International Journal of Engineering Education Vol. 36, No. 1(A), pp. 226–240, 2020
Printed in Great Britain

0949-149X/91 $3.00+0.00

Writing Attitudes and Career Trajectories of Domestic and International Students in the United States*

ELLEN ZERBE and CATHERINE G. P. BERDANIER
Department of Mechanical Engineering, Pennsylvania State University, University Park, PA, USA.
E-mail: elt5112@psu.edu, cgb9@psu.edu

Graduate engineering students are rarely taught to write in formal disciplinary coursework, but it is an essential skill required for success in industry and academic careers. This study builds on existing work exploring doctoral writing practices, processes, and attitudes, expanding it into the disciplinary context of engineering. Engineering traditionally offers few opportunities for students to practice or develop academic writing in coursework, despite the fact that most academic milestones for graduate students are based on writing. Grounded in Academic Literacies Theory, this paper seeks to determine how engineering graduate students' writing attitudes affect their career trajectories. This study surveyed N = 621 engineering graduate students at ten research-intensive universities in the United States using several previously established scales. These data were analyzed using Pearson correlations and Welch's t-test methods to answer the research questions. Results indicate that while most students consider writing to be a knowledge-transforming activity, they overwhelmingly struggle with procrastination, perfectionism, and low-writing self-efficacy. Further, strong writing attitudes are linked statistically with the likelihood to pursue a broader set of future careers after graduate school, indicating that writing may be an invisible mediator for broadening participation in all sectors of engineering.

Keywords: engineering graduate students; writing; writing attitudes; career trajectories

1. Introduction

Although most milestones in engineering graduate programs are based on written deliverables – dissertation proposals, dissertations, conference and journal papers, and grants – few engineering graduate programs offer disciplinary writing guidance or education in the formal curriculum. Across disciplines, even outside of engineering, students are expected to develop writing expertise through apprenticeship in their research groups, a process that scholars have likened to "osmosis" [1]. Many advisors do not feel comfortable or competent teaching writing [2, 3], and are further deterred by the language barriers that English as a Foreign Language (EFL) students can exhibit [4–7]. Further, in technical disciplines like engineering, research advisors may not feel that it is their job to teach academic writing to their students [2, 8].

Some universities offer writing center resources that are accessible by graduate students [9, 10], but many writing centers struggle to offer disciplinary expertise. This can be an issue because while graduate engineering students are struggling to learn to write, they are also learning to communicate as a member of their discipline, and may not have strong guidance in the disciplinary discourse expectations in their particular department or disciplinary community. Writing scholars have long anecdotally linked the development of disciplinary writing competence with disciplinary identity development [11, 12], positing that the development of this academic identity is crucial to reduce time-to-completion and that it may lead to persistence rather than attrition [13, 14], although to date these claims are not substantiated statistically.

In this work, we begin to unravel the complex relationship between writing and professional development for doctoral engineering students, a context that is typically understudied in the technical communication, writing studies, and engineering education communities collectively. We present quantitative data showing the relationships that engineering graduate students in the U.S. have with the writing process, while also answering research questions surrounding how these attitudes correlate statistically with one another, how they differ between international and U.S. domestic students, and how they impact future career trajectories of graduate engineering students.

2. Literature Review

The process of graduate student socialization is complex [15–17], requiring intensive interpersonal communication, scholarly effort, and the ability for students to unpack the invisible norms and expectations of their disciplines. Across disciplines, qualitative work shows that graduate students struggle with a variety of sociological and psychological issues during their tenure in graduate school [18], which is itself mediated by the advisor-advisee relationship [19, 20], the culture of the department and university [21, 22], funding issues [23–25], and

* Accepted 3 November 2019.

the ability to progress through academic milestones and informal threshold concepts [26]. Little research focuses on graduate engineering students, although the topic is becoming more popular recently [14, 27–29], calling attention to the fact that the ten-year completion rates are only between 65% and 76% in the U.S. for women and men respectively [30, 31] with numbers much lower for traditionally underrepresented populations, falling below 50% for Black and African American engineering doctoral students [32]. Other national reports indicate that even if engineering students achieve their degree goals, many, particularly women and women from underrepresented groups, either do not pursue careers in their technical area of expertise, or leave their technical career at some point and do not return [33].

Though literature confirms that engineering doctoral attrition is typically linked with academic inability [34, 35] faculty may rely on anecdotal rationales for the reasons why students leave their PhD programs. Some of these narratives posit that attrition only happens if a student does not pass qualifying exams [36]. Others purport that students leaving do not have an innate "taste for science" [37]. The narratives supporting an academic "taste" for research – which we posit directly represent the unarticulated knowledge, skills, and attributes required to succeed in today's academic research economy – also surrounds faculty perceptions on PhD-holding STEM students who pursue careers in industry [38, 39]. While a few researchers have investigated the skills required for diverse career pipelines for engineering PhD students [40, 41], there is little known about how the educational experiences or development of particular competencies of engineering graduate students may lead to various career trajectories. This is important in light of the fact that approximately 80% of engineering PhDs in the U.S. will pursue careers in industry [42], indicative of a changing role of faculty within academic capitalism [43] required in engineering research and increased competitiveness for fewer federal research dollars. Therefore, in this paper, we explore one of the untaught and underemphasized competencies required for graduate students to become a member of their academic discipline: academic engineering writing.

Documented worldwide, engineering graduate students are, in general, not formally taught to write and revise for academic audiences [44–47]. At the undergraduate level, most writing focuses on laboratory reports or technical writing courses [48, 49], which still lead students to be unprepared for workplace communication [50]. If students matriculate to graduate school, advisors are expected to teach their graduate students to write for academic audiences, but this rarely happens smoothly, as most faculty do not feel comfortable teaching writing or do not feel like it is their responsibility [2, 8]. A discomfort with academic engineering writing combined with advisors' poor writing instruction can lead to issues when students are working toward publications, theses or dissertations, or grant proposals, and likely has a direct impact on who will choose to pursue writing-heavy engineering careers in academia.

Few engineering education scholars study engineering writing, those that do are either examining the writing process and how students gain competency, or the relationships that the writing process has in the development of graduate engineering students more generally. Most notably, Adams' and Matusovich's Dissertation Institute brings graduate engineering students from underserved groups together for an intensive dissertation-writing bootcamp as a means to provide structure and accountability at the end of the PhD process [14]. In the technical communication and writing studies disciplines, scholars investigate the role that courses or other interventions can have to help graduate students confront barriers toward academic writing for engineering students [51–53]. These interventions explicitly and implicitly work to confront the unhealthy attitudes that engineering graduate students often bring with them to the writing process.

Writing studies scholars have long posited that the affective domain undergirds success in writing [6, 54, 55], and other scholars have promoted a variety of categories to describe the attitudes that students across disciplines have with writing [56–59]. Some of these are specific to graduate students, noting that graduate students' attitudes toward writing are important because of the amount of writing that most graduate students have to do [60, 61]. Outside of our group's recent work, these scales have not been used to describe the writing attitudes of engineering graduate students [62, 63]. The purpose of this work is to apply quantitative scales of writing attitudes to an engineering graduate student context to provide a holistic quantitative "snapshot" of the attitudes of engineering graduate students studying in the United States. To meet this need, we propose the following guiding research questions:

1. What are the predominant characteristic attitudes about writing for engineering graduate students in the United States, and how, if at all, do writing attitudes correlate with each other?
2. What differences, if any, exist between U.S. international and domestic students?
3. What correlations, if any, exist between writing attitudes and intended career trajectories?

