Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #49217

Work-in-Progress: Aerospace Engineering Faculty's Perspective on the Writing SySTEM for Increasing Self-Efficacy of Graduate Student Writers

Dr. Russell William Mailen, Auburn University

Dr. Russell W. Mailen is an Associate Professor in the Department of Aerospace Engineering at Auburn University. Dr. Mailen leads the Polymer Mechanics Research Laboratory, which focuses on the characterization of the thermal and mechanical properties polymers (including viscoelasticity), self-folding origami, and mechanical metamaterials. His research group has a significant number of undergraduate researchers, and the group engages regularly with professional development activities. Dr. Mailen is also the PI of The Writing SySTEM: A Systemic Approach to Graduate Writing Instruction and Intervention, a funded NSF IGE grant.

Dr. Jeffrey LaMondia, Auburn University

Dr. Jeffrey LaMondia is a Professor in the Civil and Environmental Engineering Department at Auburn University. Dr. LaMondia's research focuses on modeling transportation systems, developing planning tools, and analyzing travel behavior. In addition to teaching undergraduate and graduate level courses, Dr. LaMondia is the Director of the campus-wide Common Book Program.

Dr. Sushil Adhikari P.E., Auburn University

Dr. Sushil Adhikari is a Professor in the Biosystems Engineering Department and the Center for Bioenergy and Bioproducts Director at Auburn University. He is the Co-Principal Investigator of the NSF REU site: Research experience through collaborative teams in bioprocessing for conversion of waste into products of value. Adhikari devotes his efforts to teaching and research in the area of bioenergy and bioproducts and circular economy. He teaches Heat and Mass Transfer, Renewable Energy and Biomass and Biofuels courses for both undergraduate and graduate students.

Dr. Katharine H. Brown, Auburn University

Dr. Katharine H. Brown is the Associate Director of University Writing at Auburn University, where she focuses on graduate student writing support. Her research addresses graduate student writing self-efficacy, embodied contemplative pedagogies, and welcoming practices in writing centers. She has published in venues including The Writing Center Journal, WAC Clearinghouse, and Composition Forum. She is a co-PI in the NSF IGE project, "The Writing SySTEM: A Systemic Approach to Graduate Writing Instruction and Intervention."

Dr. Christopher Ryan Basgier, Auburn University

Christopher Basgier is Director of University Writing at Auburn University. In that role, he consults with departments about integrating writing and high-impact practices throughout undergraduate and graduate curricula. His research, which spans writing across the curriculum, writing centers, genre, threshold concepts, and digital rhetoric, has appeared in venues like Across the Disciplines, Composition Forum, Studies in Higher Education, The WAC Journal, and The Writing Center Journal. He is active in national organizations like the Association for Writing Across the Curriculum, the Conference on College Composition and Communication, and the WAC Clearinghouse, and he is a founding member of the RhetAI Coalition.

Jordan Harshman, Auburn University

Work-in-Progress: Aerospace Engineering Faculty's Perspective on the Writing SySTEM for Increasing Self-Efficacy of Graduate Student Writers

Abstract

Few graduate students receive sustained, discipline-specific foundational instruction in STEM writing, instead relying on ad-hoc support from faculty advisors. The *Writing SySTEM* seeks to close this gap through an innovative, multifaceted, sustainable writing structure for graduate students in engineering that encourages them to develop self-efficacy as academic and professional writers. The SySTEM introduces a research-based, inclusive, and systematic approach to STEM communication training that provides students with multiple opportunities to practice and receive feedback on writing in their discipline. It is anticipated that self-efficacy will lead to improved confidence in writing abilities and higher success rates for students. Through the project, we seek to determine the relationships among self-efficacy, self-regulation of writing, and writing ability in the context of engineering graduate education that includes systematic writing instruction and intervention structures. The four components of the *Writing SySTEM* are (1) workshops to teach writing skills and promote the recruitment of diverse participants into other components, (2) discipline-specific graduate writing courses, (3) peer writing groups, and (4) writing resources hosted on a publicly available Open Educational Resource (OER). Data for the quantitative analysis of the effects of program components on self-efficacy is still being collected for this work-in-progress. The anticipated outcome of this work is to equip graduate students with strategies and resources for writing effectively in STEM fields and to establish evidence-based, systematic writing instruction and interventions that are sustainable, scalable, and adaptable across STEM contexts. Herein, a faculty member from the Department of Aerospace Engineering will discuss their experiences facilitating all four components of the Writing SySTEM.

