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BOARD #147: Technical Communication Instruction Partnership with Engineering Faculty

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Technical Communication Instruction Partnership with Engineering Faculty

Abstract

Graduate students in STEM fields are often expected to communicate – both in writing and orally – at a professional level by the time they submit their theses and dissertations. Unfortunately, many graduate students lack opportunities to learn how to do that in a STEM setting. An informal review of US programs revealed that many offer writing courses modeled on traditional composition courses, which are not necessarily directed to the needs of STEM students. Further, many of these courses provide a series of isolated learning modules with little continuity or encouragement to revise and in which technological writing assistance is discouraged. This paper describes a collaboration between the Department of Electrical and Computer Engineering and the STEM Librarian for Engineering & Chemistry at the University of Alabama at Birmingham (UAB), a large R1 university. The result was the reinvention of Technical Communication for Engineers – a comprehensive graduate course in writing and presenting for academic, scientific audiences. The course design combined elements of general audience writing courses with those of science and technology courses. For this course, assignments were delivered in a project-based learning format whereby each assignment combined to produce a conference-style paper and presentation. The use of writing-assistive technology was encouraged. This course was also designed to introduce engineering graduate students, many of whom are international students, to a wide variety of resources available to students on campus, including the UAB University Writing Center, the Center for Clinical and Translational Science, and the UAB Libraries Office of Scholarly Communication.

Tags
co-instruction, technical communication, technical writing, academic writing, graduate preparedness, project-based learning

Introduction

The authors propose that graduate STEM students would benefit from efforts to improve instruction in writing and presenting. ABET, the organization responsible for accrediting engineering programs globally, does state requirements for teaching students to communicate with a variety of audiences. Yet these requirements do not include that a dedicated technical communication course be given during an undergraduate student's education [1]. At the University of Alabama at Birmingham (UAB), faculty of the Department of Electrical and Computer Engineering recognized the need for their graduate students to improve their communication skills and suggested reviving a dormant, previously required course – Technical Communication for Engineers. This was an opportunity for a robust collaboration between the department and its reference liaison librarian, which was taken up by the authors.

An informal review of publicly available syllabi for existing technical writing courses at colleges and universities in the United States, including those aimed at STEM and non-STEM students at

both the undergraduate and graduate levels, suggested that a combined approach would be of value. The authors sought to selectively include and exclude approaches from each. The pedagogical approaches selected for inclusion from courses directed at general students were draft writing, student-led review, and revision. The approaches selected for inclusion from courses directed to STEM students were domain-specific instruction on the requirements of scientific and technical writing, a project-based learning approach to the assignments, and the use of technology.

The STEM-specific approaches were informed by a further consideration of existing writing courses, which revealed two tendencies: a tendency for the curriculums to progress through a series of discrete, specific instances of writing, e.g. business letter, email, etc.; and a tendency to discourage the use of writing assistive technology. Against these tendencies, the authors chose to favor the more STEM-relevant approach of project-based learning driven by technology. In practice, this meant that the coursework would focus on a single project toward which each assignment would cumulate, and the use of technological writing assistance would be encouraged. In sum, the course design was built on the thesis that a STEM-focused communication curriculum would benefit from being based on the following: 1) STEM-specific instruction on writing requirements, 2) draft writing, 3) student led review, 4) revision, 5) project-based format, and 6) the use of writing technology.

Students were required to self-select topics for their projects. The main criterium was that students should select projects they had worked on either to completion or near enough to completion to allow for substantive reporting. In this instance of project-based learning, the project was the writing itself, not the STEM effort. This allowed for students to focus on the writing instead of being concerned with conducting active research. Every writing assignment was a part of the final project: a conference-style paper and its oral presentation. The pedagogy of each assignment followed a pattern: provide instruction on the requirements of the given section of the final project, assign students to write a draft of that section, facilitate student-led reviews of the drafts, assign students to revise their drafts, then incorporate that into the larger paper. The remainer of this paper will elaborate on course design decisions and provide results.