3. Theoretical Orientation

The theoretical orientation that guides this research is academic literacies theory, proposed by Lea and Street [64, 65] and extended into engineering writing disciplines by Berdanier [66]. Academic literacies theory describes how literacy in academia means knowing how to read and write as a member of a particular disciplinary community, as each discipline and subdiscipline has its own patterns, expectations, and norms for acceptable communication [44, 67–69]. The development of academic literacy pervades all aspects of graduate socialization, as strong disciplinary communication is grounded in academic rigor, appropriate research methods, and relevancy of the problem addressed. It also addresses that graduate students in their education are also learning to communicate the rigor by situating the appropriate parts of their research in a format that is most compelling to the particular audience as they communicate their research in writing and oral presentations. Undergirding the development of academic literacy is the implicit agreement to be judged by the academic community in all communicative events, a tenet that is overwhelming to most graduate students. In this study, we propose that attitudes associated with one aspect of academic literacy – that is, toward academic writing – may affect long-term career trajectories.

4. Methods

This quantitative analysis of the writing attitudes of engineering graduate students is part of a larger mixed methods study investigating writing attitudes in relation to career trajectories and persistence and attrition for engineering doctoral students. This study presents quantitative data collected from current engineering graduate students at various stages of their tenure in their doctoral programs of study.

4.1 Participants and Recruitment

A survey was developed to capture the writing attitudes of engineering graduate students. To recruit participants, we contacted chairs and administrative assistants within engineering departments at ten research-intensive universities geographically distributed across the United States, and asked them to forward a link to the survey to their graduate students. We did not selectively sample for engineering discipline or any demographic variables. Approximately eight hundred individuals completed a portion of the survey, and after cleaning the data for incomplete responses, a total of N = 621 participants are represented in this study. Participants who completed the survey were awarded a five-dollar Amazon gift card to incentivize participation. Of the N = 621 participants, 38% identified as female, 54% were domestic students, and 61% spoke English as their first language. These numbers are over representative of the both the percentage of women enrolled in engineering graduate programs (which averages between 23 and 35% across all engineering disciplines in the U.S, according to the National Science Foundation), and residency breakdown (44% of PhD students and 40% of Master's students are U.S. domestic students)[70].

The survey was distributed to U.S. domestic students, permanent resident, and international students studying in the U.S. Only 4% of the participants identified as permanent residents, 54% (N = 328 participants) as domestic, and 42% (N = 259 participants) as international students. Relevant demographic data distributed by resident status is provided in Appendix A. In our analysis, we included permanent residents in the domestic category. We did not collect specific data on nationality for international students. The survey also collected information on participants' progress through their graduate programs. Over half (56%) of participants identified as "early career" graduate students enrolled in the first or second year of their doctoral programs, students who had not completed their qualifying exams yet, and all Master's students. Master's students comprised 35% of the total participants. In contrast, only 15% of the total sample identified themselves as "late career" graduate students, defined as students in or beyond their fifth year of their PhD. We also collected data on amount of formal writing instruction, to which 61% of participants reported not having taken a writing intensive course in the two years prior to taking the survey, while nearly half reported they never or rarely speak with their PhD advisor about writing.

4.2 Scale Description, Data Collection, and Analysis

The survey instrument comprised a collection of questions regarding demographics and likelihood to pursue certain careers as well as two established writing scales investigating writing attitudes. The full instrument can be provided upon request of the corresponding authors. The question regarding career trajectory requested participants to rate the likelihood that she or he would pursue any of nine different career tracks common to engineers: four Academic options (Teaching-focused, Research-focused, Tenure-track, and Non-Tenure track), Research, Government, Industry Research & Development (R&D), Industry Non-Research & Development (non-R&D), or Entrepreneurship. A tenth, optional, "other" option was provided, but due to few participants ranking this option, it was not included in our analysis. The participants could rank each option as "highly unlikely," "unlikely," "moderately likely," and "very likely" with no limit on how many they could consider in any likelihood (e.g., an individual could mark she or he was highly likely to pursue all ten trajectories.)

To assess writing attitudes we employed two scales, the Inventory of Graduate Writing Processes [60] and Graduate Concepts of Academic Writing [61]. Collectively, we refer to the writing process factors and writing conception factors as writing attitudes. Definitions for each of the factors, named and established by the original authors, are discussed in Table 1. Both scales were originally created for graduate students in general, and we have validated them on graduate engineering student populations in this and prior work [62, 63].

The Inventory of Graduate Writing Processes developed by Lavelle and Bushrow [60], which was developed to categorize individuals by the ways they write during the composition process into seven descriptive categories: Elaborative, Low Self-Efficacy, No Revision, Intuitive, Scientist, Task Oriented, and Sculptor. Scale items from the factors are scrambed, with some items reverse-coded to confirm internal reliability. To analyze this scale, reversed items are re-coded, and within-construct items are summed and averaged. In our work, we consider a writers dominant and second-most dominant writing processes, as we believe a writer may subscribe to more than one dominant writing process. Respondents also completed the Graduate Concepts of Academic Writing survey developed by Lonka et al. [61], which characterizes writer's conceptions of writing (e.g., not what happens during the writing process) into six categories: Blocks, Procrastination, Perfectionism, Innate Ability, Knowledge-Transforming, and Productivity. The structure and analysis of this scale is the same as the prior scale.

Quantitative data downloaded from Qualtrics were re-uploaded to MATLAB R2017a for cleaning and analysis. In cleaning the data, we eliminate incomplete responses, anonymized the responses, and corrected the reverse-coded scale options. Our analysis script automatically analyzed the writing attitudes scales to output each participants' dominant and secondary writing processes and concepts. The script also identified the primary and secondary process and concept for each for each participant, and the scores were used when calculating relationships. All statistical calculations (Pearson correlations, Welch's t-tests) were performed on the data using IBM SPSS Statistics 25.

4.3 Limitations

The results of this survey represent the writing attitudes of a moderately large sample size of N = 621 engineering graduate student participants across ten R1 universities. As discussed in the recruitment section, some groups were slightly over-sampled (e.g., women), while other demographic variables (e.g., citizenship) are more closely repre-

Table 1. Description of Scale Factors in Graduate Writing Attitudes Survey

Inventory of Graduate Writing Processes (Lavelle & Bushrow [60])		**Graduate Concepts of Writing (Lonka et al. [61])**	
Writing Process Factor	**Description**	**Writing Concept Factor**	**Description**
Elaborative	writer has a personal investment in knowledge creation through writing	**Blocks**	writer's block prevents individual from starting
Low Self-Efficacy	lack of confidence in writing skills inhibits progress	**Procrastination**	individual delays starting or continuing writing
No Revision	written works are completed with little to no editing	**Perfectionism**	finished document cannot be reached due to continuous editing and revising
Intuitive	writer "feels" or senses how a written work should develop	**Innate Ability**	writing is a talent that cannot be taught and therefore cannot be developed
Scientist	writer strictly adheres to a specific order during the writing process	**Knowledge Transforming**	individual uses writing as a way to test arguments and generate new knowledge
Task Oriented	rules guide the writing process without personal investment from the author	**Productivity**	individual will stay on task and can continually make progress
Sculptor	writer quickly creates an initial draft and many revisions are done before document is complete		

sentative of academic engineering while still not being completely representative. These variations are likely due to self-selection bias. Further, we sampled from ten R1 universities that are geographically distributed across the United States, representing one type of institution. Results may differ for PhD students at other types of institutions, or for programs that have different curricular or programmatic structures. Further, we understand that to group all international students into a single category for the purposes of data analysis is problematic; however, we do not have specific country of origin/citizenship data for these participants. We would expect there to be differences based on regional linguistic or educational requirements in terms of familiarity with English. For this study, even if we had specific country of origin data, there would likely be too few students in each category to make meaningful inferences based on country or region of origin.