1. Introduction

Graduate students in engineering are expected to do a significant amount of writing. This can be a surprise for many engineering students, who are accustomed to a math- and science-focused curriculum. These students will engage in a range of writing projects, including short-term writing in the form of term papers on technical topics for their coursework, intermediate-term writing in the form of conference and journal papers, and long-term writing in the form of theses and dissertations. Although these genres of writing have significant differences, they have a commonality in that they all utilize discipline-specific conventions, which are typically learned informally "along the way". Students are expected to use their writing to demonstrate an understanding of the technical topic at hand and document their research results. This comes with the added expectation that their writing provides sufficient detail so that the work can be evaluated and replicated by others. As students progress through their academic careers, many realize that the writing process can improve their understanding of a topic, as what might seem clear in their minds must be logically organized and presented on the page. This presents challenges in parsing which information is important and in what order it must be communicated for various audiences and situations, ranging from outreach for the general public to technical presentations for subject matter experts. Finally, technical writing is a domain of knowledge that

will be used by students beyond their academic careers as they transition into professional roles in industry, national laboratories, or academia.

A significant challenge to the professional development of graduate engineering students as technical writers is that the responsibility of writing education is normally delegated to the student's faculty adviser.[1], [2] Frequently, a student will draft a major writing project, send it to their adviser for review, and receive discouraging or limited feedback. This ad hoc approach to technical writing training and feedback is inconsistent from adviser to adviser and from student to student. This results in few graduate students receiving sustained, discipline-specific foundational instruction in STEM writing, a challenge which must be addressed. Research in graduate student development identifies self-efficacy as a central factor in writing ability and related outcomes. Typical ad-hoc approaches to STEM writing support lack the four factors proven to develop self-efficacy: (1) previous successful experiences, (2) the ability to compare others to self, (3) positive and negative feedback from the community, and (4) the ability to use healthy emotional and psychological strategies to approach new challenges.[3] Our Writing SySTEM seeks to address these challenges through an innovative, multifaceted, sustainable writing structure for graduate students in engineering that encourages them to develop self-efficacy in writing. It is anticipated that self-efficacy will lead to improved confidence in writing abilities and higher success rates for students. Further, as STEM fields seek to further diversify academic and professional communities, graduate programs need to implement research-based writing instruction and interventions to reduce writing-related barriers that keep underrepresented minority and international student populations from feeling connected to their professional and institutional communities, publishing, and completing their graduate degrees.[4], [5], [6]

The Writing SySTEM seeks to answer the research question, "What is the relationship between self-efficacy, self-regulation, and performance outcomes in the context of engineering graduate education?" Previous research has not investigated these relationships robustly, it has not accounted for the specific disciplinary context of engineering, and it has not focused on graduate students as a specific population with unique experience and needs vis-a-vis self-efficacy. Our intervention structure to train graduate engineering writers uses four components: (1) writing workshops, (2) discipline-specific graduate writing courses, (3) peer writing groups, and (4) an Open Educational Resource (OER). Students can participate in any combination of these components, and we will look for how the self-efficacy of graduate student writers is related to their writing abilities and strategies employed. These will yield valuable perspectives and directions on how writing abilities can be improved. Finally, the Writing SySTEM can be exported and adapted to other STEM departments and institutions across the country that may have restricted access to campus-wide writing programs and writing program administrators, thereby having a widespread effect on the writing education of graduate STEM students.

2. Context

The Writing SySTEM is implemented at a public land-grant institution. The university is a Carnegie R1 institution and offers Bachelor's, Master's, and Doctorate degrees in engineering and agriculture, the medical and health professions, and the arts and sciences. Its 2024 enrollment of 34,145 students includes 27,907 undergraduates and 6,238 graduate and

professional students. The College of Engineering at the university has 6,700 students, which includes 5,516 undergraduates and 1,184 graduate students in 16 programs. The Writing SySTEM is being piloted in small (Biosystems Engineering, 50 graduate students), medium (Aerospace Engineering, 92 graduate students), and large (Civil and Environmental Engineering, 150 graduate students) departments. The Writing SySTEM was designed in collaboration between engineering faculty and administrators of a Writing Across the Curriculum (WAC) program.

