

THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

Investigating Patterns of Undergraduate Engineering Writing Efficacy and Career Trajectories

ADRIANA NAOMI WALP
SPRING 2023

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Mechanical Engineering and
honors in Mechanical Engineering

Reviewed and approved* by the following:

Catherine Berdanier
Assistant Professor of Mechanical Engineering
Thesis Supervisor

Daniel Cortes
Associate Professor of Mechanical Engineering
Honors Adviser

* Electronic approvals are on file.

ABSTRACT

Writing is a key aspect of communicating scientific results but is often overlooked in engineering education. This study aims to identify how undergraduate engineering students feel about their writing and if there are any correlations to potential careers. A recruitment email was sent to the respective engineering colleges within the Academic Big 10+ Alliance that asked participants to rank how much they would agree or disagree with a provided statement. The statements were from Daly and Miller's empirical instrument to writing apprehension and Bandura and Zimmerman's scale measuring the participants perceived self-efficacy. Information about potential career trajectories and demographic information was also collected. The rankings were transformed into numerical values so that participants could be grouped into categories representing high, moderate, and low writing apprehension and self-efficacy. Totals were also used to calculate the Pearson correlation coefficients for each survey against each other, the potential career trajectories, and demographic information.

There was only one significant trend between having high self-efficacy and likeliness to pursue a role in higher education. There was a strong correlation between writing apprehension and writing self-efficacy which agrees with data from the graduate level. However, there were no trends between either survey and the potential occupations which does not agree with graduate level data. This may be because undergraduate students, especially underclassmen, are likely to not have a strong sense of what they would like to do in the future. Previous research suggests that a strong self-efficacy encourages students to pursue diverse fields. Therefore, to increase the likelihood of a student going to graduate school and thriving, it is necessary to prepare students and their belief in their writing abilities more.

TABLE OF CONTENTS

LIST OF FIGURES	iii
LIST OF TABLES	iv
ACKNOWLEDGEMENTS	v
Chapter 1 Literature Review	1
Motivation	1
Writing Attitudes Affect Writing Competency	2
Writing Apprehension Research and Potential Links to Occupation Trajectory	5
Chapter 2 Methods	7
Recruitment	7
Survey Instruments	8
Data Analysis Methods	9
Limitations	10
Chapter 3 Results	12
Demographics	12
Grouping	14
Occupation Results	17
Correlation	20
Chapter 4 Discussion and Conclusion	23
Implications for Engineering Education	23
Future Work	25
Appendix A Writing Apprehension Survey Provided to Participants	27
Appendix B Writing Self-Efficacy Survey Provided to Participants	29
BIBLIOGRAPHY	31

LIST OF FIGURES

Figure 1. Distribution of students' semester standing.....	14
Figure 2. Participant distribution for low, medium, and high writing apprehension.	15
Figure 3. Distribution of writing apprehension scores.....	15
Figure 4. Participant distribution for low, medium, and high writing self-efficacy	16
Figure 5. Distribution of writing self-efficacy scores.....	16
Figure 6. Most likely occupation considerations for participants with high writing apprehension.	17
Figure 7. Most likely occupations for participants with low writing apprehension.....	18
Figure 8. Most likely occupations for participants with high writing self-efficacy.	18
Figure 9. Most likely occupations for participants with low writing self-efficacy.....	19
Figure 10. Distribution of students' top occupation by semester standing	20

LIST OF TABLES

Table 1. Gender Demographics of Participants	13
Table 2. Racial/Ethnic Demographics of Participants	13
Table 3. Correlation of career trajectories with writing apprehension.....	21
Table 4. Correlation of career trajectories with writing apprehension.....	21
Table 5. Correlation of demographics with writing apprehension.....	22
Table 6. Correlation of demographics with writing self-efficacy	22

ACKNOWLEDGEMENTS

I would like to thank literally everyone, but this page isn't long enough for that so know that I thank you even if you're not on here. A special thank you to Dr. Berdanier, it's been an honor to be able to work with you for the past four years and I cannot thank you enough for always being in my corner. Your kindness and drive to succeed is truly inspirational. Thank you to everyone in the ECRL lab, you all have been amazing to work with and I truly appreciate your collective ability to provide constructive feedback and always entertaining weekly updates. I plan on taking gongs and castanets with me forever and will always think of all of you. I would like to thank my honors advisor, Dr. Cortes. Thank you for helping me get to this point in my life with a finished thesis and all my honors requirements fulfilled.

I cannot thank my friends and family enough. There is no way that I would have been able to do this without your support. You all mean the world to me.

Chapter 1

Literature Review

Motivation

In order to share information, one must communicate their message with the appropriate context. Engineers tend to focus on completing experiments and gathering results, but to have these results accepted as valid, they must be shared and approved by the engineering community [1]. Technical communication is an important part of undergraduate engineering education and is included in the accreditation (ABET) criteria for undergraduate engineering programs. There has been much debate over the definition of technical writing, as it applies to a very broad spread of topics and applications. Technical writing is typically associated with science, engineering, and business [2], comprising technical reports, resume writing, memos, emails, and any other venue in which future engineers will need to write.

Engineers tend to view writing as a part of their job but not as part of engineering itself [1]. They see knowledge as coming from the physical world without any textual mediation. This not only devalues the writing that engineers do but implies that writing is not crucial to sharing information [1]. It is not possible to advance in a career if a person is unable to communicate. It does not matter how smart they are, the new knowledge is lost if it is unable to be shared.

Even in academic settings that seem rather unrelated to writing, it has been found that writing is crucial. There is evidence showing that a student able to write down and explain the subject will understand the material more thoroughly [3]. A study completed in 1990 found that engineers, “inscribe a written representation of physical reality and then use more writing to

build agreed-upon knowledge and their own characters as engineers [1].” This means that all engineers, even ones that do not write with the intention of publishing or formally sharing, receive intellectual benefits from the writing process.

While benefits from writing are clear, many institutions struggle with fitting writing courses into their engineering program’s curriculum. This disadvantages the people who need the most practice with writing since they are not interested in taking additional writing courses. Highly apprehensive writers find writing to be unrewarding [4] and therefore are less likely to voluntarily sign up for a course that they don’t need. While most undergraduate engineers do not often need to write a composition or essay, they do face a nonnegotiable demand for writing competency [5] in the form of technical reports, sponsor reports, project updates, memos, or workplace email communications.

Writing Attitudes Affect Writing Competency

Past research indicates that anxiety about writing is reflected in a person’s written pieces and their behavior towards writing [6]. Writing, especially for students, is typically performed alone, completed on one’s own timeline, requires extensive creative effort, and evaluated by oneself on standards of quality [6] that can seem subjective without deep domain expertise. This can make the iterative process of writing and revising extremely long and particularly difficult for those who do not believe in their own writing ability. In research on interpersonal communication, it was found that communication apprehension is an anxiety trait that affects significant parts of the population in a serious manner [5]. Researchers have coined this term “writing apprehension. [5]”

Writing apprehension is subject and situation dependent. It can be explained as “a person’s tendencies to approach or avoid situations perceived to potentially require writing accompanied by some amount of perceived evaluation [6].” In 1975, Daly and McCroskey created a scale that measured writing apprehension. This survey has 26 items in which the participants are asked to rank how much they agree or disagree with a statement related to anxiety about writings, outside evaluation of writing, and formal evaluations in general. This scale was created to help step away from the highly subjective observer-interview method that is not only time consuming, but costly [5]. It was tested on 164 undergraduate students across all majors where, after an analysis of variance was conducted, the results indicated that the scale was consistent and accurate [5].