5. Results

In this section we present study results as they pertain to each research question, such that a complete vision of graduate engineering writing attitudes in the U.S. is illuminated.

5.1 Dominant Characteristic Writing Attitudes of Engineering Graduate Students

The results of the Inventory of Graduate Writing Processes reveal the student's predominant approach when creating written work. It is a classification of "how" the student writes. These approaches can be classified as either strong/healthy (i.e., encourage productive writing) or weak/unhealthy (i.e., inhibit productive writing). The most common primary writing approach was Elaborative, a strong approach to writing. Engineering graduate students recognize that writing requires a personal investment. This is also demonstrated in the very few participants who were categorized as Task Oriented, which lacks personal investment, as their primary or secondary writing approach.

Despite these trends, weak approaches are not uncommon. Low Self-Efficacy is the second most common primary approach, meaning that many engineering graduate students struggle with confidence in their writing. Intuitive and Scientist are common secondary approaches. Intuitive is a strong approach to writing as the student connects the writing process to their senses ("this sounds right," "I see the story I want to tell"). The Scientist approach may be strong or weak depending on how it manifests in the writing process. A well-formed process for writing may help with organization, but too strict adherence to order may inhibit creativity.

Different from the writing processes, the results of the Graduate Concepts of Writing describe what the student believes about the writing process. It classifies the preconceptions about writing the student holds that may influence the success of completing a document. Writing concepts can also be divided into strong concepts, such as Knowledge Transforming and Productivity, and weak concepts, such as Blocks, Procrastination, Perfectionism, and Innate Ability. The Knowledge Transforming concept is the most common primary concept among our participants. This is encouraging, since it is expected that, as graduate students, these individuals would be generating knowledge in their research. However, a large percentage of graduate engineering students hold writer's block and Procrastination as secondary concepts, indicating that even students with healthy writing attitudes still struggle. Fig. 1 shows the primary and secondary writing approaches and concepts of the participants in aggregate.

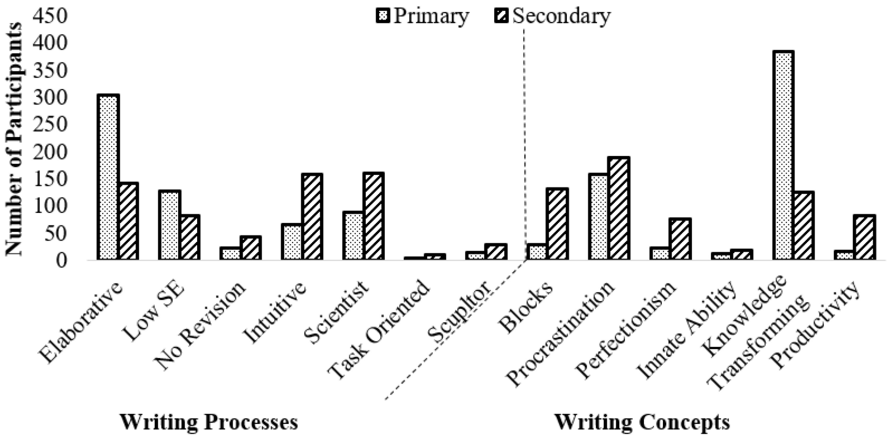

Fig. 1. Primary and secondary writing processes and writing concepts of engineering graduate students.

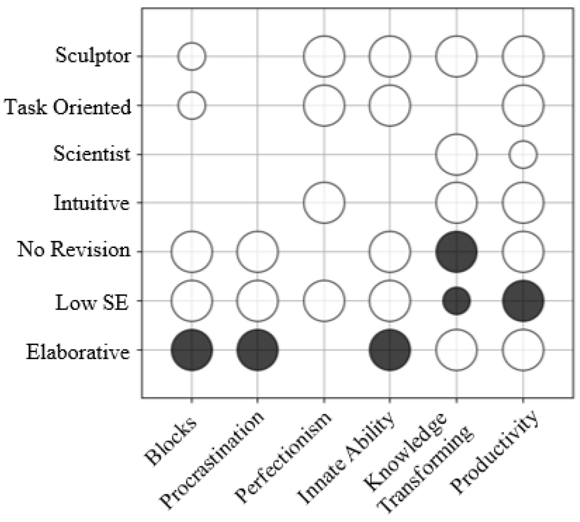

Fig. 2. Qualitative correlations between writing attiudes and concepts.

5.2 Correlations Between Writing Attitudes and Concepts

Pearson correlations were calculated to determine how attitudes linked in graduate engineering student writers. A correlation table is shown in Appendix B showing all correlations, with statistically significant correlations shown in boldface. Fig. 2 shows a qualitative summary of the correlations between writing factors and concepts from the two scales, where white dots indicate statistically significant ($p < 0.05$) positive correlations, black dots indicate statistically significant ($p < 0.05$) negative correlations, and dot size indicates the magnitude of significance (smaller dots are significant to $p < 0.05$ and larger dots are significant to $p < 0.01$). As shown, Elaborative writing processes strongly negatively correlate with Blocks, Procrastination, and Innate Ability, all weak concepts of writing, and strongly positively correlate with Knowledge-Transforming and Productivity, both strong concepts. Low Self-Efficacy is strongly negatively correlated with Productivity, adding support to the idea that progress in writing is unlikely when this is a lack of confidence in one's ability.

5.3 Differences Between U.S. Domestic and International Students Studying in the U.S.

Fig. 3 shows the primary and secondary writing processes and concepts disaggregated international or domestic student status. While Elaborative is the most common primary approach for both groups, Low Self-Efficacy is more common with international than domestic students. Most of the difference between the numbers of students in each category is a result of uneven group sizes (N = 362 are domestic, whereas N = 259 are international). Therefore, we would expect more domestic students to occupy each category because there are more domestic students than international students in our sample. The only attitudes where this is not the case are the less-common attitudes: Task Oriented, Sculptor, Perfectionism, and Innate Ability. More international students identify with these attitudes than domestic students.

To compare these groups, we employed a Welch's t-test since the variances between the groups were not equal. Results of the test are displayed in Table 2. Despite similar aggregate writing patterns overall (e.g., Fig. 1), the results show that for most factors, international students and U.S. domestic students hold statistically different attitudes. Low Self-Efficacy, No Revision, Task-Oriented, Sculptor, Perfectionism, Innate Ability, Blocks, and Productivity are all significantly different ($p < 0.01$).