2.1 Demographics

When considering the small sample sizes, the report of demographic data of participants risks violating their anonymity. Initially, the program planned to recruit underrepresented persons through outreach to identity-focused student groups (e.g., Society for Women Engineers, National Society for Black Engineers, and O-STEM). Instead, the team has pursued the broadest recruitment strategy while remaining in the college of engineering and the participating departments. Demographic data for the participating departments is presented in Table 1.

Table 1 Demographic data of participating departments.

	Aerospace Engineering			**Biosystems Engineering**			**Civil and Environmental Engineering**		
	Totals	*Female*	*Male*	*Totals*	*Female*	*Male*	*Totals*	*Female*	*Male*
Totals	**92**	**16**	**76**	**50**	**17**	**33**	**150**	**52**	**98**
American Indian or Alaska Native	0	0	0	0	0	0	0	0	0
Asian	3	1	2	0	0	0	5	2	3
Black or African American	1	0	1	1	1	0	1	0	1
Hispanics of any race	2	1	1	1	1	0	2	1	1
Native Hawaiian or Other Pacific Islander	1	0	1	0	0	0	1	1	0
Nonresident Alien	41	6	35	40	12	28	62	21	41
Race and Ethnicity Unknown	0	0	0	0	0	0	1	0	1
Two or More Races	0	0	0	1	1	0	2	1	1
White	44	8	36	7	2	5	76	26	50

3. Goals and structure

The long-term goal of the Writing SySTEM is to characterize engineering graduate students' writing self-efficacy, or the belief in one's ability to carry out a specific writing task to a desired result. Within this work, we seek to determine the influence of the Writing SySTEM's systematic writing instruction and intervention structures on engineering graduate students' self-efficacy, self-regulation of writing, and writing ability, as well as the relationships among these factors. The four main components of The Writing SySTEM are described next. Although these components have been offered at other institutions, the intent of the present work is to evaluate

the effect of these components on student self-efficacy in technical writing for engineering graduate students.

3.1 Writing workshops description

Workshops on topics related to technical writing are offered periodically in the participating departments. These workshops are often offered in the format of a graduate seminar presented within each department. These workshops are one-off events focusing on one element of writing. Example workshops include “Writing Abstracts for Technical Research Papers” and “Writing Introductions and Literature Reviews for Technical Papers”. In addition to teaching skills and strategies for technical writing, these workshops are intended to recruit students into other components of the Writing SySTEM.

3.2 Graduate technical writing courses description

Discipline-specific technical writing courses are offered in each participating department. These 3-credit-hour courses promote critical writing habits, create opportunities for students to receive direct instruction on the expectations and values for academic writing in the disciplines as well as professional communication for industry, and implement strategies for effective drafting and revising.[7], [8] Each course is taught by a faculty member in the respective department, thus providing insight into discipline-specific writing expectations and values. A course in technical writing for engineering graduate students was first piloted in the Department of Aerospace Engineering in Spring 2019. This pilot course was co-taught by a faculty member in Aerospace Engineering and a faculty member in a WAC program. This collaborative approach introduced engineering and writing perspectives to the course. Since the initial offering, the writing courses have been taught only by faculty in engineering. The collaborative approach to course design between writing program administrators and engineering faculty brings discipline-specific insight into the course and provides an opportunity for the course framework to be adapted to other STEM disciplines, not just engineering.

The framework for each course guides students systematically though the full arc of writing an original research article for submission to a peer-reviewed journal. Topics include framing the story of the research (e.g., the elevator pitch), searching and reading relevant literature, writing literature reviews, preparing graphics, submitting the manuscript, and adapting the research to other formats (e.g., conference presentations, posters, and outreach). The courses involve significant amounts of peer discussion and peer review. The technical writing course offered in Civil and Environmental Engineering includes information about statistical analysis.

3.3 Peer writing groups description

Peer writing groups consist of approximately 5 – 10 students who gather regularly (*e.g.*, on a weekly basis) to spend time on writing and giving and receiving feedback. Scholarship on writing groups in graduate student education [9], [10], [11] links the practice to a social theory of learning which encourages graduate students to participate in and form communities of practice that can serve them throughout their professional careers—an especially pressing need for interdisciplinary teams of scientists.[11] Various formats are available for these groups.