Other researchers focus on writing self-efficacy as a related, but separate, indicator of how confident an individual is in their own writing. This confidence is also referred to as writing self-efficacy. In 1994, Bandura and Zimmerman created a scale that measures how confident someone is in their writing ability in a self-report manner [7]. This survey has 25 items in which the participants are asked to rank how much they agree or disagree with a statement related to writing self-efficacy, focusing on the topics related to planning, generating content, and ability to complete writing tasks [8]. This scale was based on data from a survey with questions related to self-efficacy that was sent to a university that asked 95 randomly selected students from different English courses [7]. Thorough statistical analysis showed a significant trend between their self-regulatory efficacy and their belief that they will succeed in writing tasks [7].

Relationship Between Writing Attitudes and Performance

Past research has indicated that there is a clear relationship between a person's writing apprehension and the way that they write [4]. Those who feel anxiety about writing and communicating are likely to spend the bare minimum of time on it to minimize their anxiety response. Individuals who are categorized as highly apprehensive can be described as a "person for whom anxiety about communication outweighs his projection of gain from the situation" [9]. So not only does writing apprehension affect how a person writes, but it also affects if they will write at all.

Further, researchers found that writing apprehension affects a person's performance in the classroom [6]. Teachers perceive highly apprehensive writers as less likely to succeed in not only writing, but other subjects, as well [10]. Because a person's confidence is not directly related to knowledge or skill, this puts apprehensive individuals at a disadvantage in the educational setting and is likely the same for the workplace. Decreasing the student's self-esteem even more, teachers view students who avoid writing as people who are less likely to succeed in the future and are less likely to positively recommend the student [4].

Results of past research found that the general self-esteem of an individual is inversely related to writing apprehension. It makes sense that an individual with a strong amount of confidence would be confident in their writing and have a low amount of writing apprehension, and an individual with low self-esteem would not be confident in their writing [6]. Those with high apprehension are known to avoid situations that require writing and therefore limit their opportunities to learn and grow via practice and feedback and improve their writing as well as their confidence in their writing [4]. It has been documented that "individuals with high writing apprehension encode messages differing in diversity, length, quality and language intensity"

[11]. Not only is it possible to identify highly apprehensive individuals by assessing their confidence level, but readers are able to note differences in how the individual writes.

Writing Apprehension Research and Potential Links to Occupation Trajectory

Writing apprehension generally indicates that the writer does not enjoy writing as most people do not enjoy tasks that give them anxiety. In past research, it has been concluded that a person will choose an occupation that will maximize perceived rewards and minimize consequences [11]. Therefore, it makes sense that given a choice on how they would like to live their life, they would choose an occupation that minimizes the amount of writing they do. This is consistent with the choices they make about selecting a major in college as well. Daly and Shamo concluded that, since different majors have different amounts of required writing, individual differences related to writing strongly influence their decision when choosing their major [11]. Those who have high anxiety about their writing ability often have trouble discerning the difference between the level of writing a job or major requires. This is not true for people who have low writing apprehension [11]. Since those with high writing apprehension tend to avoid writing, a person's level of writing apprehension should predict their decision of major or occupation [11].

When putting this information together, it means that someone who tries to avoid writing will be more likely to accidentally select a major, occupation, or program that has a higher level of required writing. When this happens, the individual tends to feel dissatisfied and less successful than a person who selected a major that fit their level of writing apprehension [12]. An individual with more confidence in their writing ability is more likely to appropriately assess

the amount of writing required accurately and select something that fits their desires. Majors that are science or engineering oriented are more likely to be perceived as majors that require little writing and are therefore attractive to highly apprehensive individuals [11]. Previous research has indicated that the perceived communication requirements of a position play an important role in the decisions that individuals make about their occupations and majors [13].

While data has been collected and analyzed in reference to writing attitudes and career trajectories at the graduate level [14], there has been no research done at the undergraduate level. Benefits include contributions to the literature and what is known about undergraduate-level engineering writing. Additional benefits would be the ability to alter engineering programs and writing courses to better prepare and educate undergraduate students. It has been noted in past research that those with high writing apprehension expect themselves to do poorly in basic writing courses and are less likely to enroll in advanced composition courses. They also perceive their past writing experiences as general negative and do not report as much success [11].

To this end, the research questions that this thesis seeks to address are:

1. What are the writing attitudes (writing apprehension and writing self-efficacy) exhibited by undergraduate engineering students?
2. How do undergraduate engineering students' writing attitudes correlate with their anticipated career trajectory within engineering?

Chapter 2

Methods

Recruitment

After approval from the Institutional Review Board (IRB), participants were recruited via email. A recruitment email was sent to undergraduate coordinators of engineering programs within the Academic Big Ten+ Academic Alliance institutions. This email included text and a link for an online data collection survey using Qualtrics online survey software to be distributed to the students in their respective programs. Undergraduate students from all engineering disciplines were surveyed.

At the survey's beginning, information about the data being collected and a high-level overview of the study was given to the viewer. Next, a series of screening questions determined if the student qualified to be a part of the survey. Inclusion criteria required participants to be consenting adults over the age of 18. The participant must be enrolled in an ABET-accredited engineering or computer science program at a college or university in the U.S. This research also stipulated that participants must not be graduated with their undergraduate degree and participants spoke English. If potential participants did not meet any of these criteria, the survey ended, and no other data was collected.

No identifiers were collected as part of the research. If the participant wished to be in a drawing for a gift card to incentive their participation in the study, participants had the option to follow a link at the end of the data collection survey. This separate survey collected contact information; however, this information was not associated with their data from the data collection survey.

Students participated in the survey online on a personal device at a time convenient to them. Subjects who wished to withdraw were able to do so simply by letting the primary investigator know or by not finishing the survey. Incomplete survey responses were removed at the start of data analysis as well as those who requested to be removed. Participants were only involved for the time it takes for them to complete the survey, approximately 15 minutes. The goal was to have as many responses as possible to have the most comprehensive data set possible. Out of 160 responses, only 80 fully completed the survey and were used in analysis.

Survey Instruments

The participants filled out two academically verified survey scales, one, by Daly and Miller, measured writing apprehension, and the other, by Zimmerman and Bandura, measured writing self-efficacy. In each survey, participants ranked how much they agreed with a statement provided to them about writing. Daly and Millers' scale was from one, strongly disagree, to five, strongly agree. Zimmerman and Bandura's scale was from one, absolutely cannot complete task well to seven, absolutely can complete task well.

In a research note investigating Daly and Zimmerman's scale, it was found that in randomly ordered items withing several survey groups, scores showed consistent trends [15]. This indicates no bias from ordering and a strong indication that the survey accurately measures writing apprehension.

