.00	6.00	4.8810	0.97301	0.848
Stress	1023	0.00	42.00	13.9277	9.25348	0.845
Anxiety	1022	0.00	42.00	8.2955	8.51126	0.839
Depression	1022	0.00	42.00	11.3953	10.00285	0.895

[1] Subscale abbreviations used are as follows: Engineering Identity Scale (Eng_Idty), Engineering Department Inclusion Level Department Caring, Pride, and Diversity Subscales (DeptCaring, DeptDiversity, DeptPride), and DASS21 Stress, Anxiety, and Depression subscales (Stress, Anxiety, Depression).

Table 6. Correlations of Subscales[2]

	Eng_Idty	DeptCaring	DeptDiversity	DeptPride	Stress	Anxiety	Depression
Eng_Idty	1						
DeptCaring	**.235****	1					
DeptDiversity	**.159****	**.428****	1				
DeptPride	**.347****	**.688****	**.374****	1			
Stress	0.049	**-.162****	**-.091****	**-.117****	1		
Anxiety	0.014	**-.120****	**-.114****	**-.132****	**.736****	1	
Depression	**-.071***	**-.276****	**-.140****	**-.288****	**.646****	**.638****	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on the correlations of the survey subscales, across all survey respondents, engineering identity was positively correlated with measures of department caring, department diversity, and department pride and was negatively correlated with depression. Engineering identity was not correlated with stress or anxiety for the sample population. Measures of inclusion, as measured by the EDIL Department Caring, Department Pride, and Department Diversity subscales were significantly negatively correlated with stress, anxiety, and depression as measured by the DASS21 instrument.

Discussion

Understanding what students view as stressful and how students identify stress as an element of program culture will support the development of interventions to mitigate student stress and improve student recruitment, retention, and success. Our study indicated high percentages of students experiencing moderate to severe levels of stress, anxiety, and depression. Further, stress, anxiety, and depression were significantly negatively correlated with measures of department inclusion as measured by the Department Caring, Department Pride, and Department Diversity subscales of the EDIL survey instrument. These relationships between measures of department inclusion and stress, anxiety, and depression emphasize the importance of culture in engineering departments.

Conclusions and Future Work

In this paper we report a survey of undergraduate engineering students (N=1203) designed to assess student stress, anxiety, depression, engineering identity, and department inclusion and the relationships between these constructs. The survey subscales were validated by testing Cronbach's alpha scores which demonstrated internal consistency across the question sets for each subscale and were comparable to previous studies. We report several key findings from the survey results. We report that in our sample engineering identity was positively correlated with department inclusion and negatively correlated with depression. The Department Inclusion measures (Department Caring, Department Diversity, and Department Pride) were all

[2] Abbreviations are as defined for Table 5.

significantly correlated with stress and anxiety, suggesting that stress is a significant part of the engineering culture.

Ongoing analysis of the quantitative surveys will further explore the differences across engineering disciplines and student groups. The survey also included an open-ended response component that will also be analyzed for themes and in the context of the survey subscale results. We also plan to use the quantitative survey data to identify candidates for interviews to further understand the relationship of stress, engineering identity, and engineering culture. Interviews will allow participants to describe their individual experiences and allow us to identify common themes and triggers of student stress, anxiety, and depression as related to being an engineering student.

Ultimately, the results of the study will produce recommendations for faculty, advisors, and administrators, who directly impact the climate and reputation of engineering programs. As students identify sources of stress within the engineering culture, we can develop strategies to manage or interventions to modify the salient feature of the culture promoting stress and anxiety among the students. Training could be informed by the proposed study to improve help faculty, advisors, and administrators understand how stress is impacting student engineering identity and sense of inclusion and how advisors can discuss these effects with their students and avoid unintentional cues of ESC. For example, we can specify approaches where academic advisors minimize the stress of selecting courses for individual students. This information can create models that other institutions can model and implement into their local context. Lowering the perception of stress as part of engineering culture stress perception can also attract more students from marginalized groups.

References

1 Schneider, L. in *A Paper Presented at St. Lawrence Section Conference. Toronto, Canada. Retrieved from: www. asee. morrisville. edu.*

2 Ross, S. E., Niebling, B. C. & Heckert, T. M. Sources of stress among college students. *Social psychology* **61**, 841-846 (1999).

3 Goldman, C. S. & Wong, E. H. Stress and the college student. *Education* **117**, 604-611 (1997).

4 Hudd, S. S. *et al.* Stress at college: Effects on health habits, health status and self-esteem. *College Student Journal* **34**, 217-228 (2000).

