

Sources of Anxiety among Engineering Students: Assessment and Mitigation

Dr. Paul M. Yanik, Western Carolina University

Dr. Paul Yanik is an Assistant Professor of Electrical and Computer Engineering Technology at Western Carolina University. His areas of research include human-robot interactions, assistive devices, pattern recognition, machine learning, and engineering education.

Dr. Yanjun Yan, Western Carolina University

Yanjun Yan received her B.S. and M.S. degrees in Electrical Engineering from Harbin Institute of Technology (China), and the M.S. degree in Applied Statistics and the Ph.D. degree in Electrical Engineering from Syracuse University. She is an assistant professor in engineering and technology at Western Carolina University. Her research interests are statistical signal processing, diagnostics, and particle swarm optimization.

Prof. Sudhir Kaul, Western Carolina University

Dr. Kaul is an Assistant Professor of Mechanical Engineering at Western Carolina University. His research interests include Fracture Diagnostics, Structural Dynamics and Control, and Motorcycle Dynamics.

Dr. Chip W. Ferguson, Western Carolina University

Chip Ferguson is the Associate Dean of the Kimmel School and Associate Professor of Engineering and Technology at Western Carolina University.

Sources of Anxiety among Engineering Students: Assessment and Mitigation

Abstract

Anxiety stemming from the challenges faced by engineering students has been shown to be a strong predictor of academic performance. Such anxiety may reduce students' self-confidence and result in loss of motivation and diminished cognitive function with associated academic difficulties. Past research to analyze sources and effects of anxiety among engineering students has focused on ways to influence pedagogical strategies over the long term, or to manage certain physiological responses to anxiety. Less common are studies that investigate the efficacy of timely interventions in response to self-reported vulnerabilities and concerns of engineering students. This paper presents data from practical efforts to identify and mitigate anxiety among engineering students. A group of twenty-seven engineering and engineering technology students who were part of a scholarship program was asked to submit journal entries in which they reflected on their fears and anxieties related to their participation in their degree program. Prominent themes which emerged from student reflection included time management and its effects on academics and social activities, the likelihood of degree completion and success in engineering-specific coursework (e.g. senior capstone projects), and aspects of life following graduation such as handling accumulated debt and finding a job. As a cohort, the students participated in periodic vertically-integrated discussion groups with faculty mentors and their peers at multiple levels of seniority, and were introduced to university resources designed to address specific student needs. Results of a follow-on survey suggested that peer-to-peer discussions can be useful in alleviating anxiety on particular topics. It was also observed that the interactions facilitated by these group discussions are helpful in developing a sense of community and shared enthusiasm among the cohort.

Keywords: Engineering student anxiety, Remediation

1. Introduction

Sources of anxiety among engineering and engineering technology students may stem from both academic and non-academic demands and generalized uncertainties regarding the road ahead. Such anxiety may lead to compromised student self-efficacy^{1,2} manifesting itself as reduced motivation, concentration, or reasoning capability.³ These symptoms often lead to a loss of confidence in engineering abilities and may reduce commitment to engineering degree programs, resulting in lower retention⁴. Various studies have been conducted which analyze the direct effects of both academic and non-academic sources of anxiety in engineering programs such as curriculum requirements, academic readiness (e.g. study skills), personality type, and attitudes toward learning⁵ as a means of improving future pedagogical strategies and mitigation of physiological aspects of anxiety.⁶

Students may question their preparedness for the program they have undertaken, their ability and level of commitment to meet the demands of a challenging curriculum, their capability to be competitive in their field after graduation, and whether their academic workload leading to

diminishing quality of life in other areas. These sources of anxiety may be exacerbated for first generation college students, students suffering under financial duress, or both.

Studies of anxiety remediation strategies among engineering students are typically conducted with an eye to improving a particular course or program overall so as to benefit future students. While these efforts may result in average or program-cultural decreases in student anxiety, point sources of anxiety for individual students may persist. Others focus on management of physiological aspects (symptoms) of anxiety rather than root causes.⁶ Efforts to discern the causes of anxiety and to propose practical near-term solutions are less commonly undertaken. This research aims to identify some of the prevailing sources of anxiety among engineering students and to test the efficacy of measures to mitigate the resulting anxieties within a given academic year.