Pedagogical basis

In addition to the method of merging pedagogical approaches from general audience and STEM writing courses, the authors made additional course design decisions. These were selections from top-down and bottom-up approaches, addressing both the needs of institutions and the needs of students. For the top-down approach, the authors reviewed ABET requirements. ABET is the accrediting organization for engineering and related undergraduate programs. ABET provides a list of seven student outcomes that an accredited program must demonstratively achieve to maintain accreditation. Although ABET is concerned primarily with undergraduate programs, the authors proposed that a STEM writing course would benefit from a consideration of the ABET student outcome list. The authors identified two outcomes as being the most relevant to the course [1].

3. An ability to communicate effectively with a range of audiences.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student outcome three is an easy concept to grasp but central enough to effective communication to warrant purposeful inclusion. Also, instructing students to be aware of "a range of audiences" is not necessarily implied by the course principles previously discussed. As such, this cornerstone concept was built into the course so that it could be presented and reinforced in class.

Student outcome seven is supported in the course through information literacy librarian instruction. This was achieved by means of guest lectures and by requiring students to make appointments, as an assignment, with resource officers. This may be contrasted with the practice of providing contact information of resources in a syllabus. Collaboration between the instructors and the students as well as these other key support services on campus provide the opportunity for students to thrive in a supportive and kind environment as they develop their academic communication skills [2].

This outcome highlights the value of the collaboration between the library and the department for the development of this course, especially considering the limited previous exposure of most STEM graduate students to academic library services. For example, having face-to-face, collaborative sessions with their subject specialist librarian in creating and revising the students' first graduate literature review provides supervision and support that reinforces helpful tools and bolsters confidence in a writing process that can be intimidating.

For a bottom-up approach, the instructors considered the students' needs and expectations. The approaches selected were a mixture of practical and pedagogical considerations for instructions delivery and class management. The authors chose the following principles upon which to build the course – that the course should be:

1. Student focused
2. Practical oriented
3. STEM directed
4. Continuous not discrete
5. Iterative
6. AI forward

The "student focused" principle states the authors' goal that the course presentation should consider how students will approach the material. Graduate students at UAB have varying levels of skill in writing and presenting. The course is designed to take each student at their level and facilitate their improvement. This is different than treating the class as a homogenous unit.

The "practical oriented" principle states the authors' goal of fostering practical rather than theoretical knowledge. In other words, the course should highlight what students will need to succeed both in their graduate program at UAB and in the greater scientific community. An effort was made to avoid abstraction while talking about communication.

The “STEM directed” principle is based on the proposition that the writing needs for disciplines are highly varied. For this course, the authors purposefully designed each assignment and lecture with communication in the science, technology, engineering, and mathematics (STEM) fields in mind. Although this course was placed within the Department of Electrical and Computer Engineering, an effort was made to develop a course that would be equally helpful and accessible to STEM graduate students from a wide range of backgrounds and interests.

The “continuous not discreet” principle, commonly referred to as scaffolding in pedagogical literature, grew from experiences in STEM courses, such as math and chemistry, in which each lesson builds upon the previous, and in courses like design in which there is final project that is worked upon throughout the semester. As much as possible, every class presentation, activity, and assignment were steps toward the final project, which consisted of a journal article and oral presentation. This approach may be contrasted with discrete, modular assignments not related to one another.

The “iterative” principle stands for the notion that students should repeatedly revise their writing efforts. This is a contrast with “one and done assignments” that do not foster revision. Iteration also connects to the prior principle of continuous building. In this way, the students’ final project would represent the culmination of what they have gained through the course.

The final principle was “AI forward.” This connects, again, with principles one and two, that is student focused and practical oriented. The principal also acknowledges the reality of students’ use of generative artificial intelligence tools such as Grammarly. In the course, students are assigned to use AI-based tools to produce writing. Students then present the results to the class and a discussion is fostered to consider the suitability of the results and how they may be improved. By this, students learn, experientially, the limits of software tools to generate and improve texts.

Developing healthy review and revision habits was a top priority for the authors, as this is one very effective way to improve engineering student writing [3]. In fact, the graduate student research writing pedagogy developed by Badenhorst et al. dedicates nearly half of the time face-to-face with students to the revision process [4]. This is particularly important for multilingual students, where multilingual is defined by Qiu as “international students whose native language is not English” [5]. Although the authors did not intend to teach a highly mechanical, grammar-focused course, which would alienate domestic students and native English speakers, the authors were very aware of a real need for additional writing and reviewing support for many international students [5]. Several presentations were prepared and made available asynchronously to students to give additional support when needed.