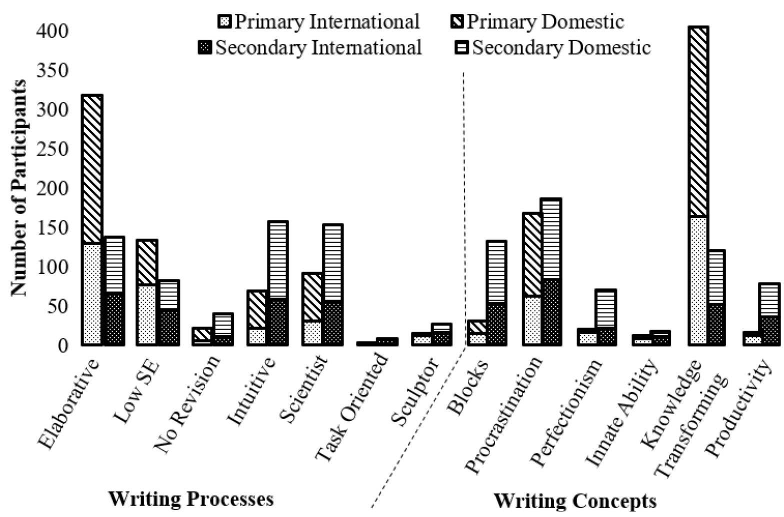

Fig. 3. Primary and secondary writing attitudes separated by international and domestic status.

Table 2. Results of Welch's t-test comparing international vs domestic student writing attitudes. Bolded effect sizes are medium to large effect sizes. ** p = 0.01

		Mean	Std. Deviation	Effect Size	Statistical Significance
Processes					
Elaborative	Domestic	3.07	0.39	0.13	0.079
	International	3.12	0.35		
Low Self-Efficacy	Domestic	2.68	0.38	**0.66**	0.000**
	International	2.92	0.35		
No Revision	Domestic	2.31	0.43	0.30	0.000**
	International	2.43	0.38		
Intuitive	Domestic	2.87	0.35	0.11	0.141
	International	2.91	0.36		
Scientist	Domestic	2.89	0.30	0.07	0.493
	International	2.91	0.31		
Task-Oriented	Domestic	2.29	0.26	**0.52**	0.000**
	International	2.45	0.35		
Sculptor	Domestic	2.43	0.40	**0.70**	0.000**
	International	2.70	0.37		
Concepts					
Blocks	Domestic	2.88	0.83	0.22	0.005**
	International	3.05	0.74		
Procrastination	Domestic	3.30	0.94	0.12	0.197
	International	3.40	0.88		
Perfectionism	Domestic	2.70	0.80	0.25	0.002**
	International	2.89	0.74		
Innate Ability	Domestic	1.71	0.76	**0.67**	0.000**
	International	2.29	0.95		
Knowledge Transforming	Domestic	4.00	0.53	0.02	0.853
	International	4.01	0.52		
Productivity	Domestic	2.30	0.74	0.45	0.000**
	International	2.65	0.83		

5.4 Correlations between Writing Attitudes and Engineering Graduate Students' Anticipated Career Trajectories

As part of the survey, we asked about the likelihood that the participant would pursue certain careers common to engineers. The distribution of likelihoods for each career is shown in Table 3. In general, the participants perceived they are less likely to pursue all Academic careers compared with Industry careers, with the Non-Tenure track as the most unlikely option. The most likely career path was Industry R&D, showing a trend, not away from research, but away from the culture of Academia.

The qualitative patterns of statistically significance between career trajectories and writing attitudes are shown in Fig. 4, with the numerical Pearson correlation values shown in Appendix B. White dots represent a statistically significant positive correlation and black dots represent statistically significant negative correlations. Small dots indicate significance at p = 0.05, and large dots indicate significance at p = 0.01.

Only the Non-R&D career trajectory produced negative correlations. Knowledge Transforming concepts and Elaborative processes, both very common writing attitudes, were negatively correlated with Industry Non-R&D. This demonstrates that students who hold these strong writing attitudes likely have had success in their experiences with writing during graduate school and believe they do not need to pursue a career that may not need to generate and communicate new knowledge. Other strong writing attitudes like Productivity and

Table 3. Distribution of likelihood to pursue certain careers after graduation

	Academic Teaching	Academic Research	Academic Tenure	Academic Non-tenure	Research	Government	Industry RD	Industry Non-RD	Entrepreneurship	Other
Highly Unlikely	146	113	144	181	44	103	19	81	144	54
Unlikely	190	206	192	269	132	189	61	152	182	30
Moderately Likely	208	191	176	137	257	243	224	200	203	13
Very Likely	72	108	105	22	184	81	313	185	87	17

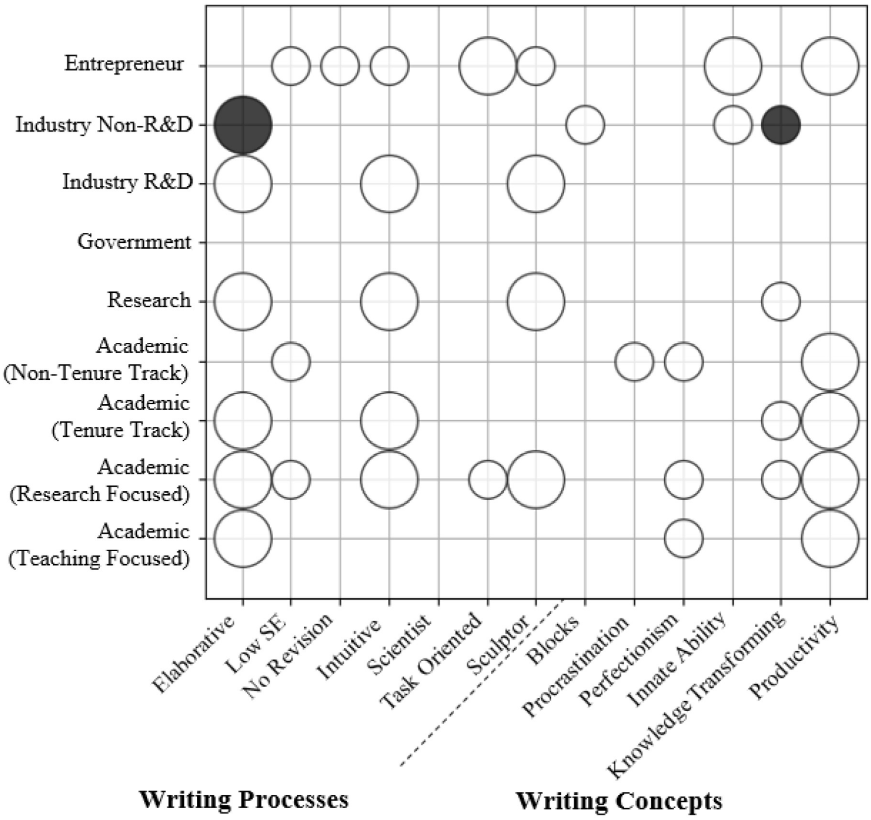

Fig. 4. Correlation between writing attitudes and certainty of career trajectories.