Accountability groups use meetings as dedicated time to write and to set and check in on writing goals. Review/critique groups perform writing and reading activities independently and use the meeting time to share feedback. Support groups meet to share resources and recommendations for writing strategies. Affinity groups coalesce around interest in a common topic. Writing groups tend to be fluid, with new groups forming at the start of each semester and dissipating at the end of the semester. However, the duration of these writing groups could span longer timeframes. As part of the Writing SySTEM, we have included faculty mentors to facilitate the writing group meetings.

3.4 Open Educational Resource description

Many students and faculty look to freely available resources to guide writing or other academic pursuits. The WAC program at the university hosts an OER on its website. This OER has publicly available guides for various aspects of writing. Each individual resource has been tagged to facilitate rapid identification of relevant resources. For the Writing SySTEM, resources related to technical writing in engineering have either been authored by engineering faculty or adapted from an existing resource and tagged with "Writing SySTEM". Resources in the Writing SySTEM section have been reviewed and edited by faculty in the WAC program. In addition, the documents have been formatted for improved accessibility.

4. Methodology

The Writing SySTEM components are being offered periodically over a 3-year period as part of the research project. The timeline for implementing program components is shown in Figure 1. To measure the outcomes of the *Writing SySTEM*, we will undertake several forms of data collection and analysis for all aspects of the project, including educational outcomes and the research question. Data collection includes pre- and post-intervention surveys for the writing courses and post-participation surveys for writing groups and workshops. Survey requests are sent to all participants. After completing the survey, students are invited to participate in semi-structured interviews with a $25 gift card incentive. Figure 2 visualizes the alignment of SySTEM components to targeted outcomes and measures. These ongoing efforts to evaluate the projects' outcomes are described in Section 4.1.

4.1 Evaluation

The research team is in the process of evaluating student writing using a validated assessment instrument for technical communication. Writing samples include recently drafted or published academic papers, sections of papers, course artifacts, or any scientific writing sample composed primarily by the student. For the purposes of the current research, the criteria for an effective rubric should have established validity and reliability in its interpretations,[12], [13] and it should be grounded in the discursive and epistemic practices germane to engineering in addition to more surface features [14], [15]. Finally, the rubric should still be adaptable across other STEM contexts.[13], [14] A technical communication rubric that meets these criteria has been selected for assessing student writing in the *Writing SySTEM*.[16] The rubric focuses on the knowledge-building (epistemic) and problem-solving features of technical communication and

includes attention to context, appropriate selection and use of methodologies, presentation of solutions or results, use of outside sources, and attention to formatting and editing.

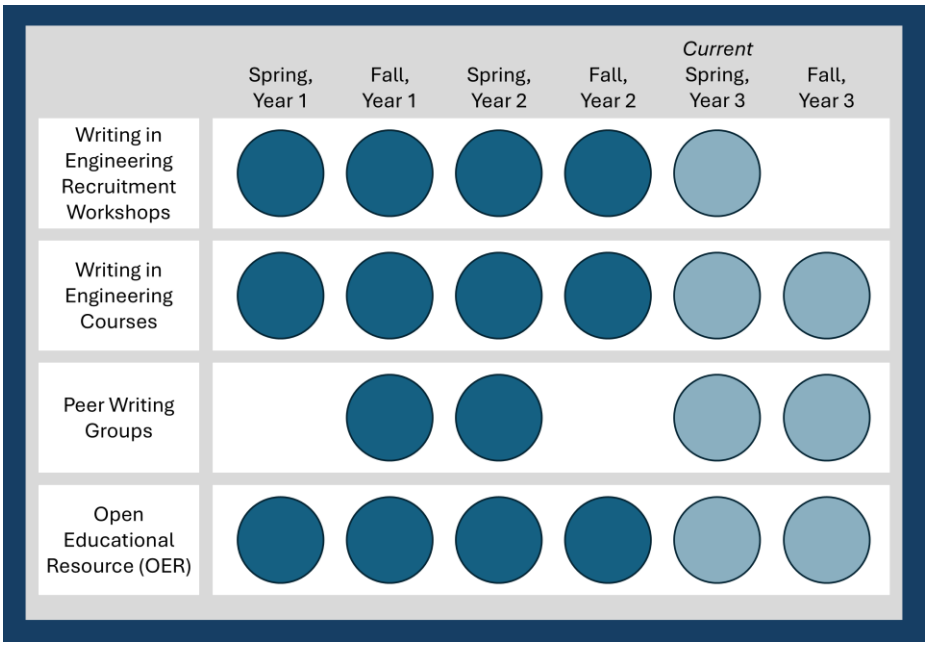

Figure 1 Timeline of program elements. The project is currently in the spring of year 3.