The authors also hoped to instill a sense of camaraderie and collaboration between students enrolled in the course, which was considered crucial to their retention and success in the graduate program, especially for the large number of international students enrolled in UAB School of Engineering as graduate students. As of Fall 2023, students from non-U.S. countries made up 19.0% of the graduate student population, 7.9% of whom are enrolled in the UAB School of Engineering [6]. Venkatesh et al. establishes four pillars for building community in the graduate classroom: “enabling meaningful interpersonal connection, facilitating participation to prime

learning, sharing insight into scientific careers, and validating student competence and potential." Their study found that building a graduate course with these pillars in mind dramatically increased students' comfort in interacting with course faculty, successfully mitigated imposter syndrome, and helped the students begin to build their scientific identities [7].

To ensure equitable access to the recommended texts for the course, all items that were not natively open access were made available on course reserve through the UAB Libraries. These texts are recommended to students to support their needs in writing and revising but are not directly utilized during class time. When possible, texts to support students were acquired in electronic format for convenient access regardless of physical location or time of day.

Course design

The pilot for this course was taught in Summer 2024 in a 10-week schedule with 1.75-hour classes to five graduate students, each from a different graduate program in the School of Engineering at UAB, a large R1 university. The students enrolled were either Masters or Doctoral students in biomedical engineering, civil engineering, electrical and computer engineering, interdisciplinary engineering, or neuroengineering. All students had program requirements to complete either a thesis or dissertation.

The stated purposes for this course were written to reflect the previously stated critical factors for the design of the course. Several of the purposes for this course are directly related to the well-being of the graduate students – fostering community between the graduate students, fighting imposter syndrome, and establishing habits that support academic and career success. Specifically, this course was designed to provide graduate students with an introduction to support services around campus, including introducing them to specific individuals they can communicate with at the Graduate School, the University Writing Center, etc. Ultimately, the course should encourage students to conduct discussions about scientific writing and presentations, highlighting the difference between this type of professional communication compared with delivering pitches, a common focus in undergraduate engineering projects. Finally, the instructors of this course seek to support the students' improvement in their writing process and products, regardless of their levels of confidence and skill when entering the course.

Upon completion of this Technical Writing for Engineers course, a student can expect to demonstrate understanding of proper written communication by authoring their own work, critiquing the work of others, and responding to others' critiques of their work. Some of the communication skills students should develop in this course are planning, conducting, and articulating the importance of academic research; differentiating appropriate style and tone of communicated ideas based on intended audience; and implementing proper citation usage, typically in IEEE style. Students should also become familiar with constructing a variety of professional and academic documents based on standard formats and conventions, including grant applications and presentation proposals.

Course assignments

Writing assignments

It was important to both authors for the graduate students to trust that we were not going to assign them busy work or other assignments that would not contribute to their major projects in the course. It was also important to have the students write and/or revise previous writing during as many classes as possible. Our solution to this was to distribute the sections for their final writing project throughout the semester. The mid-term paper, then, would contain any sections we had already covered together in class and the students had received peer and instructor feedback on by that time. All assignments were prescribed with a detailed rubric for evaluation, which the authors encouraged the students to use as guidelines for producing quality written work. As the semester proceeded, students were also asked for feedback on the rubrics and collaborative changes were made to better serve the assignments' purposes [8].

A quarter of the students' final grades were derived from daily writing/revision assignments. Each daily writing assignment was worth three points. We began the course with a daily writing rubric that highlighted three appropriate writing-related skills we would assess (1 point if sufficiently accomplished, 0 points if not), which were selected from a list of eight important writing skills we intended to highlight for the duration of the course. These eight skills were addressing the topic (responsive to criteria), grammar/spelling, word count/length, format, logic, tone/presentation, claim discipline, and citations/appropriate sources. We also included space on the feedback form to share what the student did well and what the student could improve. The three skills assessed by the instructors were not announced in advance to prevent students ignoring other skills.