This paper discusses work that has been done to identify sources of anxiety as reported by a cohort of engineering and engineering technology students. Student perceptions of their individual vulnerabilities and concerns with regard to their degree programs and their outside personal lives are presented. Actions by faculty mentors to afford these students specific and timely means of clarifying and dealing with such issues are presented. Survey data of student perceptions of the outcomes following remediation efforts are evaluated and discussed.

This paper is structured as follows. Section 2 discusses a scholarship program at Western Carolina University (WCU) from which the engineering cohort is drawn. A breakdown of the group's population is given and compared with the general population of students from the same department. Section 3 discusses journaling exercises in which the students were asked to reflect on areas in which they were personally insecure with regard to their degree pursuit. Section 4 describes remediation strategies implemented by the program directors in response to the students' journal entries. Section 5 presents and discusses survey data collected from the students on the relative usefulness of the remediation measures. Finally, Section 6 includes conclusions taken from the work.

2. Program Description and Cohort Demographics

The SPIRIT Program (Scholarship Program Initiative via Recruitment, Innovation and Transformation) at WCU, funded by the National Science Foundation, aims to provide assistance to academically gifted and financially needy students who are seeking degrees in engineering or engineering technology in the host department. The program⁷ promotes student self-efficacy and retention through intensive mentoring by four program directors, undergraduate research with faculty guidance, promotion of a collegial and vertically-integrated cohort⁸, and connection of students with institutional resources to foster their success. The program, begun in fall 2014, is presently in its second of four funded academic years.

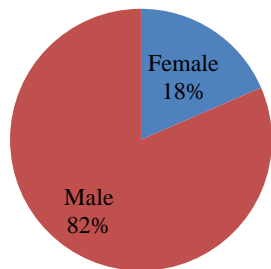
The program was populated during its inaugural semester by a diverse group of 27 students (10 freshman, 9 sophomores, 8 juniors). Figures 1 through 3 show the percentages of students as classified by gender, ethnicity, and major, along with comparisons to relevant groups at the host institution. Students may select majors from electrical engineering (BSEE), mechanical engineering (BSE ME), mechanical engineering technology (BS ET), and electrical and

computer engineering technology (BS ECET). With regard to gender and ethnicity, the program cohort is significantly more diverse than the general population of the host department (which houses all engineering and engineering technology majors).

All scholars in the program are required to conduct research on a topic of their choosing under the guidance of a department faculty member. Over the course of their participation in the program (i.e. before graduating), each scholar will conduct a literature review, propose and conduct experiments, and presents their results to the group. Each research project is expected to reach the level of a publication/presentation at an undergraduate, professional, or academic research conference.

The scholars meet as a group with the program directors once per week. During these meetings, they listen to invited speakers, participate in group discussions and problem solving exercises, and present their research advancements.

Program Gender (%)



Dept. of Engr. and Tech. Gender (%)

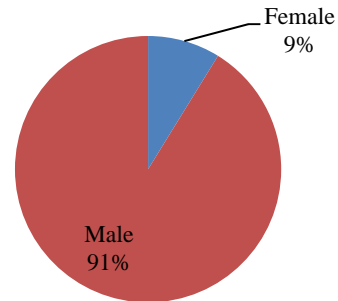
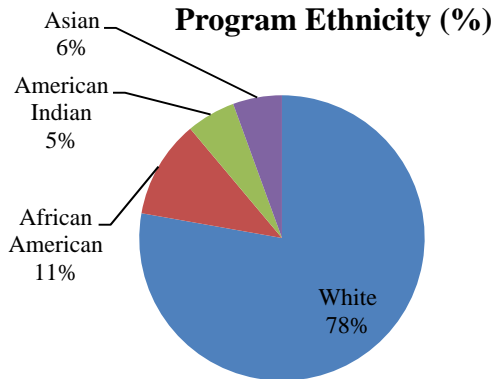


Figure 1 – Gender demographics for the program as compared with the host department

Program Ethnicity (%)



Host Institution Ethnicity (%)