The self-report method is one of the best methods for surveying writing apprehension as it has low expenses, low administrative needs, and the survey is adjustable and able to be modified for any specific research needs [5]. In this case, the scales were not adjusted at all.

Since they have been already academically verified and accepted as accurate writing apprehension and self-efficacy measurement tools, there was no need to change them. It was found that other research methods, such as an observational-interview or monitoring physiological responses, require significantly more time, expenses, and time to analyze [5]. All items for the writing apprehension survey given to participants can be found in Appendix A and the writing self-efficacy survey can be found in Appendix B.

In addition to these validated writing scales, participants also filled out a series of questions investigating their intended career trajectory considerations across a variety of sectors and career paths. The survey also collected demographic information, including gender, racial and ethnic background, international student status, year in school, and engineering department. Part of this survey included asking students to select demographics that they identify with. This included gender and race. Only one student that fully completed the survey opted to not answer these questions. Because most engineering programs have low diversity rates [16], identifying if a traditionally minoritized group particularly struggles with this topic can allow for a customized intervention or change to the program to reduce attrition rates.

Data Analysis Methods

All data were analyzed via accepted statistical methods using Excel. The Daly and Miller writing apprehension scale and the Zimmerman and Bandura Writing Self-Efficacy scale asked participants to rank a situation about writing on a scale of five options ranging from strongly agree to strongly disagree. The five options were given number values and then totaled for each participant. Because these surveys ask questions that both represent low apprehension/efficacy

and high apprehension/efficacy, questions representing low values were added to the total and questions representing high values were subtracted from the total (as a form of reverse coding). All participants' scores were summed and averaged individually to result in a singular number representing each individual's score on each scale. In essence, this procedure resulted in net scores on the surveys which convey that a higher score represents a more comfortable and confident writer.

The average of each participant's total was calculated as well as the standard deviation. For the purpose of analysis, participants were placed into one of three groups. Those who scored lower than the average minus one standard deviation were considered part of the "low" group. Those who scored higher than the average plus one standard deviation were considered part of the "high" group. Anyone in between those values were labeled "moderate." Using statistical methods, correlations and descriptive statistics were conducted.

Limitations

The survey distributed is based on qualitative traits being put into quantitative measurements and is not one size fits all. While the scales have been validated, self-report measures are subject to bias: in this case, participants may not be able to identify exactly what their career trajectory is or their confidence in their writing ability, or the career trajectories may change quickly. Further, only 80 participants fully completed the survey. A larger data set would have led to a better representation of the population, but this work can be considered exploratory. This set also represents undergraduate students at Big 10+ Academic Alliance institutions, which are large research intensive universities, historically land-grant institutions with a very specific

institutional mission, and are predominantly white institutions. Future studies should investigate engineering students being educated at other types of institutions.

Chapter 3

Results

Demographics

At the end of the survey, participants were asked to answer questions about their demographics to lend more insight into what groups are thinking what. The demographics of this survey do not match the statistics of the major and profession. The representation of women was significantly higher than what is expected. According to the American Society for Engineering Education's *By the Numbers* report from 2021, found that 75.9% of bachelor's degrees were awarded to men, leaving only 24.1% awarded to women [16]. This analysis did not evaluate any other genders. In this current study, men only represented 40% of the participants whereas, those who do not identify as men made up the other 58.5%, with the last 1.25% being from one participant who chose not to provide demographic information. Compared to the statistics provided by ASEE, the racial/ethnicity results from this study follow a similar pattern. The vast majority of participants were white, followed by Asian, and a mix of small percentages for all other ethnicities.

Table 1. Gender Demographics of Participants

Gender Demographics	Number	Percentage
Woman	44	55%
Man	32	40%
Transgender woman	1	1.25%
Transgender man	0	0%
Non-binary	2	2.5%
Other	0	0%
Prefer Not to Answer	1	1.25%

Table 2. Racial/Ethnic Demographics of Participants

Racial/Ethnic Demographics	Number	Percentage
American Indian or Alaska Native	0	0%
Asian	9	11.25%
Black or African American	1	1.25%
Hispanic or Latino	2	2.5%
Native Hawaiian/Other Pacific Islander	0	0%
White	64	80%
Race/Ethnicity Unknown	3	3.75%
Other	0	0%
Prefer Not to Answer	1	1.25%

The semester standing of each participant was also observed. The majority participants ended up being in their third or fourth year of engineering which is highly preferable. Most higher education institutions have first and second year engineering students in a pre-engineering classification. This gives students time to understand the differences in each major and to see which they are most interested in. It also allows the university to filter out students who are not prepared for the workload or intensity of engineering courses. By the time students are in their third year of engineering courses, they are firmly positioned in the major they have selected and are out of any pre-engineering classification.

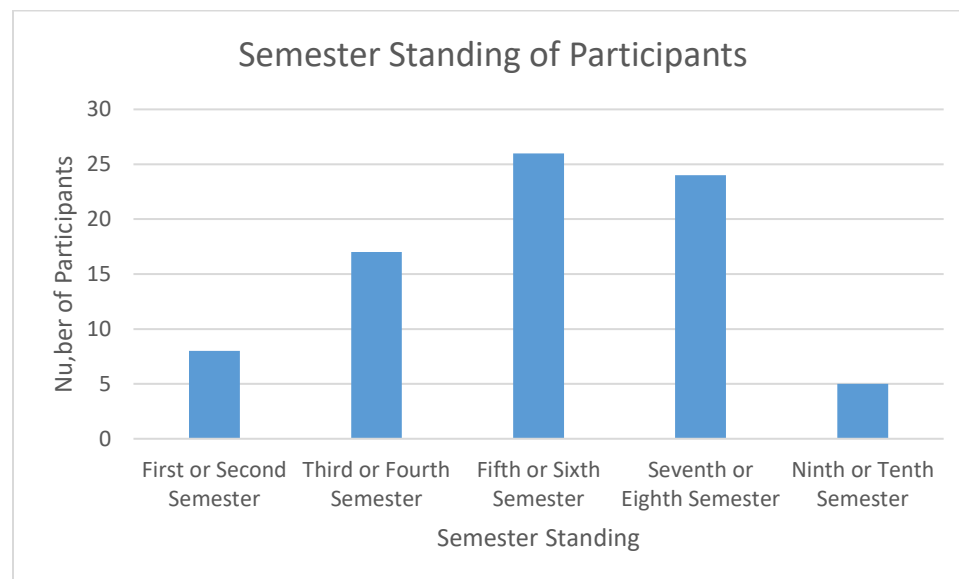


Figure 1. Distribution of students' semester standing

Grouping

Data from 80 fully completed surveys were analyzed for this study. To evaluate the results of this survey, students were placed in one of three categories. First, the average and standard deviation of each scale was calculated. All values between one standard deviation added and subtracted from the average were placed in the moderate category. Any values greater than

the average plus the standard deviation were considered high and any values lower than the average plus one standard deviation were considered low. The results of the two surveys were calculated separately so that analysis can be done in reference to self-efficacy and writing apprehension and then inspect the relationship between the two. In this study, there is a particular interest in the high and low groups. This categorization is specific to this group of participants since the division is based on the average and standard deviation of this data set. In figure 3, the score distribution for the writing apprehension scores is depicted in a histogram. In figure 4, the score distribution for the writing self-efficacy scores is depicted in a histogram.