In-class discussion and review of each other's writing accounted for the next quarter of the students' final grades. The authors provided a feedback rubric for students that included all eight of the above skill categories for class discussions of each other's writing assignments so that students could practice providing each other feedback about specific communication skills. Most review sessions began with the instructors sharing some of their feedback on a student's work demonstrating good practice in providing constructive feedback and recommendations, then opening the floor for the feedback of the student's peers. Students often made suggestions that led to collegial group discussions between instructors and students alike. The authors planned to have the students work in small groups to aid in building community and keeping one another accountable for writing goals [8], but the small size of the Summer 2024 pilot cohort for the course prevented this from being possible.

The mid-term paper was worth a quarter of the students' final grades. During Summer 2024, the mid-term paper required an introduction (10 points), methodology (20 points), results & discussion (15 points), and conclusion & future work section (10 points). References and AI usage appendices were also required (5 points and 15 points respectively). All these sections were discussed, partially written, and reviewed together during class time – dates on which the sections were going to be discussed and assigned for the first time were outlined in the document given to students with the mid-term assignment information and grading rubric. The grading

rubric included criteria for each section that were worth up to 5 points each, which can be found in the supplemental information for this work.

The final paper and oral presentation were worth the final quarter of the students' final grades. This final written assignment required revised versions of all the above sections from the mid-term paper and added an abstract, a literature review, and the addition of limitations to the conclusion & future work section. The breakdown of points for this assignment were distributed as shown in Table 1. The rubric for the final paper contained criteria for each of these sections, each of which was worth up to 5 points each, which can be found in the supplemental information for this work.

Table 1. Point distribution for final writing assignment for graduate Technical Communication for Engineers course.

Section	**Points**
Abstract	5
Introduction	10
Literature Review	15
Methods	20
Results & Discussion	15
Conclusion, Limitations, & Future Work	15
References	5
GAI Appendix	15
Total	**100**

Presentation assignment

As part of their final project, students were also asked to create and present an academic conference-style 20-minute presentation as the capstone assignment for the course based on their final paper. Students were asked to minimally include five sections of their presentation, each worth 10 points – statement of the problem, literature review (a review of past solutions), methodology (the design choices for their solution), results & discussion, and conclusions (contributions to the field, limitations, & future work).

As with all writing assignments, students were required to present a draft of their slides to the class before their final presentation, which allowed fellow students and instructors to provide constructive feedback, suggestions, and corrections prior to the final presentation. Students informally shared with the instructors that this helped them feel much more comfortable and confident when giving their final presentations during the final week of the course. To incorporate peer feedback into the evaluation of this assignment, 3 of the 10 points available for each required section of the presentation were assigned by averaging the scores awarded by each student's classmates (3 points maximum for each section).

Classroom activities

The authors felt that one of the important roles of this course for graduate students, specifically graduate students early to their programs and/or international students, was to introduce them to various support services at UAB. Orientation programs are often compressed into a day or less and rarely comprehensively cover research-specific support. Graduate students, whether domestic or international, routinely fail to thrive in their programs in part due to hidden competencies, identified by Zerbe et al. as research fundamentals, career growth, disciplinary communication, managing mental health, and managing social health [9]. To remove these barriers for the graduate students in this course, the authors intentionally included multiple discussions throughout the course either as classroom discussions or by inviting in a relevant guest speaker. Several of our two-hour class meetings were used to invite speakers from many UAB offices to present special topics that we feared students would not be formally introduced to otherwise – these departments and topics are listed below in Table 2.

Table 2. Invited speakers for graduate Technical Communication for Engineers course from university partners.

