# Work in Progress: Design of a First-Year Rhetoric Course for Engineering Students

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## Introduction

This paper describes an initiative to intervene at a first-year curricular level, asking engineering students to consider writing as an essential and crucial element of being an engineer while developing rhetorical awareness and writing skills. The ability to effectively and efficiently communicate is an essential skill for engineers. Communication skills are widely recognized by educators and employers as critical for undergraduates [1] and are evaluated under ABET student outcome g "an ability to communicate effectively" [2]. Even with this focused directive, engineering students' lack of sufficient technical writing skills remains a problem nationally [3].

To complicate the problem, we find that students undervalue the importance of writing skills. Undergraduate engineering students, especially early in their college years, often do not recognize that their careers will require extensive writing. Many students have an aversion to writing, some even citing a perceived inability to write as a motivation to study engineering or believing themselves to be poor writers or communications based on the myth that engineers are "bad writers." The misconception that writing is not part of a career in engineering is prevalent among undergraduate students and contributes to poor student attitudes towards writing and writing-intensive courses. Yet, in reality, writing is extremely important in an engineering career, and students must be educated about the typical genres and quantities of writing associated with engineering careers. Mastering technical skills alone is not sufficient to advance and succeed in an engineering career.

Improving technical writing instruction is a recurring topic; however, the current introductory course at University of Illinois at Urbana-Champaign (UIUC) neither satisfies situated-learning [4] development of writing skills nor demonstrates the value of writing to engineering students. Demonstrated value and application to engineering professions are needed to satisfy engineering students' desire to bridge the gap between their instruction in communication and their careers as professional engineers [5]. Without engineering-specific examples, the current introductory course (RHET 105, offered by the English Department) does not fulfill these student needs. The RHET 105 course is the introductory component of the writing instruction requirements for engineering majors at UIUC, with the final component being an advanced composition course. At present, RHET 105 is a general writing course that focuses on developing skills in argument and rhetorical analysis, as well as research strategies and source usage. Though the RHET 105 course is taught across many sections that are allowed to employ different readings and/or approaches to assignments, all sections share common student learning outcomes (Table 1). The learning outcomes require students to develop unified skills and competencies by the end of the course, and these outcomes are measured through evaluation of student work on drafted and

revised research-based writing. Credit for the RHET 105 course can be earned with established scores on the Advanced Placement (AP) English exam or ACT. However, neither the AP English exam nor the ACT evaluate technical writing skills, nor do they measure how well students develop arguments and research topics over time, or revise writing to meet the needs of different audiences and rhetorical situations.

Currently, approximately 50% of students entering the College of Engineering (COE) place out of the RHET 105 course, eliminating student exposure to college-level writing rigor and situated practice. These students lose the opportunity to develop their writing skills during freshman year. Additionally, because at least half of all COE students place out of the RHET 105 course, some students inaccurately view the course as remedial. Importantly, neither students who place out of RHET 105 course nor those who complete the RHET 105 course are prepared for writing in their disciplines. In one sophomore Bioengineering class, **over 50% of students reported feeling unprepared for technical writing assignments** (data unpublished), despite some of these students having earned credit for the RHET 105 course. In sum, while the RHET 105 course provides many valuable lessons in rhetoric and research-based writing, it cannot provide engineering students with disciplinary-specific skills necessary to write in the genres that engineering careers will demand.

Lack of student preparation for technical writing assignments is one of several challenges that faculty face when developing student writers. Teaching technical writing is also very time-intensive. Peer review has been used successfully in some cases, but it requires that students be trained in reviewing, such that the feedback they provide is meaningful. Feedback is also provided by graduate student teaching assistants (TAs) who may or may not have sufficient training in technical writing themselves and may further lack experience in providing meaningful feedback on student writing. Recent studies have highlighted writing-across-the-curriculum approaches that have shown student benefit [6, 7]. However, we believe these approaches will be most effective when students enter disciplines with a baseline skill set.