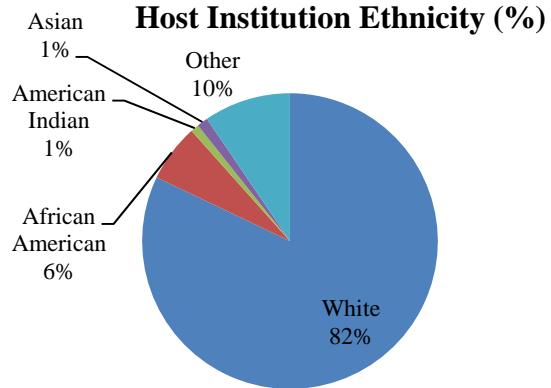


Figure 2 – Ethnicity demographics for the program as compared with the host university

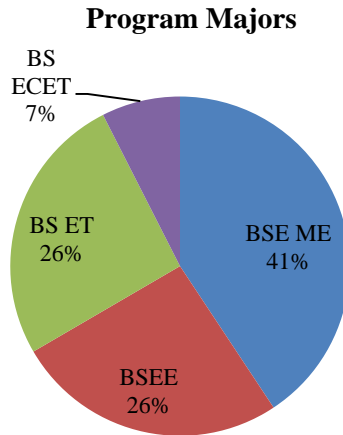


Figure 3 – Academic major selection among students in the program

Scholars are vertically integrated through cross-year interactions in a series of five interdisciplinary Project-Based Learning (PBL) courses. In these courses, students engage in progressively open-ended engineering projects for which they have responsibility for management of time, cost, performance criteria, and other constraints. Vertical integration occurs as students interact with peers in separate courses at different year levels from their own to share experiences and project management insights.

As part of their participation in the program, scholars are periodically asked to complete surveys or journaling assignments. Journaling prompts are intended to provoke scholars' reflection on various aspects of their experiences at the university and in the program. Journal entries were typically 1-2 pages. These data are used to assess student needs, perceptions of the program, and the efficacy of program activities. Prior to the start of the program, a request for human subjects research was submitted and approved by the Institutional Review Board (IRB) at the university. The program directors completed appropriate training to conduct such research. Participating students were required to sign an informed consent form that was approved by the IRB.

3. Reported Sources of Anxiety

During the first semester of the program in fall 2014, the program directors conducted exercises with the scholars to establish mentoring relationships with faculty, to build intragroup cohesion and to assess students' potential academic needs.⁷ Toward the goal of assessing academic needs and perceptions of the program, students were given a series of prompts for weekly journaling assignments. Among these, students were asked to reflect on sources of fear, anxiety, and uncertainty with regard to their choice of major, their academic preparedness, and their prospects for professional life.

Analysis of these writings revealed three prominent themes. These themes are listed below along with representative student comments.

1. **Time management.** Anxiety related to time management habits fell broadly into two categories. The first involved procrastination and its effects on quality of work. One student described the problem as follows:

“Since the start of college my greatest fear is that of not organizing and staying ahead of schedule with my work load. Failing to organize and adhere to the rules I set for myself sets me up for failure both academically and professionally.”

Another student reported the difficulty of balance between academics, personal life, and extracurricular activities.

“My second greatest fear right now is being able to balance academics, extra-curricular activities, and my social life. I know that this mostly comes down to time management, but I have yet to be able to find a routine to follow that is able to successfully balance everything that I have to and want to do.”

2. **Completion of the degree.** Anxiety related to success and eventual completion of the degree seemed to stem from generalized lack of confidence in the students’ academic ability. As one student noted:

“I am a first-generation college student, and the fear not being a first-generation college graduate is one that haunts me.”

Other students listed specific deficits in academic preparation and the obstacles they present. One student comment in this category is as follows.

“I have a great fear that I won’t be able to overcome the many obstacles this degree has to offer. One of the obstacles that has contributed to this fear to perform is math. Math always requires the majority of my time and focus compared to other studies.”