Components	Writing in Engineering Recruitment Workshops	Writing in Engineering Courses	Peer Writing Groups	Open Educational Resource (OER)
Targeted Outcomes	• Recruitment into other components	• Increased self-efficacy • Increased self-regulatory strategies	• Increased self-efficacy • Increased publication activity	• Distribution of materials

Measures	• Participants
	• Number of workshops given
	• Percentages of attendees recruited into Writing SySTEM
		• WSRES*
		• MSKT*
		• Writing samples*
		  • Rubric
		• Faculty Teaching Journal
		• Interviews
			• WSRES*
			• MSKT*
			• Writing samples*
			  • Rubric
			• Publication record
			• Continuation of writing group participation
			• Interviews
				• Use analytics
				  • Clicks and views
				  • Downloads
				• User survey responses
				• Feeedback from writing groups and courses

*Contributes to research question

What is the relationship between self-efficacy, self-regulation, and performance outcomes in the context of engineering graduate education?

Figure 2 Alignment across outputs and research.

Student-focused direct measures include students' self-efficacy and self-regulatory factors for writing, collected through the Metacognitive Strategy Knowledge Test (MSKT).[17] This inventory is designed to measure strategies mapped to the three stages of writing (before/planning, during/writing, and after/reflecting) predicted by Metacognitive Writing Knowledge framework,[18], [19] which provides natural subscales. To measure self-efficacy and self-regulation, the Writing Self-Regulatory Efficacy Scale (WSRES) [20] has been adopted and administered to participating students in the *Writing SySTEM*. The adoption process will involve minor rewording to items to make them more realistic for a graduate engineering student. Instruments will be given prior to any student participating in the *Writing SySTEM* course and writing groups as well as at their conclusion. This means data collection has involved only a few dozen students at a time for each iteration of the class and writing group; data will then be aggregated at the end of the project to build an adequate sample.

While quantitative survey results will yield important insights, further depth is warranted to uncover the unique context of engineering education in the relationship of self-efficacy, self-regulation strategies, and writing outcomes. For this reason, we will conduct semi-structured interviews [21] with approximately 30 component participants with the intention of providing supplementary evidence to these relationships for the purpose of triangulation. The interview protocol was built by adapting questions from several other qualitative efforts [22] that examine writing self-efficacy (e.g., *"*How do you think of your abilities in academic writing" [23]), impact of content and writing experts (e.g., describe your *"*interaction with the mentor and other peers during the writing process" [22]), and self-regulated strategies (e.g., "What do you remember learning about writing or having reinforced about writing from being in the writing seminars" [24]). All interviews will be validated via member checking [25] and analyzed via deductive coding according to the four factors of self-efficacy, providing a framework for which to develop themes. It is noted here that it is difficult to evaluate the effects of program elements on the level of self-efficacy because each participant has a different level of previous experience. Therefore, our analysis looks for changes in self-efficacy rather than level of self-efficacy.

5. Results and discussion

In the first two years of the project, we have offered discipline-specific technical writing courses six times, twice for each department, reaching a total of 50 students. Similarly, six workshops have been conducted. The peer writing groups were first offered in the second year of the project, and a total of six groups have been organized, one per department each semester for two semesters. Sixteen interviews have been conducted.

5.1 Engineering faculty perspective on program elements

The following sections document the perspective of the lead author of this paper, who is a faculty member in the Department of Aerospace Engineering and has engaged with all four components of the Writing SySTEM. This discussion does not necessarily capture all details of the experiences but describes some key observations that were not thought of prior to the experience with each component.