Writing-across-the-curriculum (WAC) and writing-in-the-disciplines (WID) have become foundational theoretical frameworks used to address writing concerns within specialized fields and departments, an area that has drawn much attention in the past thirty-five years [11]. Since then, WAC/WID research has highlighted the need not only for disciplines to incorporate writing assignments and instructions into their curricula (including engineering) but also to develop clear lines of understanding, cooperation, and co-development between first-year writing programs and engineering departments [12, 13]. While helpful, integrating writing assignments into engineering disciplinary courses has not proven as significant as expected [14], and the lack of integration/cooperation between disciplinary writing content and first-year writing has been cited as a potential method for strengthening WAC/WID approaches [15]. Thus, we developed a pilot course to strengthen cooperation between first-year writing and engineering departments, as well as serve as an introduction to genres and attitudes toward writing that students will encounter in later years of their field-specific coursework.

By developing the introductory writing course in the context of engineering communication, we sought to improve both student writing and student attitudes about writing. Instead of viewing writing as something trivial that the Engineering College outsources to other departments, students will be trained in the importance of writing in engineering through a collaboration between Engineering and English. The outcome of this collaboration is our pilot course that was co-developed and is being co-taught, thereby (1) demonstrating the engineering commitment to writing, (2) enabling engineering examples to be utilized in the course, and (3) fostering a culture of collaboration between Engineering and English. Through these changes, we anticipate a change in student opinions towards the importance of writing in engineering careers.

**Table 1. Comparison of learning objectives in the current freshman composition course and the Writing in the Engineering Fields course.**

| Freshman Composition (RHET 105) | Writing in the Engineering Fields |
|---|---|
| Identify and explain the role rhetorical appeals and the rhetorical triangle can play in non-fiction print and/or multimodal texts. | Understand and describe forms of written communication important for scientists and engineers (e.g., journal articles, quality reports, specification sheets, abstracts, protocols, progress reports). |
| Create and sustain across one or more pieces of writing a focused research question that responds to an exigent issue, problem, or debate. | Develop content for specific engineering documents that are focused on an engineering idea, product proposal, quality review, etc. |
| Compose cogent, research-based arguments, in print-based and/or multimodal texts, for specialist and/or non-specialist audiences. | Compose written documents that use quantitative, not qualitative, descriptions and incorporate figures and supporting data that address the appropriate purpose of the report and audience. Write with clarity, brevity, exact wording, and appropriate use of scientific terms. Apply rules for hyphenation, expression of numbers, capitalization, acronyms, and tense in scientific documents. |
| Locate, accurately cite (through summary, paraphrasing, and quoting) and critically evaluate primary and secondary sources. | Locate and accurately cite ideas, text, and figures by other authors. Use citation manager software (e.g., EndNote, BibTex, Mendeley) and properly format references in scientific documents. Incorporate these source materials in a meaningful way toward the presentation of an argument or proposal. Learn the rules of plagiarism, including self-plagiarism, in the use of source materials. |
| Demonstrate knowledge of writing as a process, including consideration of peer and/or instructor feedback, in one or more pieces of writing from initial draft to final version. | Demonstrate knowledge of writing as a process, including outlining, drafting, and consideration of peer and/or instructor feedback to create a logical, coherent narrative arc for any form of technical communication. Provide constructive feedback on documents by other authors and implement feedback received. |

## Course Design and Structure

To achieve these goals, a community of practice was created, composed of engineers from a variety of fields (physics, electrical and computer engineering, bioengineering, and materials science and engineering) along with composition-studies experts from the Undergraduate Rhetoric Program. The team developed a course designed to focus on introducing engineers to relevant genres and types of writing prominent in many engineering disciplines. The "Writing in Engineering Fields" course, designed to mirror in structure and delivery the university's first-year composition course (Table 1), aims to inculcate these skills in a single semester.

Our team developed the course in one semester by meeting every two weeks to discuss content and provide feedback on drafted material. Throughout the development and offering, two team members (our graduate TAs—one from English and one from Engineering) were essential in promoting the success of the project. These TAs are the instructors of the course to mirror the current UIUC Rhetoric model. As instructors, the TAs were instrumental in the development phase and led the effort to design the curricular outline and assignments for the course. The TAs developed this material throughout the semester and presented content at bi-weekly meetings, with the outcome of this development phase being the course structure described herein.