Elaborative are positively correlated with many career paths, whereas weak writing attitudes (e.g., Blocks, Procrastination, Innate Ability, and No Revision) are correlated with few career trajectories. This trend is perhaps evident of a self-limiting belief in which students who struggle with writing believe they will not be successful in careers that they perceive to require a substantial amount of writing. The Scientist approach to writing is not correlated with any career trajectories, indicating that the order in which an individual approaches writing does not influence belief in her or his ability to succeed in certain careers.

6. Discussion and Implications

6.1 Discussion of Results

The results of this study show that not all engineering graduate students approach writing in the same way or have the same mentality regarding writing. A student's resident status and first language are likely to influence their attitude about writing. Therefore, a "one-size-fits-all" approach to writing instruction may not be beneficial for engineering graduate students. Ways to support strong writing attitudes in engineering graduate students are discussed more in the implications section to follow. Beyond simply writing in a foreign language, academic literacies theory demonstrates how these students are expected to understand discipline-specific discourse, communicate their work effectively, and be judged according to the expectations of their academic community. The prevalence of Low Self-Efficacy in our population of International students (most of whom are EFL) group is unfortunate, yet backed by a substantial community of research on writing issues for EFL graduate students [6, 71, 72], which lead them to experience less success with their written works and consequentially a decrease in confidence in their abilities [73]. While correlations do not infer causality related to any writing attitudes, we fear that without proper support, a lack of confidence could lead to a students' belief that they can never improve [60], or lower levels of emotional well-being, which is indicative of a more inclusive picture of success in graduate school.

"Success" in graduate school may also be represented by a student's ability achieve employment in her or his desired career sector, for which the choices are ever-diversifying for science and engineering graduate students [39, 74]. In this study, we reported that stronger writing attitudes were correlated with more career paths, while weaker attitudes correlated with fewer career paths. While it seems intuitive that students who seek a PhD may be more likely to pursue careers in academia, in practice nearly 80% of engineering PhDs are employed in industry careers [42]. Further, we cannot make assumptions with regard to the trajectories of Master's students with respect to academic careers, as they may be considering pursuing a PhD or academic careers in the future. However, regardless of career trajectory, written engineering communication is a critical skill [40, 41], and this study correlates strong writing attitudes with the likelihood of pursuing a wider variety of careers.

Interpreted through academic literacies theory, since the discipline of engineering has established standards and expectations for written work published and presented in the community – as do all disciplines – students who have weaker attitudes toward writing and who struggle with low writing self-efficacy may limit themselves in terms of potential career pathways, including those they perceive to include more writing. It is plausible that graduate engineering students have reflected on their perceived strengths and weaknesses, and are already self-selecting out of academic career trajectories due to unfamiliarity with academic writing processes, their goals as a terminal Master's degree student, or their aversion to writing combined with an understanding of the amount of writing required for success in academia. This aligns with Daly and Shamo's [75] work that determined that students often select engineering disciplines because they do not think they will have to write. Writing scholars also propose linkages between the development of academic literacy and the development of disciplinary identity and belongingness [4, 12, 76–78] that may perpetuate into belongingness in certain career pathways, particularly if students choose careers where they perceive they will not have to write.

More interesting are the patterns that hold for strong engineering writers to be likely to consider a wide breadth of careers. This might represent that professional competency in engineering writing can facilitate preparation and success across engineering sectors, and that students are confident in their ability to pursue both academic and non-academic careers. While our study does not capture causality, the mixed methods portion of the research indicates that engineering graduate students both identify that they are lacking exposure to written competency required for them to be successful in academic careers, and also have an overall distaste and mistrust for academic careers, which adds to the desire to pursue academic careers as well. These students have built academic literacy surrounding the system of academic engineering and publication, and many have decided not to pursue these career avenues [79].

6.2 Implications for Graduate Programs, Research Advisors, and Instructors

These interpretations on academic literacy offer a unique perspective for engineering graduate programs and research advisors. For EFL students in particular, programs and faculty must be conscious of the fact that students are encountering two different "languages" at the same time – one as English, and the other as the disciplinary academic discourse community. At the very least, discussion of these issues and access to departmental, university, or online resources or tutorials about writing may help EFL students to better approach their attitudes toward writing in graduate school while also operating in a foreign environment. For both domestic and international students, who struggle similarly with procrastination as a weak writing concept, instruction aimed at combatting procrastination (e.g., timed writing exercises, writing journals, distributed deadlines, writing accountability groups) would be beneficial to most students. Explicit discussion of weak writing attitudes and the self-limiting correlations between writing attitudes with career trajectories, perhaps using the present findings to facilitate discussion, may also be an effective method for talking about writing with graduate students.

To prepare competitive graduate students for a broad set of careers, we must also help them develop accurate perceptions of and attitudes toward engineering writing while teaching them to write in an environment that increases their competency to communicate in a disciplinary context. As suggested by existing initiatives, graduate writing courses should be taught by engineering faculty, in conjunction with technical writing faculty, where students learn to write through authentic disciplinary tasks, such as journal manuscripts or grants [53, 80]. Students should also be encouraged to form peer writing and support groups, as recommended by writing researchers to add accountability and peer mentorship to make writing a more social experience [5, 45], *en route* to developing academic literacy.

The correlations indicated in this research indicate that facilitating writing competency in engineering graduate student might be one actionable item toward broadening participation, if healthy attitudes toward writing "level the playing field" for all students to pursue the widest breadth of careers in which they are interested, regardless of their past affective experiences with academic writing. If academic writing is a barrier for students who are lacking social or academic capital [81], then these students may be deterred from pursuing careers in academia or those that may require publishing.

7. Conclusions

Engineering graduate programs often require many milestones are based in written documents, requiring graduate students to know how to effectively communicate their research with little prior experience or instruction. This study sought to understand engineering graduate students' attitudes toward writing, and how these may influence career trajectories. Results of this study show that while most engineering graduate student identify with strong writing attitudes like Elaborative and Knowledge Transforming, they still struggle with weaker attitudes like Procrastination and Low Self-Efficacy. International students studying in the U.S. are statistically different in their writing attitudes compared to domestic students, notably in Low Self-Efficacy being more present in the international students. With a majority of engineering graduate students being international, specialized writing instruction may be necessary to properly support these students, but strong tendencies toward procrastination are in common in both international and U.S. domestic students. Supporting and encouraging strong writing attitudes is important as strong writing attitudes correlate with students' likelihood to see themselves in a wide variety of careers, important to broadening participation in engineering careers. Our interpretation of these findings through theory guide implications for engineering faculty and programs in developing writing programs to facilitate the success of graduate engineering students.