5.1.1 Writing workshops experience

Two workshops have been presented by the lead author of this paper. These workshops were offered during the departmental graduate student seminar to encourage attendance of the students. Similar strategies have been employed by the other participating engineering faculty. These workshops are a way to engage students in incremental skill improvements, wherein they do not have to commit to a full semester. The main drawback is that the one-off workshops are not able to convey the full arc of the writing process, do not provide opportunities to give and receive feedback, and may capture students at different points in the writing process. Students have responded positively to these workshops, indicating a need for this type of professional development. These workshops have also been useful for recruiting students into the technical writing course by offering the workshop during the enrollment period for the next semester.

5.1.2 Graduate technical writing course experience

The lead author of the paper has taught the Technical Writing of Aerospace Engineering Graduate Students course twice as part of this project (with an additional four offerings prior to this project). This version of the course focuses on frameworks and strategies for writing peer reviewed journal articles, with notes about adaptations to other major writing projects. An ideal student for the course has completed a year and a half of graduate school, understands their research area (e.g., key papers or leaders in the field), and has sufficient research results to begin writing at the beginning of the semester. The approximate breakdown of the course is four weeks for planning to write, eight weeks for writing, and another four weeks for adapting the work to alternative formats, during which complete manuscripts are being peer reviewed and revised. One of the biggest challenges early on was getting students to offer meaningful feedback about the structure of the manuscript narrative when reviewing drafts outside of their subdiscipline (e.g., for a student in mechanics of materials, a peer reviewer from computational fluid mechanics would only provide surface-level comments regarding active versus passive voice or first-person versus third-person perspective). This has been partially addressed by exposing students to each other's research topic throughout the semester by having students present brief summaries of key articles to the class (Journal Club presentations). Anecdotally, this has improved the quality of the reviews as students have gained a better understanding of the work of their peers. These Journal Club presentations have the added benefit of encouraging students to thoroughly read and understand papers in their own field, thereby adding to their body of knowledge. Students have had a positive response to the course overall, with several students reporting to the faculty member, years after taking the course, that they continue to use the strategies and frameworks presented in the class. A recurring suggestion from the students is that a version of the course that focuses on literature searching and reviews should be offered earlier on in the graduate program.

5.1.3 Peer writing groups experience

Peer writing groups have posed challenges including student recruitment, student attendance, and faculty availability for group facilitation.

Our initial approach to recruit students to participate in peer writing groups was an email announcement from the university WAC program at the beginning of each semester. These announcements asked students to complete a survey that adds them to a contact list of interested students, but the response rate from engineering graduate students was low. The engineering faculty then divided the students based on discipline and emailed the students to arrange a time to meet as a group. This process took several weeks at the beginning of the semester, and it was difficult to find a time for everyone to meet. Further, the impersonal nature of email resulted in a low response rate to the initial announcement. Since then, we have implemented a strategy involving emails sent to the engineering graduate student listserv from the Associate Dean for Graduate Studies, emails sent to departmental listservs in participating departments from involved faculty, and direct communication with previous participants. This has resulted in a higher response rate from interested students.

For the writing groups that have formed, it was found that participation and attendance decreased throughout the semester as students tended to deprioritize the writing groups as other commitments increased. Previously, the university WAC program attempted virtual and asynchronous models for writing groups as a way to increase participation, but the removal of face-to-face social, relationship- and trust-building elements of the groups resulted in decreased participation.

The use of a faculty facilitator was found to improve the experience of the writing groups, but the faculty perception was that students wanted large amounts of support, somewhere between the workshop experience and enrolling in one of the writing classes. This level of effort from the faculty is not sustainable; thus, striking a balance of faculty facilitation and student independence is needed. Ultimately, writing groups would be more sustainable if they were fully student-led. This would require consistent participation in writing groups from a sufficient number students who would gradually learn the processes for operating a writing group and eventually take the initiative to manage their own group. Student led groups could be supported by Writing SySTEM OERs, which would enable students in writing groups to learn strategies independently.

5.1.4 Open Educational Resource experience

The Writing SySTEM OER documents are a work in progress. To date, one OER document has been published on the topic of finding relevant papers. At the time of writing, eight additional OER documents are in progress, covering topics that include writing groups, how to read a paper, and writing for different audiences. There exists a synergy between these OER documents and the writing courses such that the OER documents can be incorporated into the writing courses. From the lead author's perspective, the task of writing or adapting an OER initially seems daunting, but once the effort is started, the process goes quickly. This creates opportunities for faculty to develop discipline specific resources.