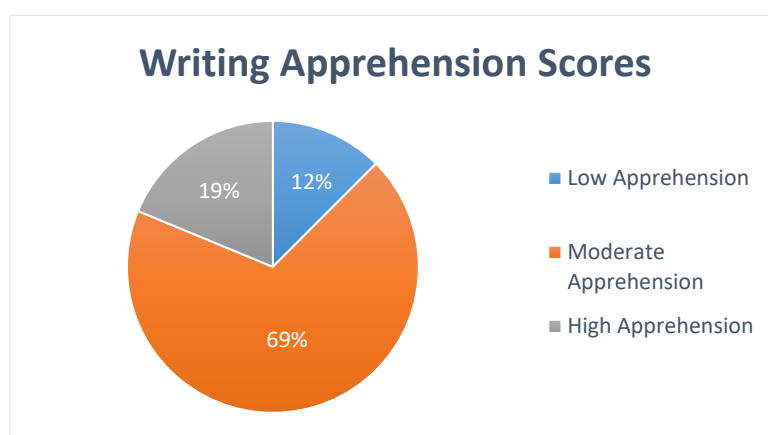


Figure 2. Participant distribution for low, medium, and high writing apprehension.

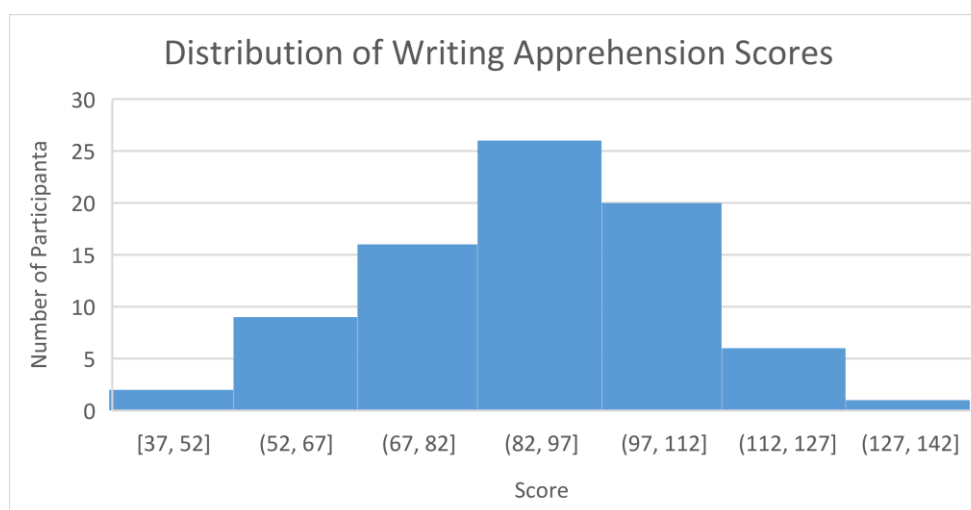


Figure 3. Distribution of writing apprehension scores

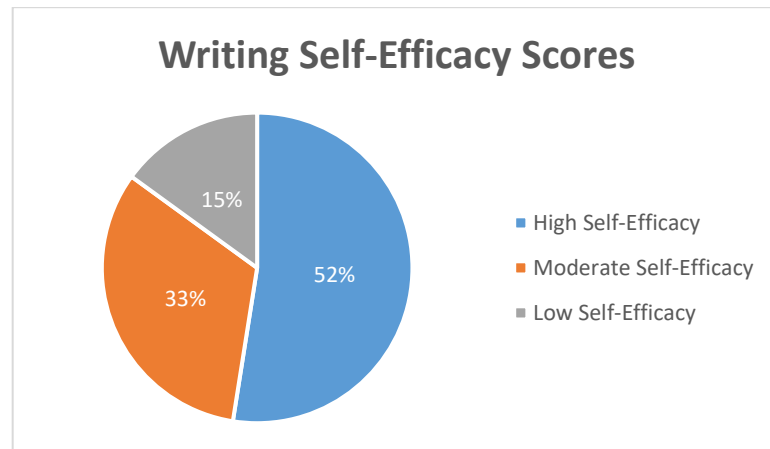


Figure 4. Participant distribution for low, medium, and high writing self-efficacy

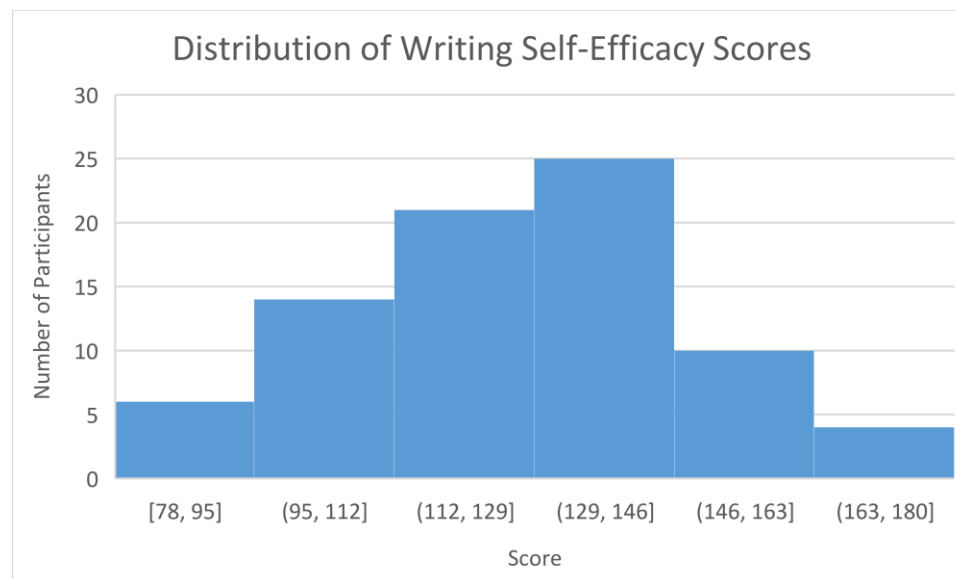


Figure 5. Distribution of writing self-efficacy scores

Occupation Results

For each grouping, a graph was created to show the most popular occupations for that group. The y-axis represents the number of participants in that group that selected likely or highly likely for that occupation and the x-axis lists the occupation options that participants were given. There are two graphs per scale, one for the high end of the scale and one for the low end. The four figures below display that data.