References

1. A. Paré, D. Starke-Meyerring and L. Mcalpine, Knowledge and Identity Work in the Supervision of Doctoral Student Writing: Shaping Rhetorical Subjects, *Writ. Knowl. Soc.*, pp. 215–236, 2011.
2. J. Catterall, P. Ross, C. Aitchison and S. Bergin, Pedagogical approaches that facilitate writing in postgraduate research candidature in science and technology, *J. Univ. Teach. . . .* , **8**(2), pp. 1–10, 2011.
3. B. Kamler, Rethinking doctoral publication practices: Writing from and beyond the thesis, *Stud. High. Educ.*, **33**(3), pp. 283–294, Jun. 2008.
4. A. R. Abasi, N. Akbari and B. Graves, Discourse appropriation, construction of identities, and the complex issue of plagiarism: ESL students writing in graduate school, *J. Second Lang. Writ.*, **15**(2), pp. 102–117, 2006.
5. D. Allison, L. Cooley and J. Lewkowicz, Dissertation writing in action: The development of a disseration writing support program for ESL graduate research students, *English Specif. Purp.*, **17**(2), pp. 199–217, 1998.
6. H. Mei-ching, Exploring Writing Anxiety and Self-Efficacy among EFL Graduate Students in Taiwan, *High. Educ. Stud.*, **6**(1), pp. 24–39, 2016.
7. Y. S. Cheng, A measure of second language writing anxiety: Scale development and preliminary validation, *J. Second Lang. Writ.*, **13**(4), pp. 313–335, 2004.
8. R. Goldsmith and K. Willey, 'It's not my job to teach writing': Activity theory analysis of invisible writing practices in the engineering curriculum, *J. Acad. Lang. Learn.*, **10**(1), pp. A118–A129, 2016.
9. S. Simpson, R. Clemens, D. R. Killingsworth and J. D. Ford, Creating a Culture of Communication: A Graduate-Level STEM Communication Fellows Program at a Science and Engineering University Program Development at New Mexico Tech, *Across Discip.*, **12**(3), 2015.
10. M. Di Pierro, Excellence in Doctoral Education: Defining Best Practices, *Coll. Stud. J.*, **41**(2), pp. 2–10, 2007.
11. D. Bartholomae, Inventing the university, in *When a Writer Can't Write: Studies in Writer's Block and Other Composing-Process Problems*, M. Rose, Ed. New York, NY: The Guildford Press, 1985, pp. 134–165.
12. M. Rose and K. A. McClafferty, A Call for the Teaching of Writing in Graduate Education, *Educ. Res.*, **30**(2), pp. 27–33, 2001.
13. L. A. Locke and M. Boyle, Avoiding the A . B . D . Abyss: A Grounded Theory Study of a Dissertation-Focused Course for Doctoral Students in an Educational Leadership Program, *Qual. Rep.*, **21**(9), pp. 1574–1593, 2016.
14. I. M. Hasbun, H. M. Matusovich and S. G. Adams, The dissertation Institute: Motivating doctoral engineering students toward degree completion, in *IEEE Frontiers in Education Conference*, 2016, vol. 2016-Novem, p. American Society for Engineering Education (ASEE).
15. P. A. Duff, Problematising academic discourse socialisation, *Learn. discourses discourses Learn.*, **1**(1), pp. 1–18, 2007.
16. J. M. Braxton and L. L. Baird, Preparation for professional self-regulation, *Sci. Eng. Ethics*, **7**(4), pp. 593–610, Jul. 2001.

17. N. Ibrahim and R. M. K. Nambiar, Scaffoldings in academic writing: The role of intercultural rhetoric and genre analysis in academic socialization, *Procedia – Soc. Behav. Sci.*, **59**(1), pp. 438–442, Oct. 2012.
18. M. Nerad, The PhD in the US: Criticisms, Facts, and Remedies, *High. Educ. Policy*, **17**(2), pp. 183–199, Jun. 2004.
19. N. Curtin, A. J. Stewart and J. M. Ostrove, Fostering Academic Self-Concept: Advisor Support and Sense of Belonging Among International and Domestic Graduate Students, *Am. Educ. Res. J.*, **50**(1), pp. 108–137, 2013.
20. D. H. Mansson and S. A. Myers, Using Mentoring Enactment Theory to Explore the Doctoral Student-Advisor Mentoring Relationship, *Commun. Educ.*, **61**(4), pp. 309–334, Oct. 2012.
21. E. C. Paschal, Factors influencing attrition in U.S. universities: Examining transitional cognitive dissonance in a new meta-model for analysis, *Diss. Abstr. Int. Sect. A Humanit. Soc. Sci.*, **70**(2–A), p. 606, 2009.
22. S. K. Gardner, Fitting the Mold of Graduate School: A Qualitative Study of Socialization in Doctoral Education, *Innov. High. Educ.*, **33**(2), pp. 125–138, Mar. 2008.
23. R. G. Ehrenberg, G. H. Jakubson, J. A. Groen, E. So and J. Price, Inside the Black Box of Doctoral Education: What Program Characteristics Influence Doctoral Students' Attrition and Graduation Probabilities?, *Educ. Eval. Policy Anal.*, **29**(2), pp. 134–150, 2007.
24. P. Mendoza and A. Gunderson, Within-Year Retention Among Ph.D. Students: The, pp. 650–685, 2014.
25. Y. J. Xu, Advance to and Persistence in Graduate School: Identifying the Influential Factors and Major-Based Differences, *J. Coll. Student Retent.*, **16**(3), pp. 391–417, 2015.
26. M. Kiley, Identifying threshold concepts and proposing strategies to support doctoral candidates, *Innov. Educ. Teach. Int.*, **46**(3), pp. 293–304, 2009.
27. E. Crede and M. Borrego, Learning in graduate engineering research groups of various sizes, *J. Eng. Educ.*, **101**(3), pp. 565–589, 2012.
28. E. Crede and M. Borrego, Understanding retention in US graduate programs by student nationality, **39**(9), pp. 1599–1616, 2014.
29. C. Whitehair and C. G. P. Berdanier, Capturing Narratives of Graduate Engineering Attrition through Online Forum Mining, in *125th ASEE Annual Conference and Exposition*, pp. 1–10, 2018.
30. National Academies, *Graduate STEM Education for the 21st Century*. Washington D.C.: National Academies Press, 2018.
31. Council of Graduate Schools, *Ph.D. Completion and Attrition: Analysis of Baseline Data*, 2008.
32. R. Sowell, J. Allum and H. Okahana, *Doctoral initiative on minority attrition and completion*, 2015.
33. N. A. Fouad, R. Singh, M. E. Fitzpatrick and J. P. Liu, Stemming the tide: Why women leave engineering. University of Wisconsin-Milwaukee, Final report from NSF Award, 827553, 2011.
34. E. Zerbe and C. Berdanier, 'If I knew what else I should do , I would have left by now:' Two engineering PhD students' experiences with Master's -level departure, in *IEEE Frontiers in Education Conference*, pp. 1–9, 2019.
35. C. Whitehair, C. G. P. Berdanier, A. Kirn and D. Satterfield, Analysis of Social Media Forums to Elicit Narratives of Graduate Engineering Student Attrition, *J. Eng. Educ.*
36. E. Crede and M. Borrego, From Ethnography to Items: A Mixed Methods Approach to Developing a Survey to Examine Graduate Engineering Student Retention, 2013.
37. M. Roach and H. Sauermann, A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry, *Res. Policy*, **39**(3), pp. 422–434, 2010.
38. C. Cañibano and B. Bozeman, Curriculum vitae method in science policy and research evaluation: the state-of-the-art, *Res. Eval.*, **18**(2), pp. 86–94, 2009.
39. C. N. Fuhrmann, D. G. Halme, P. S. O'Sullivan and B. Lindstaedt, Improving graduate education to support a branching career pipeline: Recommendations based on a survey of doctoral students in the basic biomedical sciences, *CBE Life Sci. Educ.*, **10**(3), pp. 239–249, 2011.
40. C. G. P. Berdanier, A. Tally, B. Ahn and M. F. Cox, Aligning engineering education with disciplinary expectations: A strategic blueprint for doctoral competency assessment, *Int. J. Eng. Educ.*, **32**(4), pp. 1759–1773, 2016.
41. J. Watson and J. Lyons, Aligning Academic Preparation of Engineering Ph.D. Programs with the Needs of Industry, *Int. J. Eng. Educ.*, **27**(6), pp. 1394–1411, 2011.
42. M. Schillebeeckx, B. Maricque and C. Lewis, The missing piece to changing the university culture, *Nat. Biotechnol.*, **31**(10), pp. 938–41, Oct. 2013.
43. P. Mendoza, Academic Capitalism and Doctoral Student Socialization: A Case Study, *J. Higher Educ.*, **78**(1), pp. 71–96, 2007.
44. U. Wingate, Using academic literacies and genre-based models for academic writing instruction: A 'literacy' journey, *J. English Acad. Purp.*, **11**(1), pp. 26–37, Mar. 2012.
45. C. Aitchison, Writing groups for doctoral education, *Stud. High. Educ.*, **34**(8), pp. 905–916, Dec. 2009.
46. Y. Fujimoto, P. Hagel and P. Turner, Helping university students to 'read' scholarly journal articles: The benefits of a structured and collaborative approach, *J. Univ. Teach. Learn. Pract.*, **8**(3), pp. 1–12, 2011.
47. R. Goldsmith, K. Willey and D. Boud, Investigating invisible writing practices in the engineering curriculum using practice architectures, *Eur. J. Eng. Educ.*, pp. 1–14, 2017.
48. B. Yalvac, H. D. Smith, J. B. Troy and P. Hirsch, Promoting Advanced Writing Skills in an Upper-Level Engineering Class, *J. Eng. Educ.*, **96**(2), pp. 117–128, 2007.
49. A. Parker, D. Ph, K. Marcynuk and V. Scholar, Undergraduate Writing Assignments in Engineering: Targeting Communication Skills (Attribute 7), no. Attribute 7, pp. 1–5, 2016.
50. S. Conrad, A Comparison of Practitioner and Student Writing in Civil Engineering, *J. Eng. Educ.*, **106**(2), pp. 191–217, 2017.
51. J. A. Leydens, Sociotechnical communication in engineering: an exploration and unveiling of common myths, *Eng. Stud.*, **4**(1), pp. 1–9, Apr. 2012.
52. J. A. Leydens, Novice and insider perspectives on academic and workplace writing: Toward a continuum of rhetorical awareness, *IEEE Trans. Prof. Commun.*, **51**(3), pp. 242–263, 2008.
53. J. Leydens and B. Olds, Publishing in Scientific and Engineering Contexts: A Course for Graduate Students, *IEEE Trans. Prof. Commun.*, **50**(1), pp. 45–56, Mar. 2007.
54. S. Mcleod, Some thoughts about feelings: The affective domain and the writing process, *Coll. Compos. Commun.*, **38**(4), pp. 426–435, 1987.
55. M. Castelló, A. Iñesta, and C. Monereo, Towards self-regulated academic writing: An exploratory study with graduate students in a situated learning environment, *Electron. J. Res. Educ. Psychol.*, **7**(3), pp. 1107–1130, 2009.