3. **Success after graduation.** Anxiety related to life following graduation was a recurring theme across the group. Concerns about the likelihood of finding desirable employment were common:

“I’ve heard so many stories from friends and family about students who can’t find employment after graduation that it’s become something I’m also fearful of. More than just finding a job, I’m afraid that I won’t be able to find the job that I want. I suppose that lends question to what job I want, and that is something I also fear. It’s said that we always fear what we don’t know and right now I don’t know what I want to do with my degree. I have some very general ideas about what I might be interested in but I haven’t found a specific job that I can point to and say, “that’s what I want to pursue”. The number one factor contributing to my fear about a job is concern for my family. I want more than anything to be able to provide for myself and my wife and to do so while working somewhere that I enjoy.”

Still others were uncertain of their ability to project competence to a prospective employer based on knowledge and experience gained during their degree pursuit.

“I am concerned that, upon leaving WCU, I will not be able to adequately apply myself to real-world scenarios. Now, this anxiety could also apply to an engineering internship; yet, I feel more comfortable with the idea of an internship because the purpose of one is to help you become industry ready. Naturally, I have felt the panic of beginning a new job on a few occasions, but the severity of those cases was different. Entering into an engineering job means that I will be reflecting (to an employer) the knowledge that I have learned and the experience that I have gained. When I think of such a thing, it can be overwhelming.”

Other sources of anxiety also mentioned in isolated cases included the accumulation of debt, loneliness, and an inability to take full advantage of opportunities available through the college experience. Although these were of interest to the authors, the mitigation of items enumerated above are the focus of this research at this stage.

4. Mitigation Strategies

With the major sources of anxiety identified from student responses that have been discussed in the previous section, the program directors devised a series of mitigation strategies using the weekly meeting time and the cohort dynamics to facilitate their implementation. The strategies were selected for their immediacy of effect (near term benefit being of concern in promoting the success of the scholars) and for their ease of implementation. They included the following activities.

1. Whole-group discussions of each anxiety type that were facilitated by the program directors. Graduate students were also present to assist with the discussion and to offer the perspective of older students.
2. Small peer-group discussions. Each group was limited to students in a specific year of their degree progress (freshman, sophomores, or juniors).
3. Journaling assignments that were aimed to stimulate discussion of the common themes in more detail.
4. A presentation by a representative from the Career Services department of the university in which the job market for engineering majors as well as job search strategies were covered.

For discussions, students were divided into the appropriate peer groups of around six student each. The directors issued prompts to spark discussion. Groups submitted notes of their conversation. Journaling topics were posted on line. Students were given one week to submit responses of 1-2 pages.

5. Results and Discussion

The activities described in the previous section were conducted over the first seven weeks of the semester. Following these activities, students were asked to complete a survey to help the directors assess the relative efficacy of the activities. The survey consisted of the questions listed below.

1. I had anxiety about time management prior to program meeting activities.
2. Discussing effective time management practices with my peer discussion group (freshmen, sophomores, or juniors) reduced my anxiety concerning time management.
3. Journaling about my anxieties and fears clarified my thoughts and reduced my anxiety concerning time management.
4. Discussing effective time management practices with the program directors reduced my anxiety concerning time management.
5. I had anxiety about degree completion prior to the program meeting activities.
6. Discussing effective degree completion strategies with my peer discussion group (freshmen, sophomores, or juniors) reduced my anxiety concerning degree completion.
7. Journaling about my anxieties and fears clarified my thoughts and reduced my anxiety concerning degree completion.
8. Discussing effective degree completion strategies with the program directors reduced my anxiety concerning degree completion.
9. I had anxiety about post-graduation prior to program meeting activities.
10. Discussing effective post-graduation practices with my peer discussion group (freshmen, sophomores, or juniors) reduced my anxiety concerning post-graduation.
11. Journaling about my anxieties and fears clarified my thoughts and reduced my anxiety concerning post-graduation.
12. Discussing effective post-graduation practices with the program directors reduced my anxiety concerning post-graduation.
13. The presentation by Career Services reduced my anxiety concerning post-graduation.

Response options were one of: *Strongly Agree* (SA), *Agree* (A), *Disagree* (D), or *Strongly Disagree* (SD). Seventeen of 27 students responded to the survey. Compiled results of the survey are given in Table 1. Students generally found the activities to have a positive impact as evidenced by majority percentages of SA and A responses to survey questions. Results in the aggregate (SA+A) are discussed below. Student comments from a related journaling assignment on the efficacy of the activities are also given.