Department	**Topic**
UAB University Writing Center	Academic Writing vs Pitching
UAB Libraries	Ethical AI Usage
UAB Libraries, Office of Scholarly Communication	Copyright, Predatory Journals and Conferences
UAB Libraries	Plagiarism (Unintentional or Otherwise)
UAB School of Engineering, Department Electrical & Computer Engineering	Creating Charts, Graphs, and Figures Using Software Tools
UAB Center for Clinical and Translational Science (CCTS)	Grant Writing
UAB School of Engineering, Career Services	Resumes vs CVs
UAB Graduate School	Theses & Dissertations

Evaluation of student performance and feedback

Feedback on assignments

Detailed written feedback was a priority for all student writing assignments. With the small number of students enrolled in the Summer 2024 pilot, discussed below, both instructors were able to provide feedback to each student on every assignment. This level of feedback does require a lot of time, which required negotiating reasonable due dates for each assignment that

would provide the students with enough time to complete the writing assignment and enough time for the instructors – teaching this course in addition to their full-time positions' duties – to respond thoughtfully. Students' work was also shared on the course's learning management system (LMS) so that other students could read each other's work in advance of having in-class reviews. This provided opportunities for students to learn from one another's mistakes or uncertainties, supporting each other in their growth as writers, and developed trust between the instructors and students.

Summer 2024 pilot – challenges, successes, & lessons learned

There were only five students that enrolled in the Summer 2024 pilot of Technical Communication for Engineers. This small size was ideal for the pilot of this course – a larger course would have required breaking the class into smaller groups for discussions and collaborative review of one another's work. Having only five students allowed both authors to engage deeply with all the students and the work they produced weekly, including detailed feedback and recommendations as their writing projects progressed. Unfortunately, one student left the course before it concluded – and, ultimately, the graduate program – for reasons not related to the course.

The authors expected to spend a significant amount of time helping students with the more mechanical skills related to writing, including grammar and punctuation. They were pleasantly surprised to find that students did not seem to need as much support as expected. Although comma placement and other common errors were still present and routinely discussed during reviews of the students' writing, students seemed to have a good grasp of most of the fundamental mechanics. Regardless, Lipscomb created a series of asynchronous presentations that students could access if and when they needed them that addressed many mechanical writing skills. These were made available to the students through the LMS.

Student perceptions

An anonymous survey, created with Microsoft Forms, was provided for the four students who successfully completed the Summer 2024 pilot of this course. All students reported feeling more confident in academic writing, academic presenting, understanding their thesis/dissertation requirements, locating resources to support writing and research on campus, and their likelihood of using the resources available through the UAB Libraries. These students reported that guest speakers, major writing assignments (mid-term and final papers) and the major presentation assignment (final presentation) were extremely effective. All but one student found the daily writing assignments and in-class review of writing extremely effective – one student reported feeling that the daily writing was only somewhat effective and that the in-class review of writing was neutral in effectiveness. When asked whether they would recommend the class to a friend or classmate, the average likelihood was a 9.5 out of 10. When asked about their satisfaction with the knowledge gained from the course, two students reported being very satisfied, one satisfied, and one very dissatisfied, although the authors believe the "very dissatisfied" response to be in error. The same respondent who reported being very unsatisfied with the knowledge gained from the course wrote a lengthy, very positive free response at the end of their survey. The content of this response, collected before IRB was obtained for this work, stated that the student felt

gratitude for this course, which not only helped with the student's writing skills but also eased the stress and inevitable challenges of being an international graduate student.

Planning and promoting for spring 2025

The authors encouraged students during the Summer 2024 offering of the course to provide regular feedback on the assignments and content of the course, which were considered when modifying the course for its next offering. For example, McGuire created the assignment descriptions for the mid-term and final paper assignments based on her experience publishing as a chemist – however, conventions within engineering publications differ, which were considered in the second iteration of the course. For example, the "methods" section is not as common in engineering literature, so the section was renamed "research plan & methodology." Similarly, the "results & discussion" section was renamed "case study & results." The description of each of these sections was also refined to circumvent confusion and questions that the original descriptions caused. The sections of the final paper required for the mid-term assignment were also modified, moving the "conclusions" section to the final paper assignment only so that more time could be spent revising the "research plan & methodology" and "case study & results" sections in the first half of the course. Additionally, the authors redistributed the points for the rubrics of these major written assignments and edited the criteria to better reflect skills described in the assignment itself. There is also time to review mid-term papers in detail added to schedule for Spring 2025 to provide opportunity to discuss the progress on the writing projects more holistically. At the request of the faculty of the Department of Electrical and Computer Engineering and other faculty from the UAB School of Engineering, the authors have also built more time into the course to discuss data visualization.