56. A. Onwuegbuzie, The relationship between writing anxiety and learning styles among graduate students, *J. Coll. Stud. Dev.*, **39**(6), p. 589, 1998.
57. J. A. Daly, Writing apprehension, in *When a Writer Can't Write: Studies in Writer's Block and Other Composing-Process Problems*, M. Rose, Ed. New York, NY: The Guilford Press, pp. 43–82, 1985.
58. A. Al Asmari, Investigation of Writing Strategies, Writing Apprehension, and Writing Achievement among Saudi EFL-Major Students, *Int. Educ. Stud.*, **6**(11), pp. 130–143, 2013.
59. L. Z. Bloom, Anxious writers in context: Graduate school and beyond, in *When a Writer Can't Write: Studies in Writer's Block and Other Composing-Process Problems*, M. Rose, Ed. New York, NY: The Guildford Press, pp. 119–133, 1985.
60. E. Lavelle and K. Bushrow, Writing Approaches of Graduate Students, *Educ. Psychol.*, **27**(6), pp. 807–822, 2007.
61. K. Lonka, A. Chow, J. Keskinen, K. Hakkarainen, N. Sandstrom and K. Pyhalto, How to Measure PhD. Students' Conceptions of Academic Writing–and are the Related to Well-being?, *J. Writ. Res.*, **5**(3), pp. 245–269, 2014.
62. E. Zerbe and C. G. P. Berdanier, Correlations between graduate student writing concepts and processes and certainty of career trajectories, in *IEEE Frontiers in Education Conference*, p. 9, 2018.
63. C. G. P. Berdanier and E. Zerbe, Quantitative investigation of engineering graduate student conceptions and processes of academic writing, in *IEEE Professional Communication Conference (Procomm)*, pp. 1–8, 2018.
64. M. R. Lea and B. Street, Writing as academic literacies: Understanding textual practices in higher education, in *Writing: Texts, Processes, and Practices*, C. N. Candlin and K. Hydlan, Eds. New York, NY: Longman, pp. 62–81, 1999.
65. M. R. Lea and B. V Street, The 'academic literacies' model: Theory and applications, *Theory Pract.*, **45**(4), pp. 368–377, 2006.
66. C. G. P. Berdanier, Learning the Language of Academic Engineering: Sociocognitive Writing in Graduate Students, Purdue University, 2016.
67. F. Williamson and R. Goldsmith, PASSwrite: Recalibrating student academic literacies development, *J. Univ. Teach. Learn. Pract.*, **10**(2), pp. 1–11, 2013.
68. E. M. Johnson, Toward the building of a cross-disciplinary doctoral research and writing culture, *J. Univ. Teach. Learn. Pract.*, **11**(1), pp. 1–15, 2014.
69. T. Lillis and M. Scott, Defining academic literacies research: Issues of epistemology, ideology and strategy, *J. Appl. Linguist.*, **4**(1), pp. 4–32, Sep. 2008.
70. B. L. Yoder, *Engineering by the Numbers*, 2018.
71. M. C. Astorga, Teaching academic writing in the EFL context: Redesigning pedagogy, *Pedagog. An Int. J.*, **2**(4), pp. 251–267, Nov. 2007.
72. Y.-S. Cheng, A measure of second language writing anxiety: Scale development and preliminary validation, *J. Second Lang. Writ.*, **13**, pp. 313–335, 2004.
73. A. Badran, *The Relationship of Writing Apprehension and Self-Esteem to the Writing Quality and Quantity of EFL University Students*, Report Research, Faculty of Education, Mansoura University. Mesir, 2001.
74. L. Turk-Bicakci, A. Berger and C. Haxton, *The Nonacademic Careers of STEM PhD Holders*, 2014.
75. J. A. Daly and W. Shamo, *Academic Decisions as a Function of Writing Apprehension*, 1978.
76. K. Hyland, Authority and invisibility: authorial dentity in academic writing, *J. Pragmat.*, **34**, pp. 1091–1112, 2002.
77. M. Jazvac-Martek, Oscillating role identities: the academic experiences of education doctoral students, *Innov. Educ. Teach. Int.*, **46**(3), pp. 253–264, Aug. 2009.
78. O. Ferenz, EFL writers' social networks: Impact on advanced academic literacy development, *J. English Acad. Purp.*, **4**(4), pp. 339–351, 2005.
79. E. Hocker, E. Zerbe and C. G. P. Berdanier, Characterizing Doctoral Engineering Student Socialization: Narratives of Mental Health, Decisions to Persist, and Consideration of Career Trajectories, in *IEEE Frontiers in Education*, pp. 1–7, 2019.
80. J. L. Smith, C. Stoop, M. Young, R. Belou and S. Held, Grant-writing bootcamp: An intervention to enhance the research capacity of academic women in STEM, *Bioscience*, **67**(7), pp. 638–645, 2017.
81. S. K. Gardner and K. A. Holley, 'Those invisible barriers are real': The Progression of First-Generation Students Through Doctoral Education, *Equity Excell. Educ.*, **44**(1), pp. 77–92, 2011.

