

Predictors of Test Anxiety in Undergraduate Engineering Students

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Introduction

Anxiety disorders are the most common mental health disorders in the United States, with 29% of adults meeting criteria for an anxiety disorder at some point in their lives (Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). College students are particularly at risk for developing anxiety disorders (Pariat, Rynjah, & Joplin, 2014), and evidence suggests anxiety is the most common problem students face (CCMH, 2018). Test anxiety is a specific form of state anxiety that can occur in any stage of the learning-testing cycle, including test preparation, test performance, or test reflection (Cassady, 2004). It is frequently broken down into four parts: worry and test-irrelevant thinking (often combined as "cognitive"), and tension and bodily symptoms (often combined as "emotionality"; Benson & El-Zahhar, 1994). During test preparation, students with test anxiety often report cognitive symptoms such as poor study skills and habits. During tests, high-anxiety students can experience all types of test anxiety, manifested, for example, as a racing heartbeat, one's mind going blank, or getting distracted during the exam. Finally, following an exam, students with test anxiety report higher levels of helplessness and worry about mistakes or how one will perform on the next exam (Cassady, 2004). This type of anxiety effects between 10-40% of college students (Lowe, 2015) and is associated with a variety of negative outcomes including reduced academic achievement (Cassady, 2004). Little research has been conducted on anxiety in Engineering students, and no research has been done looking at predictors of test anxiety specifically in Engineering students.

These results are part of a larger study testing whether mastery-based STEM education can reduce test anxiety among engineering students. The purpose of this arm of the study was to determine the factors that predict test anxiety in undergraduate engineering students. The major research question was: Are there specific factors that predispose undergraduate engineering students to develop test anxiety?

Method

Participants

The current study looked at undergraduate students at a small, liberal arts college ($N = 66$, 72.7% male, 86.4% White) enrolled in at least one of three engineering courses: Circuit Analysis (EGR210), Statics (EGR260), and Dynamics (EGR360). Students in these three classes were recruited to take part in this study. Participant demographics were representative of the overall population of engineering majors.

Instruments

Survey measures consisted of The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970), the Revised Test Anxiety Scale (RTAS; Benson & El-Zahhar, 1994), the Engineering Identity Scale (Godwin, 2016), and demographic items.

Procedure

After providing informed consent, participants completed the survey measures during one of the first four class meeting periods of the Fall 2018 semester.

Results

Participants reported levels of state anxiety in the 68th percentile for male and 58th percentile for female college students ($M = 39.4$, $SD = 10.67$). Trait anxiety levels, however, were quite high relative to published norms ($M = 50.8$, $SD = 2.53$), rating in the 88th/85th percentile (M/F) for college students. Test anxiety scores ($M = 52.9$, $SD = 15.06$) were significantly higher than a published sample of British college students ($M = 45.2$, $SD = 15.58$, $p < .001$, $d = 0.50$; Putwain, Woods, & Symes, 2010).

A multiple regression analysis examined the relationship between test anxiety and its potential predictors (see Table 1). Significant predictors of higher test anxiety were increased levels of state anxiety ($p < .001$) and higher levels of engineering interest ($p < .001$). Identifying as a racial minority and lower levels of engineering competence ($p = .08$) approached significance. Given the apparent relationships between engineering identity and test anxiety, we decided to conduct an exploratory analysis of demographic predictors of the engineering identity subscales.

Table 1. Regression analysis predicted test anxiety score

Source	B	SE	β	t	p
Constant ^a	30.39	36.23	--	.84	.41
Upperclassmen	-2.51	2.79	-0.08	-.90	.37
White	-7.19	4.00	-0.17	-1.80	.08
First Generation Status	5.04	3.75	0.13	1.35	.18
Male	2.19	3.28	0.07	.67	.51
Parent who works in STEM field	-1.90	2.12	-0.09	-.90	.37
State Anxiety	0.83	0.15	0.59	5.43	< .001
Trait Anxiety	-0.57	0.63	-0.10	-.91	.39
Engineering Identity: Recognition	0.01	0.48	0.00	.02	.99
Engineering Identity: Interest	2.61	0.68	0.38	3.83	< .001
Engineering Identity: Competence	-0.82	0.47	-0.19	-1.77	.08

Note: ^aReference category = female, underclassmen of color who do not identify as first-generation and do not have a parent who works in a STEM field.

A four-way multivariate analysis of variance (MANOVA) found no significant main effects, but there was a significant three-way interaction between race, first-generation status, and class (Wilks's $\Lambda = .847$, $F(3,50) = 3.01$, $p = .04$). The follow up univariate analyses found no significant results, but engineering competence came close ($p = .08$; see Figure 1). This may mean that the MANOVA finding was a type 1 error, or it may be an issue of power. The interaction showed first-generation students of color start college feeling more competent than they finish, whereas continuing-generation students of color get marginally more competent as they get more educated. First-generation White students have marginally lower competence than continuing generation White students for both upper and lower classmen.