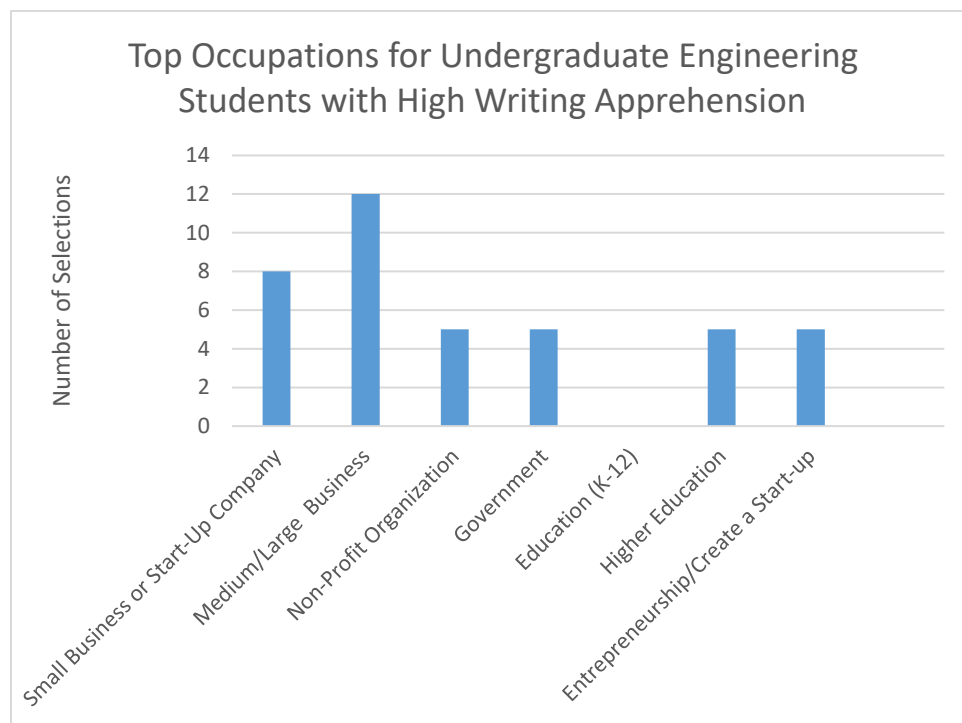


Figure 6. Most likely occupation considerations for participants with high writing apprehension.

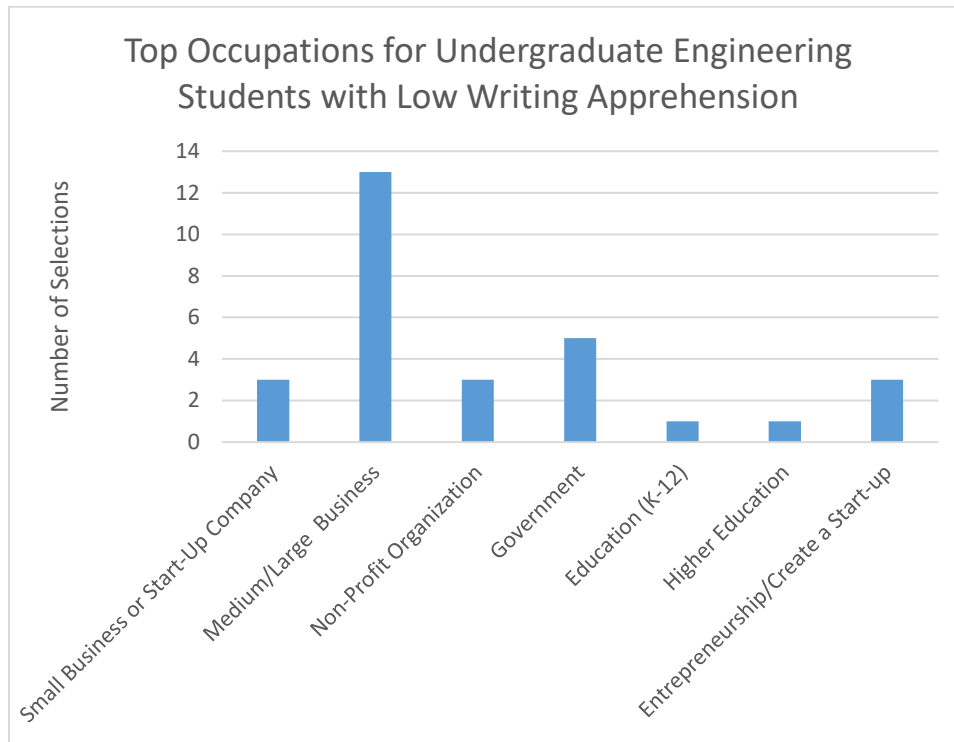


Figure 7. Most likely occupations for participants with low writing apprehension.

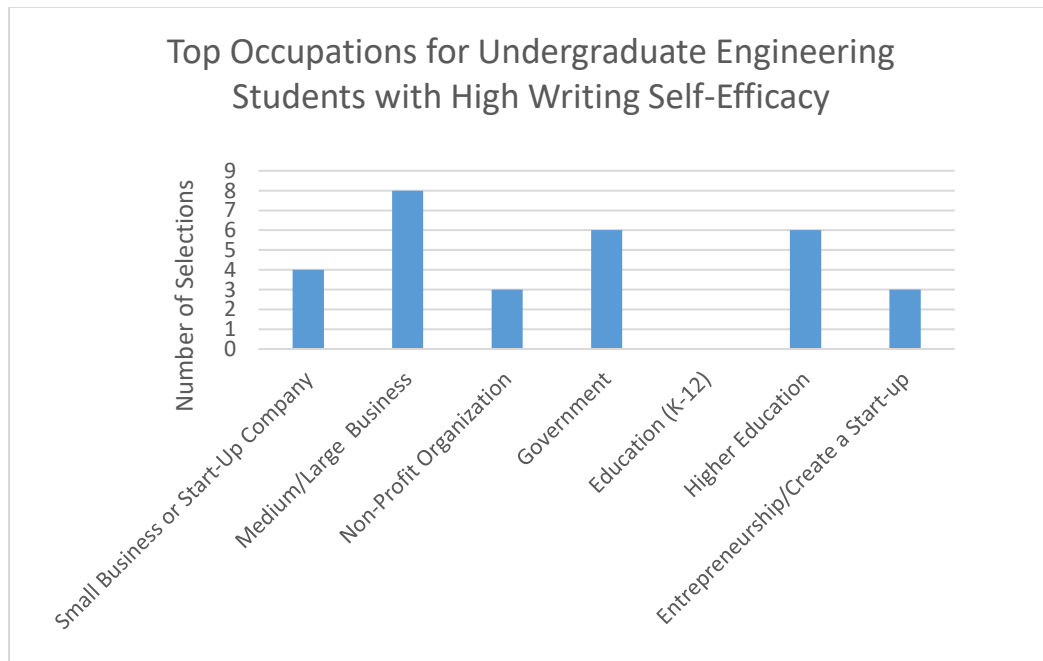


Figure 8. Most likely occupations for participants with high writing self-efficacy.