Available data shows that the one published OER has been downloaded almost 90 times from wide ranging geographic regions, including the Philippines, Thailand, India, Nigeria, Germany, and the United States of America. Unfortunately, limited metrics are available for how the downloaded OERs are used. We envision a wider distribution of the OER materials, on the basis that the materials are freely available to anyone with an internet connection. This reduces

financial barriers that arise from purchasing print materials (e.g. textbooks) that cover the material presented in the OERs. It is anticipated that dissemination of the OERs will be enhanced by increasing the visibility and promotion of the resources. For instance, the materials can be incorporated into various engineering courses that include technical writing elements.

5.1.5 Student Survey and Interview Responses

Although data for statistical analysis is still being collected, a preliminary analysis has been conducted on the participant responses to the semi-structured interviews. The analysis of responses reveals how participants view feedback processes and feedback as a social activity. In terms of feedback processes, participants have responded with an awareness of three primary types of feedback: (1) grammar and structure, (2) arrangement, and (3) correction. The responses indicate that both positive and negative feedback can contribute to self-efficacy and that healthy emotional states when addressing challenges are a factor in self-efficacy, as noted by other researchers.[3] In terms of feedback as a social activity, participants described evaluating feedback, explaining their choices, and negotiating with reviewers. Feedback was also viewed as necessary to scientific conversation and may include opportunities for comparative self-assessment, which is a key factor in developing self-efficacy.

6. Future work

With approximately one year left in the project, the research team will continue to offer program components according to Figure 1. Entering the final year of the project, we will continue offering program components along with collecting data from MSKT and WSRES instruments and participant interviews. In addition, analysis of the instrument results and interviews will be conducted to evaluate the effect of program components on self-efficacy as it relates to technical writing for graduate engineering students.

As the project draws to a close, the team will also work to package program elements so that the *Writing SySTEM* can be implemented at other institutions of higher education. The intent is that the *Writing SySTEM* can be exported and adapted to other STEM departments and institutions across the country that may have restricted access to writing programs (such as WAC) and writing program administrators. To encourage transfer, the research team will offer a faculty workshop on graduate-level writing support in STEM locally and broadcast via a virtual meeting platform in the final year of the award. This workshop will feature the grant's findings and materials.

7. Acknowledgements

This work has been funded by a National Science Foundation Innovations in Graduate Education grant, award number 2224967.

8. References

[1] 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.," *Across the Disciplines*, vol. 12, pp. 167–187, 2015.

[2] D. Allison, L. Cooley, J. Lewkowicz, and D. Nunan, "Dissertation writing in action: The development of a dissertation writing support program for ESL graduate research students," *English for Specific Purposes*, vol. 17, no. 2, pp. 199–217, Jan. 1998, doi: 10.1016/S0889-4906(97)00011-2.

[3] A. Bandura, *Self-efficacy: The exercise of control*. in Self-efficacy: The exercise of control. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co, 1997, pp. ix, 604.

[4] G. Kuh, K. O'Donnell, and C. G. Schneider, "HIPs at Ten," *Change: The Magazine of Higher Learning*, vol. 49, no. 5, pp. 8–16, Sep. 2017, doi: 10.1080/00091383.2017.1366805.

[5] N. Haslam and S. M. Laham, "Ten Years on: Does Graduate Student Promise Predict Later Scientific Achievement?," *Current Research in Social Psychology*, vol. 14, no. 10, pp. 143–149, Jun. 2009.

[6] H. Horta and J. M. Santos, "The Impact of Publishing during PhD Studies on Career Research Publication, Visibility, and Collaborations," *Research in Higher Education*, vol. 57, no. 1, pp. 28–50, Feb. 2016, doi: 10.1007/s11162-015-9380-0.

[7] L. R. Micciche and A. D. Carr, "Toward Graduate-Level Writing Instruction," *College Composition and Communication*, vol. 62, no. 3, pp. 477–501, 2011.

[8] M. Rose and K. A. McClafferty, "A Call for the Teaching of Writing in Graduate Education," *Educational Researcher*, vol. 30, no. 2, pp. 27–33, 2001.