In categories 1-3, it can be seen that group discussions were of greatest perceived value. Peak benefits for these categories are noted in questions 2, 4, 6, 8, 10 and 12. Generalized benefit arising from the sharing of anxiety experiences and resulting comradery was frequently described as indicated in the following student quotes.

Table 1 – Anxiety mitigation strategies survey results (percentages):
Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD)

Anxiety Source	Mitigation Strategy	Question	SA	A	D	SD	SA+A	D+SD
Time Management	self assessment	1	29.4	58.8	11.8	0.0	88.2	11.8
	1	2	0.0	82.4	17.6	0.0	82.4	17.6
	2	3	11.8	52.9	35.3	0.0	64.7	35.3
	3	4	23.1	53.8	23.1	0.0	76.9	23.1
Degree Completion	self assessment	5	16.7	44.4	33.3	5.6	61.1	38.9
	1	6	11.8	70.6	17.6	0.0	82.4	17.6
	2	7	12.5	43.8	43.8	0.0	56.3	43.8
	3	8	17.6	64.7	17.6	0.0	82.4	17.6
Success After Graduation	self assessment	9	23.5	70.6	5.9	0.0	94.1	5.9
	1	10	17.6	64.7	17.6	0.0	82.4	17.6
	2	11	11.8	41.2	47.1	0.0	52.9	47.1
	3	12	35.3	52.9	11.8	0.0	88.2	11.8
	4	13	47.1	47.1	5.9	0.0	94.1	5.9

“The group discussions and journal assignments have absolutely been key in keeping my anxieties in check. They have been a way for me to place fears back into the proper perspective. I found that through explaining what I feared and why I feared it I became less fearful of whatever it was. Sometimes understanding anxiety is the greatest factor in mitigating it. It also helps to see other people who are having the same sort of problems and how they’re capable of moving past them as well.”

“Another huge aspect of the SPIRIT program is the general attitude of people caring for one another. Through each of these journal assignments I feel as though someone truly wants to hear my problems.”

With regard to anxiety related to time management, 88.2% of students reported concerns. For this topic, discussion groups with peers (82.4%) and with the larger group (76.9%) were seen to be of value.

“Speaking to other people with similar types of stress at the meetings and seeing how they cope with these stresses was very productive for me. I discovered ways other people were using to manage stress that I could apply to my own study habits and daily routines. As a consequence of these meetings, I do not procrastinate as much as I did. This in turn makes me get my assignments done earlier and more efficiently. As a result, I am not as stressed and I have more free time.”

Younger students also pointed out the relevance of hearing the anxieties of older students (upperclassmen and graduate students):

“I knew of course that the graduate students had some sort of fear of the future such as finding a job after everything was over, but I didn’t realize they had such similar academic fears such as not being able to manage their time efficiently. I had this belief in my head that if they’ve made to graduate school, then they’ve pretty much mastered time management, but now I know that they still have to give up certain times of their day or week to meet their academic needs just as freshmen do.”

Anxiety related to classwork and completion of the degree was the least prevalent of the emergent themes (61.1 %). Again, group discussions, especially with regard to younger students hearing from upperclassmen showed greatest positive effect.

“The older students know what it takes to make it through a rigorous curriculum. Being able to pick their brains has helped me to understand what I am going to encounter within the next couple of years and how to handle many of the situation that I am going to face being an engineering major. It has also been helpful listening to the fears of the upper classmen so that I can start preparing now to eliminate some of the anxiety that they are currently experiencing.”

Discussion of post-graduation anxieties and employment also showed benefit.

“[Discussion groups] can receive insight from students about what the major program is about, what types of jobs they can have later in life, and can hopefully figure out what type of engineering that they truly have a passion for.”

The presentation by the Career Services representative was especially well received by the students (94.1 %).

“Also, the speaker from career services was very useful. Before, I did not even realize we had that kind of resource on campus where we could go and discuss a resume, look for jobs, and practice interview skills. This is a resource that I definitely plan on using in the future.”