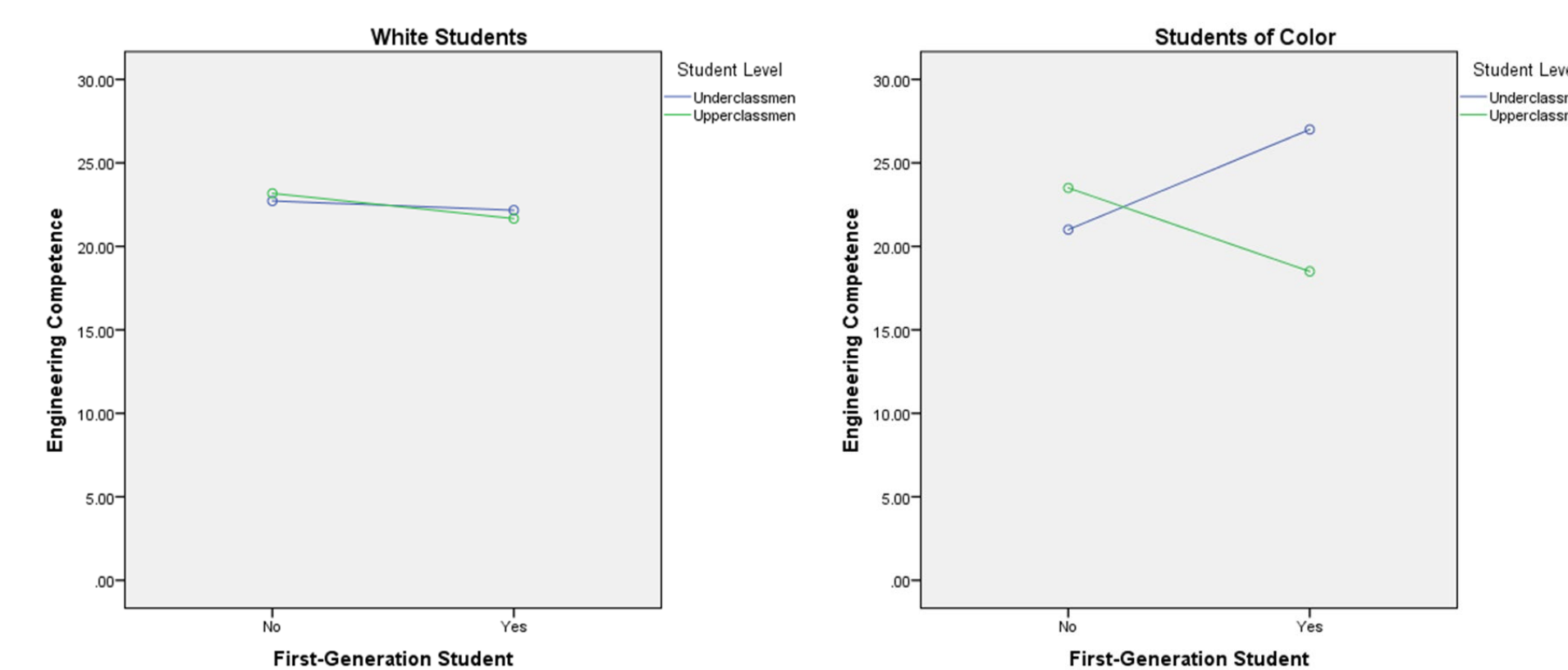


Figure 1. Three-way interaction for differences in self-reported engineering competence based on student racial identity, first-generation status, and academic level.

Discussion

Findings

The interaction showed first-generation students of color start college feeling more competent than they finish, whereas continuing-generation students of color get marginally more competent as they get more educated. There are a number of possible explanations for this finding.

- First generation students of color experience double minority status. There are often programs for first-generation students during their first year of school, but once they end students lose the support and confidence.
- Another possibility is that as minority first-generation students get older, stereotype threat increases in their higher level classes, meaning the greater pressure to do well leads to decreased confidence.

First-generation White students were found to have marginally lower competence than continuing generation White students for both upper and lower classmen.

Limitations

- One weakness of the current study is the lack of power due to small sample size.
- Another weakness of this study is that the initial measure occurred in a non-testing situation during which students only had the option to think back to previous exam situations instead of experiencing it in the moment.
- The baseline data collection occurred early in the semester when anxiety levels were not at their peak.

Recommendations

Further research should be conducted extending the results of this study with a larger sample size and other institutional settings (e.g., geographic location, state schools, R1 universities) and additional courses. It would be beneficial to capture introductory and capstone courses in the major as well to further understand the range of effects. Future research should focus specifically on the interaction between first-generation status, race, and class.

The next stages of this study will examine how test anxiety evolves over the course of an academic semester and determine if incorporating a mastery-based approach (compared to traditional educational model) can help reduce test anxiety and/or improve course performance in undergraduate engineering students.

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