[9] C. Aitchison and C. Guerin, Eds., *Writing Groups for Doctoral Education and Beyond Innovations in practice and theory*, 1st ed. London: Routledge, 2014.

[10] S. Gradin, J. Pauley-Gose, and C. Stewart, "Disciplinary Differences, Rhetorical Resonances: Graduate Writing Groups Beyond the Humanities," 2006, Accessed: Jan. 08, 2025. [Online]. Available: http://hdl.handle.net/2152/62402

[11] T. Phillips, "Graduate Writing Groups: Shaping Writing and Writers from Student to Scholar," 2012, Accessed: Jan. 08, 2025. [Online]. Available: http://hdl.handle.net/2152/62144

[12] R. K. Boettger, "Rubric Use in Technical Communication: Exploring the Process of Creating Valid and Reliable Assessment Tools," *IEEE Transactions on Professional Communication*, vol. 53, no. 1, pp. 4–17, Mar. 2010, doi: 10.1109/TPC.2009.2038733.

[13] R. E. Glaser, "Design and assessment of an assignment-based curriculum to teach scientific writing and scientific peer review," *Journal of Learning Design*, vol. 7, no. 2, Art. no. 2, Sep. 2014, doi: 10.5204/jld.v7i2.202.

[14] J. Swarts and L. Odell, "Rethinking the evaluation of writing in engineering courses," in *31st Annual Frontiers in Education Conference. Impact on Engineering and Science Education. Conference Proceedings (Cat. No.01CH37193)*, Oct. 2001, pp. T3A-25. doi: 10.1109/FIE.2001.963905.

[15] T. Rakedzon and A. Baram-Tsabari, "To make a long story short: A rubric for assessing graduate students' academic and popular science writing skills," *Assessing Writing*, vol. 32, pp. 28–42, Apr. 2017, doi: 10.1016/j.asw.2016.12.004.

[16] C. Bodnar and J. Kadlowec, “Initial Validation of a Technical Writing Rubric for Engineering Design,” *International Journal of Engineering Pedagogy (iJEP)*, vol. 8, no. 1, Art. no. 1, Feb. 2018, doi: 10.3991/ijep.v8i1.7728.
[17] Y. Karlen, “The development of a new instrument to assess metacognitive strategy knowledge about academic writing and its relation to self-regulated writing and writing performance,” *Journal of Writing Research*, vol. 9, no. 1, pp. 61–86, Jun. 2017, doi: 10.17239/jowr-2017.09.01.03.
[18] S.-J. Cindy Lin, B. W. Monroe, and G. A. Troia, “Development of Writing Knowledge in Grades 2–8: A Comparison of Typically Developing Writers and Their Struggling Peers,” *Reading & Writing Quarterly*, vol. 23, no. 3, pp. 207–230, May 2007, doi: 10.1080/10573560701277542.
[19] D. McCutchen, “Cognitive factors in the development of children’s writing,” in *Handbook of writing research*, C. A. MacArthur, S. Graham, and J. Fitzgerald, Eds., 2006, pp. 115–130.
[20] 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, Dec. 1994, doi: 10.3102/00028312031004845.
[21] J. W. Creswell and C. N. Poth, *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Sage Publications, 2018.
[22] J. Shah, A. Shah, and R. Pietrobon, “Scientific Writing of Novice Researchers: What Difficulties and Encouragements Do They Encounter?,” *Academic Medicine*, vol. 84, no. 4, p. 511, Apr. 2009, doi: 10.1097/ACM.0b013e31819a8c3c.
[23] Y. Zhang, “Exploring EFL Learners’ Self-Efficacy in Academic Writing Based on Process-Genre Approach,” *English Language Teaching*, vol. 11, no. 6, pp. 115–124, 2018.
[24] S. A. Gardner, L. M. Salto, M. L. Riggs, C. A. Casiano, and M. De Leon, “Supporting the Writing Productivity of Biomedical Graduate Students: An Integrated, Structured Writing Intervention,” *LSE*, vol. 17, no. 3, p. ar45, Sep. 2018, doi: 10.1187/cbe.16-12-0350.
[25] N. Hoffart, “A Member Check Procedure to Enhance Rigor in Naturalistic Research,” *West J Nurs Res*, vol. 13, no. 4, pp. 522–534, Aug. 1991, doi: 10.1177/019394599101300408.