Additionally, during the development semester, a consulting expert (Dr. Mya Poe) on WAC was invited to UIUC, co-hosted by English and Engineering. Dr. Poe met with our entire team to discuss significant challenges and concerns for the project, met separately with the two TAs to discuss curriculum, assignments, and overall structure of the pilot course, and presented an overview of her work in a seminar. The team also consulted with an industry representative having an engineering background from Wolfram Alpha, who provided insight into types of documents/genres used in industry, solidified the importance of writing in industry, and offered to speak to a larger audience at UIUC.

Our pilot course was established to have a maximum enrollment of 19 students to mirror the current UIUC Rhetoric model and because literature suggests small sections of 15-20 students are optimal for writing instruction [8, 9]. However, this approach presents a challenge for institutions having large enrollments and limited capacity or willingness of faculty to teach time-intensive writing courses. Currently at UIUC, the freshman composition course sections are led by graduate students and lecturers. To develop a course that would be scalable to meet the needs of our large freshman engineering class, we adopted a similar model for the *Writing in Engineering Fields* course. The course is overseen (coordination level) by engineering and English faculty, and the section (current enrollment is 12) is taught by one English graduate TA and one engineering graduate TA who worked collaboratively in the development stage and continue to work collaboratively in course delivery, including implementing lesson plans and providing feedback to students.

While engineering students often write lab reports and research proposals for class assignments, in the workplace, engineers are tasked with a variety of writing deliverables, including manuals, quality reports, and specification sheets [10]. To best prepare our students for writing in their careers, we must first identify the types of documents that they will prepare. In developing the course, the community of practice engaged with professionals across the COE and industry to converge on a set of document styles that would prepare engineering students moving into the workplace. To incorporate our findings into the pilot class, the writing assignments include genres such as lab reports, abstracts, problem statements, technical instructions, and more "public"-oriented engineering writing. Also included are rhetorical reflections that ask students to consider the choices made in their own writing and to understand writing as a process in which they engage.

The *Writing in Engineering Fields* pilot course was designed to be delivered in three units: Unit 1: Basic Skillsets for Rhetoric/Why do Engineers Write?", Unit 2: Writing to Engineering Audiences, and Unit 3: Writing to Wider Audiences—with each unit designed to meet three core learning objectives (Table 2). Unit 1 began with an introduction to the Grand Challenges concepts, culminating in an assignment that asks students to analyze, along with providing a rhetorical reflection on, the written and rhetorical choices made across three texts that reflect a Grand Challenge concern. In addition, students were introduced to the purposes and aims of writing as an engineer and to the variety of writing genres engineers must master. The second unit focused on engineering writing that is primarily intended to be read by other engineers, and included discussion/study of genres such as problem statements, "state-of-art" reviews, and technical instructions, among others. This middle unit culminated in two different major assignments—a set of technical instructions and a "state-of-art" review for the student's chosen engineering field, each also having a rhetorical reflection attached. The final unit shifted to considering how engineers must be capable of writing for non-engineering audiences as well as technically knowledgeable audiences, so this unit returned to asking students to consider the rhetorical choices required, culminating in a "remix" of an earlier assignment into a different, more public genre.

In addition to the course design, the community of practice sought to identify the best opportunities for training engineering and English graduate teaching assistants to deliver the course. The Rhetoric Program currently provides a week of pre-semester training for new graduate-student TAs in August of each year, as well as a semester-long fall practicum in the teaching of rhetoric. The engineering TA completed the week of pre-semester training and attended the semester-long fall practicum, while the English TA audited an upper-level technical writing course taught in the Physics Department. As the project evolves, we are also developing a comprehensive interdisciplinary training program to train engineering and English graduate TAs to co-teach effectively and provide meaningful student feedback.