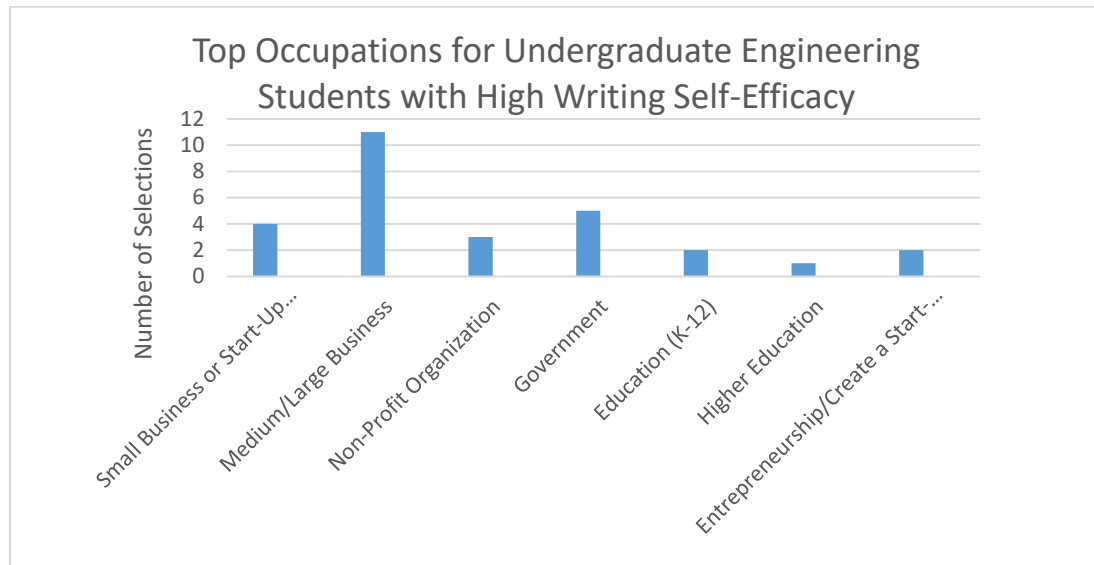


Figure 9. Most likely occupations for participants with low writing self-efficacy.

As evident in the graphs, working at a medium to large size business was the most popular option in all categories with a noticeable disparity between it and all other occupation options. The general results did not show any meaningful trends. The only notable distinctions were that writers with a high level of self-efficacy or a high level of writing apprehension were more likely to pursue a role in secondary education than the other classifications.

While this initially feels contradictory, it could be interpreted as students who are confident but critical of their writing are likely to pursue roles in academia. When examining the data, there were seven participants who scored both high writing apprehension and high writing self-efficacy. Four of these participants ranked secondary education as an occupation they were likely to pursue. The other occupations these participants were interested in were a government position and a large to medium sized business.

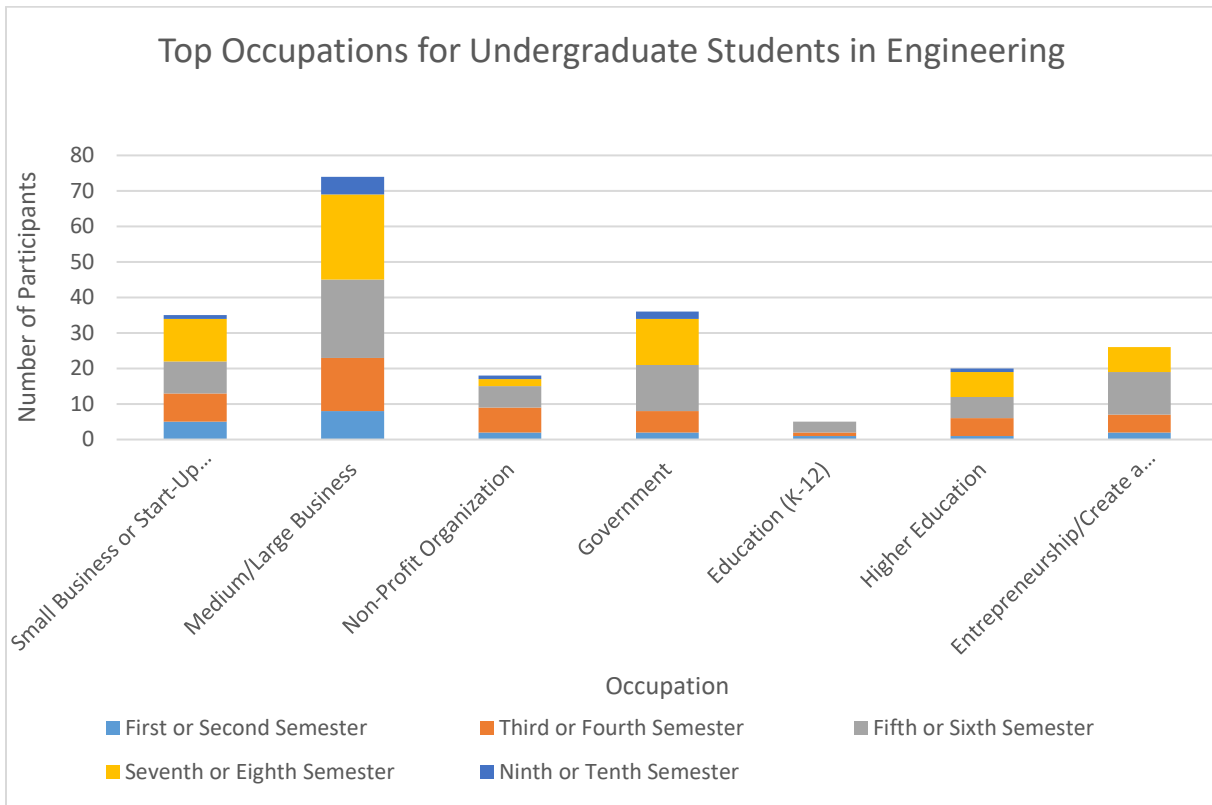


Figure 10. Distribution of students' top occupation by semester standing

Correlation

To evaluate the correlation between participants' writing apprehension writing self-efficacy, the Pearson correlation coefficient between the two scales' scores were calculated. Since the participants responded with a ranking, it was possible to create a final total score and then use numeric values in the analysis. With a Pearson correlation coefficient value of 0.711 and $p < 0.05$, the correlation of the two scales have a notable and significant trend. If a student was apprehensive about writing, they were likely to also struggle with low self-efficacy, and vice versa. These results concur with prior work by Zerbe et al. using the same scales on engineering graduate students [14].

Table 3. Correlation of career trajectories with writing apprehension

Correlation of Each Occupation with Writing Apprehension Survey				
<i>Occupation</i>	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Small Business/Start-up Company	0.1437	0.0947	1.5177	0.1335
Medium/Large Business	-0.2197	0.1407	-1.5613	0.1229
Non-Profit Organization	0.0869	0.0873	0.9951	0.3230
Government	0.0541	0.0745	0.7254	0.4706
Education (K-12)	-0.0639	0.1257	-0.5083	0.6128
Higher Education	0.1107	0.0828	1.3377	0.1853
Entrepreneurship/Create a Start-up	-0.0698	0.0888	-0.7856	0.4347

In table 3, shown above, the statistical analysis via regressions between the writing apprehension scale scores and the ranking of the occupations is displayed. A high score on the writing apprehension survey represents a high amount of writing apprehension. When investigating the correlation between the scores of the scale and the rankings of the occupation, no significant trends are found as all p-values are greater than 0.05.