Although the data show that journaling was of lesser impact than group discussions, several students found the journaling exercises to be of high impact, providing them an opportunity to reflect on and clarify their own anxieties, even where other strategies fell short.

“Out of all of the things we’ve done in the program the journaling was probably the most beneficial for me. Just having to sit down and think about things that might keep me from achieving my goals has helped me realize that there are a few areas in which I need to grow. It has helped me find a little more direction and hone in on my strengths and weaknesses”

“The SPIRIT program has not been anything except a nuisance to go to every Thursday night at six. I was expecting when I joined the program that we would be working together to learn things, and to challenge our minds in the field of engineering. I believe that it has done the opposite for me, the meetings are boring and the drag on forever. ...

The journal entries about the fears and the anxiety about college has been good because it allowed myself to recognize what I am scared of with college. I don't believe it has made my fears subside but it has made me aware and I can start doing things to help curb my fears."

6. Conclusions and Future Work

Toward identifying sources of anxiety among engineering students and ways in which these sources can be ameliorated in the near term, this paper has presented relevant data gathered for an engineering student cohort. It was observed that personal reflection through written narrative and discussion had a positive effect on students' understandings of the sources and possible remedies for commonly occurring anxieties. These activities were easily implemented and fostered both self-awareness among individuals and cohesion among the larger group. It is perceived that these benefits effectively reduced academic anxieties and constructed an environment in which students were able to freely discuss problems with their peers.

It is noted that the sample group for this study is small. Further, since the student cohort that participated in this study was of high academic merit, there is no evidence that these results would generalize to all students, regardless of academic standing. Further research would be needed to verify the strength and extensibility of the observations from this study. Future work would involve a comparison between students in the scholar cohort and those in the general population of the host department. The PBL courses through which the scholars are vertically integrated would provide a convenient platform for this comparison. Extension of these results to much larger groups of students would likely be difficult without some organizational vehicle to facilitate segmentation into small groups as were used here.

A longitudinal study of the scholar cohort wherein the current younger scholars who will have matured through the program repeat these activities with future inductees will also be of interest. I would also be interesting to explore gender differences with regard to the activities performed in this study to mitigate anxieties.

Acknowledgments

This material is based upon work supported by the National Science Foundation under grant number 1355872. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Carberry, A.R., Lee, H., Ohland, M.W. (2010). "Measuring Engineering Design Self-Efficacy." *Journal of Engineering Education*, 99(1), pp. 71-79.
2. Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). "Factors influencing the self-efficacy beliefs of first-year engineering students". *Journal of Engineering Education*, 95(1), pp. 39-47.

3. Vitasari, P., Wahab, M.N.A., Othman, A., Herawan, T., Sinnadurai, S.K. (2010). "The Relationship between Study Anxiety and Academic Performance among Engineering Students." *Proc. International Conference on Mathematics Education Research 2010 (ICMER 2010)*, pp. 490-497.
4. Sullivan, K., Davis, R. (2007). "Increasing Retention of Women Engineering Students." *American Society of Engineering Education*, pp. 1-15.
5. Bernold, L.E., Spurlin, J.E., Anson, C.M. (2007). "Understanding Our Students: A Longitudinal Study of Success and Failure in Engineering with Implications for Increased Retention." *Journal of Engineering Education*, 96(3), pp. 263-274.
6. Vitasari, P., Wahab, M.N.A., Herawan, T., Othman, A. and Sinnadura, S.K. (2011). "A pilot study of pre- post anxiety treatment to improve academic performance for engineering students." *Procedia-Social and Behavioral Sciences*, 15, pp. 3826-3830.
7. Ferguson, C.W., Yanik, P.M., Chang, A. and Kaul, S. (2015). "Scholarship Program Initiative via Recruitment, Innovation, and Transformation." *Proc. 122nd ASEE Annual Conference and Exposition*, Seattle, WA.
8. Kaul, S., Chang, A., Yanik, P.M. and Ferguson, C.W. (2015). "Development of a Mentorship Program in Engineering and Technology." *Proc. 122nd ASEE Annual Conference and Exposition*, Seattle, WA.