5 Macgeorge, E. L., Samter, W. & Gillihan, S. J. Academic Stress, Supportive Communication, and Health A version of this paper was presented at the 2005 International Communication Association convention in New York City. *Communication Education* **54**, 365-372 (2005).

6 Burt, K. B. & Paysnick, A. A. Identity, stress, and behavioral and emotional problems in undergraduates: Evidence for interaction effects. *Journal of college student development* **55**, 368-384 (2014).

7 Felsten, G. & Wilcox, K. Influences of stress and situation-specific mastery beliefs and satisfaction with social support on well-being and academic performance. *Psychological Reports* **70**, 291-303 (1992).

8 Pritchard, M. E. & Wilson, G. S. Using emotional and social factors to predict student success. *Journal of college student development* **44**, 18-28 (2003).
9 Zhang, Z. & RiCharde, R. S. Prediction and Analysis of Freshman Retention. AIR 1998 Annual Forum Paper. (1998).
10 Dyson, R. & Renk, K. Freshmen adaptation to university life: Depressive symptoms, stress, and coping. *Journal of clinical psychology* **62**, 1231-1244 (2006).
11 Hunt, J. & Eisenberg, D. Mental health problems and help-seeking behavior among college students. *Journal of Adolescent Health* **46**, 3-10 (2010).
12 Regehr, C., Glancy, D. & Pitts, A. Interventions to reduce stress in university students: A review and meta-analysis. *Journal of affective disorders* **148**, 1-11 (2013).
13 Downs, M. F. & Eisenberg, D. Help seeking and treatment use among suicidal college students. *Journal of American College Health* **60**, 104-114 (2012).
14 Smart, J. C., Feldman, K. A. & Ethington, C. A. *Academic disciplines: Holland's theory and the study of college students and faculty*. (Vanderbilt University Press, 2000).
15 Tonso, K. L. in *Cambridge handbook of engineering education research* (eds Aditya Johri & Barbara M. Olds) Ch. 14, 267-282 (Cambridge University Press, 2014).
16 Kapp, E. Improving student teamwork in a collaborative project-based course. *College Teaching* **57**, 139-143 (2009).
17 Cross, K. J. The Experiences of African-American Males on Multiracial Student Teams in Engineering. (2015).
18 Marra, R. M., Rodgers, K. A., Shen, D. & Bogue, B. Leaving Engineering: A Multi-Year Single Institution Study. *Journal of Engineering Education* **101**, 6-27 (2012).
19 Seymour, E. & Hewitt, N. M. Talking about leaving: Why undergraduates leave the sciences, 1997. *Boulder, CO: Westview*.
20 Garlow, S. J. *et al.* Depression, desperation, and suicidal ideation in college students: results from the American Foundation for Suicide Prevention College Screening Project at Emory University. *Depression and anxiety* **25**, 482-488 (2008).
21 Neville, H. A., Heppner, P. P., Ji, P. & Thye, R. The relations among general and race-related stressors and psychoeducational adjustment in Black students attending predominantly White institutions. *Journal of Black Studies* **34**, 599-618 (2004).
22 Johnson, D. W., Johnson, R. T. & Smith, K. The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review* **19**, 15-29 (2007).
23 Tajfel, H. & Turner, J. C. The Social Identity Theory of Intergroup Behavior. (2004).
24 Meyers, K. L., Ohland, M. W., Pawley, A. L., Silliman, S. E. & Smith, K. A. Factors relating to engineering identity. *Global Journal of Engineering Education* **14**, 119-131 (2012).
25 Spears, R. in *Handbook of identity theory and research* 201-224 (Springer, 2011).
26 Hogg, M. A. & Reid, S. A. Social identity, self-categorization, and the communication of group norms. *Communication theory* **16**, 7-30 (2006).
27 Hogg, M. A. in *Understanding Peace and Conflict Through Social Identity Theory* 3-17 (Springer, 2016).
28 Tanis, M. & Postmes, T. A social identity approach to trust: Interpersonal perception, group membership and trusting behaviour. *European Journal of Social Psychology* **35**, 413-424 (2005).

29 Sidanius, J. *The diversity challenge : social identity and intergroup relations on the college campus*. (Russell Sage Foundation, 2008).
30 Jones, B. D., Paretti, M. C., Hein, S. F. & Knott, T. W. An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans. *Journal of Engineering Education* **99**, 319-336 (2010).
31 Lee, W. C., Matusovich, H. M. & Brown, P. R. Measuring underrepresented student perceptions of inclusion within engineering departments and universities. *International Journal of Engineering Education* **30**, 150-165 (2014).
32 Lovibond, S. & Lovibond, P. (Sydney, 1993).
33 Henry, J. D. & Crawford, J. R. The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British journal of clinical psychology* **44**, 227-239 (2005).