Table 4. Correlation of career trajectories with writing apprehension

Correlation of Each Occupation with Writing Self-Efficacy Survey				
<i>Occupation</i>	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Small Business/Start-up Company	0.216	2.126	0.101	0.920
Medium/Large Business	-2.854	3.161	-0.903	0.370
Non-Profit Organization	-1.226	1.961	-0.625	0.534
Government	0.693	1.674	0.414	0.680
Education (K-12)	-0.489	2.823	-0.173	0.863
Higher Education	4.510	1.859	2.426	0.018
Entrepreneurship/Create a Start-up	1.235	1.995	0.619	0.538

In table 4, shown above, the statistical analysis via regressions between the writing self-efficacy scale scores and the ranking of the occupations is displayed. A high score on the writing self-efficacy survey represents a high amount of self-efficacy. This means that a higher score

represents a more confident individual. When investigating the correlation between the scores of the scale and the rankings of the occupation, there was one significant trend identified. There is a positive correlation between a participant's self-efficacy and their ranking of entering the field of higher education. This is shown in the highlighted row which displays the occupation's positive coefficient and a corresponding p-value that is smaller than 0.05.

Table 5. Correlation of demographics with writing apprehension

Correlation of Each Demographic with Writing Apprehension Survey				
<i>Demographic</i>	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Semester Standing	3.2326	2.0426	1.5826	0.1179
Race/Ethnicity	0.5442	1.6994	0.3202	0.7497
Gender	2.4167	4.5125	0.5356	0.5939

Table 6. Correlation of demographics with writing self-efficacy

Correlation of Each Demographic with Writing Self-Efficacy Survey				
<i>Demographic</i>	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Semester Standing	0.0038	0.0924	0.0413	0.9672
Race/Ethnicity	0.0581	0.0753	0.7713	0.4430
Gender	-0.1739	0.2001	0.8694	0.3875

Chapter 4

Discussion and Conclusion

The trends observed in the data were similar to findings with engineering students at the graduate level. There is a strong correlation between writing apprehension and writing self-efficacy. However, there was no notable trends between undergraduate engineering students' career trajectories and their writing apprehension and self-efficacy levels. This may be explained in that undergraduate students are still furthering themselves in class. This may mean that they have not yet been exposed to material or experiences that they are highly interested in or that they do not have fully formed plans for the future in general since most are not searching for jobs or applying to graduate school programs yet.

Implications for Engineering Education

The results of this study indicate that writing apprehension and writing self-efficacy are not major factors that play into the potential career trajectories for undergraduate engineering students. A student who currently experiences high levels of apprehension towards writing is not deterred from occupations that require large amounts of writing. This does not eradicate the issue of students having high apprehension and low self-efficacy with writing. This study indicated that there is a correlation between high writing apprehension and low writing self-efficacy. Undergraduate engineering students who do not enjoy writing or do not feel they are good at writing, are likely to avoid it. It is extremely difficult to make progress in any skill without practicing. By avoiding writing, these students are avoiding valuable feedback and the chance to

improve their writing apprehension and self-efficacy levels. To remedy this, there are steps both students and faculty could take.

Many campuses have writing support that students can take advantage of. Having someone with training in writing could help students alleviate some of the apprehension and low self-efficacy. This would allow someone else to validate their current draft and would enable the student to talk out any unclear points. Students could also consider having a friend read over their assignments. While the friend might not be an expert in the topic at hand, they would be able to give the perspective of someone outside of field and help point out any sections that do not provide enough detail and clarity.

Faculty should consider the approaches they currently have in their courses with respect to how and why they include writing assignments, and support for those writing assignments. While solutions to high apprehension and low-self efficacy point towards increasing the amount of writing exposure, reaffirming the student's negative experience will not reduce these negative feelings. One idea is to connect writing to the assignment. Viewing the writing as part of the necessary steps to communicate their findings will be better received than assigning a write-up just to make the assignment a large project. If an instructor can focus students on how they can best communicate information to an outside reader or stakeholder in the way that would be required in a future career, students can connect writing assignments from class with their future career trajectories and gain more familiarity, rather than feeling that the writing is simply a task for a class to be accomplished.

Including writing assignments in a technical course is a good idea but students will need additional support to begin to change negative attitudes toward writing. By including smaller reports that hold less weight in their grade prior to a big final report, students are able to receive

important feedback and learn from the process. They will be more comfortable with what is expected of them and their ability to deliver it. To increase students' comfort with the assignment, faculty can lean into providing feedback and support prior to the assignment being due. Most faculty already hold office hours. By letting students know that they can attend office hours with the intention of receiving feedback on the direction and style of their piece, students will become more confident in their ability to meet or exceed expectations. While there does not appear to be a link between writing apprehension and self-efficacy with career trajectory at the undergraduate level, the ability to write is crucial in all fields of engineering. By improving students' ability to write well, universities will improve the likelihood of success after graduation.

Future Work

Future directions for this research will include sending the survey out to more large, ABET-accredited universities to gather more data. The more data collected, the more accurate the data will be. This would also allow a more comprehensive data set which may allow minor trends to become more prominent. Another option to direct future work would be to involve international undergraduate students. This has been done at the graduate level but not at the undergraduate.

Future research may also include an open-ended set of questions. While this work was rather quantitative, the nature of writing is qualitative. Getting longer answers with reasoning would provide significantly more insight into the thought process of undergraduate students. This would allow more specific interventions and modifications to engineering programs.

One of the unexpected faults in completing this research was the rate of completion of the survey. Only 50% of the participants fully completed the survey. Feedback indicated that the survey appeared too long, and that survey fatigue set in. Future research may decide to split the two scales into separate surveys so that students feel accomplished between them or are able to provide complete data that may be analyzed even if they do not fill out both.

Appendix A

Writing Apprehension Survey Provided to Participants

Below are a series of statements about writing. There are no right or wrong answers to these statements. Please indicate the degree to which each statement applies to you by circling whether you (1) strongly agree, (2) agree, (3) are uncertain, (4) disagree, or (5) strongly disagree with the statement. While some of these statements may seem repetitious, take your time and try to be as honest as possible. Thank you for your cooperation in this matter.

1. I avoid writing
2. I have no fear of my writing being evaluated
3. I look forward to writing down my ideas
4. I am afraid of writing essays when I know they will be evaluated.
5. Taking a composition course is a very frightening experience
6. Handing in a composition makes me feel good
7. My mind seems to go blank when I start to work on a composition
8. Expressing ideas through writing seems to be a waste of time
9. I would enjoy submitting my writing to magazines for evaluation and publication
10. I like to write my ideas down
11. I feel confident in my ability to clearly express my ideas in writing
12. I like to have my friends read what I have written
13. I am nervous about writing
14. People seem to enjoy what I write
15. I enjoy writing
16. I never seem to be able to clearly write down my ideas

17. Writing is a lot of fun
18. I expect to do poorly in composition classes even before I enter them
19. I like seeing my thoughts on paper
20. Discussing my writing with others is an enjoyable experience
21. I have a terrible time organizing my ideas in a composition course
22. When I hand in a composition, I know I 'm going to do poorly
23. It's easy for me to write good compositions
24. I don't think I write as well as most other people
25. I don't like my compositions to be evaluated
26. I'm not good at writing

Appendix B

Writing Self-Efficacy Survey Provided to Participants

Below are a series of statements about writing. Please indicate the confidence in which you could complete the stated task- (1) absolutely cannot complete task well, (2) most likely cannot complete task well, (3) would try task and would probably not be pleased with results, (4) uncertain, (5) would try task and would probably be okay with results, (6) most likely can complete task, or (7) absolutely can complete task.