Appendices

Appendix A: Participant distribution

	U.S. Domestic	Permanent Residents	International
Gender Identity			
Male	181	12	187
Female	153	9	72
Other/Prefer not to disclose	4	3	0
First Language			
English	314	17	47
Another	24	7	212
Academic Level			
Early career (year 1–2 or before qualifying exam) or Master's student	201	12	137
Mid career (years 3–4 or between qualifying exam and proposal defense)	87	5	80
Late career (years $\geq$5 or after proposal defense)	50	7	42

Appendix B: Pearson correlation table with inter- and intra-scale correlations and career trajectories. Statistically significant correlations are presented in boldface and of those the negative correlations are shaded. Asterisks indicate significance level

		Career Trajectory								
		Academic (Teaching focused)	**Academic (Research focused)**	**Academic (Tenure Track)**	**Academic (Non-Tenure Track)**	**Research**	**Government**	**Industry R&D**	**Industry Non-R&D**	**Entrepreneur**
Career Trajectory	**Academic (Teaching focused)**	**1**								
	Academic (Research focused)	**0.590****	1							
	Academic (Tenure Track)	**0.645****	**0.767****	1						
	Academic (Non-Tenure Track)	**0.608****	**0.530****	**0.544****	1					
	Research	**0.112****	**0.361****	**0.184****	**0.203****	1				
	Government	0.043	0.038	–0.011	**0.082***	**0.308****	1			
	Industry R&D	**–0.165****	–0.052	**–0.151****	–0.058	**0.330****	0.006	1		
	Industry Non-R&D	**–0.257****	**–0.385****	**–0.405****	**–0.154****	**–0.181****	0.038	**0.331****	1	
	Entrepreneur	**–0.080***	–0.041	**–0.109****	0.019	–0.012	0.073	**0.226****	**0.377****	1
Graduate Process of Writing	**Elaborative**	**0.121****	**0.241****	**0.217****	0.069	**0.161****	–0.055	**0.133****	**–0.169****	0.035
	Low SE	0.040	**0.101***	0.052	**0.105****	0.015	–0.012	0.062	0.041	**0.090***
	No Revision	–0.008	0.017	–0.076	0.023	–0.054	–0.007	–0.074	0.067	**0.091***
	Intuitive	0.075	**0.167****	**0.122****	0.023	**0.145****	0.024	**0.149****	–0.005	**0.102***
	Scientist	0.025	0.063	0.019	0.021	0.070	–0.009	**0.080***	0.023	–0.023
	Task-Oriented	0.047	**0.099***	0.039	0.038	0.049	0.004	0.011	0.058	**0.140****
	Sculptor	0.032	**0.118****	0.051	0.014	**0.118****	–0.005	**0.134****	–0.006	**0.102***
Graduate Concepts of Writing	**Blocks**	–0.018	–0.030	–0.066	0.024	–0.039	–0.021	0.046	**0.104****	0.032
	Procrastination	0.022	0.011	–0.009	**0.088***	–0.005	0.001	–0.033	–0.034	–0.048
	Perfectionism	**0.097***	**0.093***	0.064	**0.096***	0.044	–0.006	–0.010	0.001	0.072
	Innate Ability	0.046	0.047	–0.027	0.053	–0.004	0.001	–0.003	0.103*	**0.121****
	Knowledge Transforming	0.033	**0.089***	**0.092***	0.013	**0.098***	–0.036	0.068	**–0.093***	0.023
	Productivity	**0.136****	**0.168****	**0.128****	**0.124****	**0.080***	–0.038	0.056	0.014	**0.147****

Boldface values are statistically significant, shaded values are negative corrections. * $p < 0.05$, ** $p < 0.01$.

		Graduate Process of Writing							Graduate Concepts of Writing					
		Elaborative	Low SE	No Revision	Intuitive	Scientist	Task-Oriented	Sculptor	Blocks	Procrastination	Perfectionism	Innate Ability	Knowledge Transforming	Productivity
Graduate Process of Writing	Elaborative	1												
	Low SE	–0.225**	1											
	No Revision	–0.229**	0.114**	1										
	Intuitive	0.476**	–0.016	–0.225**	1									
	Scientist	0.239**	–0.042	–0.089*	0.329**	1								
	Task-Oriented	0.175**	0.077	0.283**	0.318**	0.157**	1							
	Sculptor	0.206**	0.144**	0.081*	0.335**	0.137**	0.271**	1						
Graduate Concepts of Writing	Blocks	–0.399**	0.636**	0.214**	–0.048	–0.022	0.113**	0.095*	1					
	Procrastination	–0.297**	0.526**	0.120**	–0.015	–0.041	0.055	0.056	0.694**	1				
	Perfectionism	–0.054	0.436**	0.051	0.226**	0.061	0.303**	0.209**	0.514**	0.477**	1			
	Innate Ability	–0.128**	0.300**	0.359**	–0.017	–0.054	0.304**	0.309**	0.346**	0.190**	0.337**	1		
	Knowledge Transforming	0.558**	–0.104**	–0.391**	0.465**	0.289**	0.082*	0.119**	–0.199**	–0.044	0.095*	–0.225**	1	
	Productivity	0.263**	–0.161**	0.188**	0.199**	0.091*	0.379**	0.262**	–0.183**	–0.304**	0.100*	0.301**	0.144**	1

Boldface values are statistically significant, shaded values are negative corrections. * $p < 0.05$, ** $p < 0.01$.

Ellen Zerbe is a PhD candidate in the Department of Mechanical Engineering at Pennsylvania State University. She earned her Bachelors of Science in Mechanical Engineering at Grove City College. Her research interests include engineering graduate student writing, graduate level attrition and persistence, and engineering identity in undergraduates from non-R1 universities.

Catherine G. P. Berdanier is an Assistant Professor in the Department of Mechanical Engineering at Pennsylvania State University. She earned her BS in Chemistry from The University of South Dakota, her MS in Aeronautical and Astronautical Engineering and PhD in Engineering Education from Purdue University. Her research interests include graduate-level engineering education, including inter- and multidisciplinary graduate education, and engineering communication.