The format of the course for Spring 2025 is also fundamentally different – the course now has a 15-week schedule with 1.25-hour classes rather than 10-week schedule with 1.75-hour classes. This required some juggling of the original schedule, which has been rearranged with built in writing assignments given for the weekend with review days for that writing on the first day of class each week, providing a better balance between student time to work and instructor time to provide feedback.

In offering the class for Spring 2025, the authors realized that one of the major challenges they would face going forward was convincing the graduate students to take the course. Low enrollment led to the cancellation of this course for Fall 2024, which the authors hoped to avoid in the next semester. In this, they needed to capture two kinds of students: (1) students for whom English was not their native language and who were likely embarrassed by their perceived struggles with academic writing and (2) students for whom English was their native language who assumed that their ability to read and write at the undergraduate level meant that this class was not useful for them. The following message was sent to UAB School of Engineering graduate students as graduate student registration for Spring 2025 was opening:

> "I wanted to make you aware of a course that's being offered this Spring – EE 610: Technical Communication for Engineers. This course is co-taught by McGuire and Lipscomb. Despite the fact that it is technically listed as a course in

> the ECE department, the material in this course is geared for any graduate student in science and engineering.
>
> The purpose of this course is to build your skills and confidence in communicating, both in writing and orally, as an academic scientist. We will work together to improve your writing through review and revision, build an academic journal-style manuscript from your previous work, and practice presenting an academic conference-style presentation. You will also be introduced to many units across the UAB campus who are here to support you in your academic pursuits, learning to write grants, and more!"

A version of this message was sent to all UAB School of Engineering faculty one week later with the course's syllabus and information about the course's major assignments. While this course is being taught in Spring 2025, low course enrollment continues to be a challenge that the authors hope to address going forward.

Conclusions

Convincing graduate students who are intimidated by a writing course or don't believe the course would benefit them to take Technical Writing for Engineers is a significant challenge, which the authors are still learning to navigate. However, the feedback from the students who enrolled in the Summer 2024 pilot of the course provided ample feedback on their perceived value in having taken the course, both during informal conversations and on the course's anonymous evaluation at the end of the term. By building a sense of community and regularly reminding students that the most important goal is to get a little better each day, instructors and graduate students found themselves in a productive relationship with one another and with other support offices and programs around the campus of UAB. Although somewhat nontraditional compared to other similarly named graduate courses, the authors found great satisfaction in building this practical, STEM-focused, student-oriented course that provided the graduate students with the opportunity to spend a term continuously writing, reviewing, and revising work strengthened by the ethical use of various AI tools.

The authors are encouraged by the response of the students who participated in the Summer 2024 pilot of this course and have successfully applied for an IRB to study the effect of this course on the engineering graduate students' confidence in their abilities as an academic writer and as a graduate student. Gassman et al. found that their "Writing for Publication" course, with many of the same goals and structure as the course discussed in this work, significantly raised their graduate engineering students' self-reported confidence level with respect to professional writing – from an average score of 4.8 out of 10 at the beginning of the course to an average of 6.4 at the end of the course [8]. While all our students have reported feeling their writing improved, we look forward to quantifying these results to compare with the literature. The research questions for our future study are:

1. Does participation in this course improve the graduate students' confidence in academic writing?

2. Does participation in this course improve the graduate students' confidence in academic presenting?
3. Does participation in this course improve the graduate students' awareness of various supports within the university?

While a factor in the original ideation of the course, the authors have not yet produced all the asynchronous support materials they would like to put in place to support student learning outside of the classroom. For example, a series of short videos on various professional communication topics were planned to complement the discussions covered in class daily that students could refer to when needed. These videos, created by McGuire, would also be shared publicly through UAB Libraries for the benefit of the entire UAB scholarly community.

The authors acknowledge that their approach to creating this course derives from their experiences outside of their current roles as an academic reference librarian and a member of the School of Engineering. However, the authors suggest that replication of this course at other institutions is possible and would require a robust collaboration between the engineering department and their institution's academic reference librarian(s). Engineering departments can seek additional support from their institution's center for teaching and learning, if available.

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