1. When given a specific writing assignment, I can come up with a suitable topic in a short time.
2. I can start writing with no difficulty.
3. I can construct a good opening sentence quickly.
4. I can come up with an unusual opening paragraph to capture readers' interest.
5. I can write a brief but informative overview that will prepare readers well for the main thesis of my paper.
6. I can use my first attempts at writing to refine my ideas on a topic.
7. I can adjust my style of writing to suit the needs of an audience.
8. I can find a way to concentrate on my writing even when there are many distractions around me.
9. When I have a pressing deadline on a paper, I can manage my time efficiently.
10. I can meet the writing standards of an evaluator who is very demanding.
11. I can come up with memorable examples quickly to illustrate an important point.
12. I can rewrite my wordy or confusing sentences clearly.

13. When I need to make a subtle or an abstract idea more imaginable, I can use words to create a vivid picture.
14. I can locate and use appropriate reference source when I need to document an important point.
15. I can write very effective transitional sentences from one idea to another.
16. I can refocus my concentration on writing when I find myself thinking about other things.
17. When I write on a length topic, I can create a variety of good outlines for the main sections of my paper.
18. When I want to persuade a skeptical reader about a point, I can come up with a convincing quote from an authority.
19. When I get stuck writing a paper, I can find ways to overcome the problem.
20. I can find ways to motivate myself to write a paper even when the topic holds little interest for me.
21. When I have written a long or complex paper, I can find and correct all my grammatical errors.
22. I can revise a first draft of any paper so that it is shorter and better organized.
23. When I edit a complex paper, I can find and correct all my grammatical errors.
24. I can find other people who will give critical feedback on early drafts of my paper
25. When my paper is written on a complicated topic, I can come up with a short informative title.

BIBLIOGRAPHY

- [1] D. A. Winsor, "Engineering Writing/Writing Engineering," *College Composition and Communication*, vol. 41, no. 1, 1990, pp. 58–70.
- [2] M. D. Blickle and M. E. Passe, *Readings for Technical Writers*. Ballston Lake: NY Ronald Press, 1963.
- [3] E. Wheeler and R. L. McDonald, "Writing in engineering courses," *Journal of Engineering Education*, vol. 89, no. 4, pp. 481–486, 2000.
- [4] J. A. Daly, "Writing apprehension and writing competency," *Journal of Educational Research*, vol. 72, no. 1, pp. 10–14, 1978.
- [5] J. A. Daly and M. D. Miller, "The Empirical Development of an Instrument to Measure Writing Apprehension," *Research in the Teaching of English*, vol. 9, no. 3, 1975, pp. 242–249.
- [6] J. A. Daly and D. A. Wilson, "Writing Apprehension, Self-Esteem, and Personality," in *Research in the Teaching of English*, vol. 17, no. 4, 1983, pp. 327–341.
- [7] B. J. Zimmerman and A. Bandura, "Impact of Self-Regulatory Influences on Writing Course Attainment," *American Educational Research Journal.*, vol. 31, no. 4, pp. 845–862, 1994.
- [8] C. G. P. Berdanier, "Learning the Language of Academic Engineering: Sociocognitive Writing in Graduate Students.," *ProQuest Dissertations and Theses*, 2016.
- [9] G. M. Phillips, "Reticence: Pathology of the normal speaker," *Speech Monographs*, vol. 35, no. 1, pp. 39–49, 1968.
- [10] J. A. Daly, "Writing Apprehension in the Classroom: Teacher Role Expectancies of the Apprehensive Writer," *Research in the Teaching of English*, vol. 13, no. 1. 1979.

- [11] J. A. Daly and W. Shamo, "Academic Decisions as a Function of Writing Apprehension," *Research in the Teaching of English*, vol. 12, no. 2, pp. 119–126, 1978.
- [12] J. C. McCroskey and J. F. Andersen, "The Relationship Between Communication Apprehension and Academic Achievement Among College Students," *Human Communication Research*, vol. 3, no. 1, pp. 73–81, 1976.
- [13] J. A. Daly and W. G. Shamo, "Writing Apprehension and Occupational Choice," *Journal of Occupational Psychology*, vol. 21, no. 1, pp. 55–56, 1976.
- [14] E. Zerbe and C. G. P. Berdanier, "Writing Attitudes and Career Trajectories of Domestic and International Students in the United States," *International Journal of Engineering Education*, vol. 36, no. 1(A), pp. 226–240, 2020.
- [15] J. C. McCroskey, "The Implementation of a Large-Scale Program of Systematic Desensitization for Communication Apprehension," *The Speech Teacher*, vol. 21, no. 4, pp. 255–264, 1972.
- [16] American Society for Engineering Education. (2022). *Profiles of Engineering and Engineering Technology*, 2021. Washington, DC.

ACADEMIC VITA

Adriana Walp

EDUCATION

Mechanical Engineering, B.S.

Graduation: May 2023

The Pennsylvania State University, *Schreyer Honors College*

EMPLOYMENT

Mechanical Engineering Co-op, Bechtel Plant Machinery Inc., *Monroeville, PA*

Machinery Health Analyst, Fleet Support

Fall 2020, Summer 2021

- Received training on the history, theory, technology, and operations of the Naval Nuclear Propulsion Program
- Completed vibration data analysis for machinery health concerns
- Wrote/received correspondence regarding topics including data collection and transmittal methods
- Collaborated with my primary team and additional departments to create required changes for a technical manual
- Coordinated with other organizations and departments to certify the safety of an assembly modification

Cognizant Engineer, Auxiliary Pumps

Spring 2022

- Developed a scope of work to have a supplier complete testing on their support system
- Planned a material certification review of 14 pieces of hardware to ensure supplier compliance with material and work quality specifications
- Authored a scope of work based on my research of 1,156 nonconformance reports from a supplier and evaluated if there were drawing changes that would reduce nonconformances and improve manufacturing efficiency
- Participated in several weekly technical discussions with 4 different suppliers as well as government customers
- Wrote/received correspondence on degradation of specifications reports, the implementation of supplier corrective actions, provisioning, and changes to drawings and specifications

SKILLS & SOFTWARE

Non-Destructive Testing | Project Management | Supplier Surveillance | Materials Processing
MATLAB | SolidWorks | Abaqus | Autocad | Audacity | C++ | Adobe Photoshop

INVOLVEMENT

Undergraduate Research Assistant , Engineering Cognitive Research Laboratory	2020-2023
Member , Phi Sigma Rho Engineering Sorority	2019-2023
Envoy , Penn State Women Engineering Program	2019-2020
Member , Society of Women Engineers	2018-2023
Volunteer , State College Meals on Wheels	2020-2021
Volunteer , Center County PAWS Animal Shelter	2021-2023