Our pilot course, *Writing in Engineering Fields,* was offered for the Spring 2017 semester. The section was open to engineering freshman and was advertised via email and posters as an

alternative to the current freshman Rhetoric course. Enrollment was offered on a first-come–first-serve basis. Twelve students from a variety of engineering disciplines enrolled, including physics, bioengineering, aerospace engineering, electrical and computer engineering, civil engineering, and systems engineering.

**Table 2. Writing in Engineering Fields learning objectives by unit.**

| |
|---|
| Unit 1: Basic Skillsets for Rhetoric/"Why do Engineers Write?" |
| 1. Develop a rhetorical awareness of why engineers write |
| 2. Develop audience awareness in engineering writing |
| 3. Develop understanding of purpose in engineering writing |
| Unit 2: Writing to Engineering Audiences |
| 1. Introduce students to prominent writing genres in the engineering disciplines |
| 2. Teach students how to communicate technical/specialized knowledge to appropriate audiences |
| 3. Ask students to demonstrate knowledge of rhetorical understanding of technical information through specific writing genres |
| Unit 3: Writing to Wider Audiences |
| 1. Teach students to take technical information and make it accessible to non-technical audiences |
| 2. Teach students to navigate and identify rhetorical differences in over-explaining and under-explaining based on audience |
| 3. Teach students to make (and reflect upon) rhetorical decisions in audience engagement and the genres they work in |

## Methods

*Participants*

The participants of the study comprised two groups. The experimental group comprised the students enrolled in the pilot course. The control group comprised students enrolled in the traditional freshman composition course. In order to protect participant anonymity, all student names have been replaced with a unique identifier with the key known only by the specified data coder in this study and not by the course instructors or other faculty and staff.

*Course Structure*

Participants of the *Writing in Engineering Fields* course met three times a week (Monday, Wednesday, and Friday) for 50 min in an active-learning classroom (https://iflex.illinois.edu/2015/04/10/collaborative-spaces/) during the Spring 2017 semester. The detailed overview of topics covered in each unit is shown in Table 3.

**Table 3. Writing in the Engineering Fields course schedule overview.**

| |
|---|
| **Unit 1: Basic Skillsets for Rhetoric/"Why do Engineers Write?"** |
| Week 1: Syllabus/Introduction and What Does Writing Look like in Engineering? |
| Week 2: Introduction to Concept of Genre and Working Within Engineering Genres |
| Week 3: Introduction to Problem Statements; Reading/Analyzing Engineering Discourses |
| Week 4: Identifying and Comparing Rhetorical Choices; Introduction to Writing Arguments |
| Week 5: How to Do Rhetorical Meta-Cognitive Work; Workshopping/Peer-Reviewing Drafts |
| **Unit 2: Writing to Engineering Audiences** |
| Week 1: Introduction to Technical and Field-Specific Engineering Writing/Talking about Technical Instructions |
| Week 2: Introduction to Visuals/Writing Technically |
| Week 3: Peer-Reviewing and Introduction to Discourse Communities |
| Week 4: Introduction to Assignment 3, Citation Management, and Research Reports |
| Week 5: Discussing Pre-Writing and Exigency |
| Week 6: Conference Week |
| Week 7: Revision and Peer Review |
| **Unit 3: Writing to Wider Audiences** |
| Week 1: Writing for People Outside of Your Field |
| Week 2: Building and Delivering Presentations |
| Week 3: Peer Review and Presentations |

*Data Collection and Procedure*

The course efficacy in achieving established goals will be assessed through several methods including surveys, exit interviews, and writing assessments, as approved by UIUC's Institutional Review Board (IRB) in January 2017. Student consent to participate in the study was given electronically via a consent form before completing the electronic surveys. These short surveys are designed to evaluate students' attitudes toward and perceptions of technical writing and consist of a pre-survey at the beginning of the semester, a post-survey at the end of the semester, and three follow-up surveys at the end of each academic year until the students graduate. The survey consists of nine Likert scale questions, one multiple choice, and three free-response questions. Three questions ask students about their perceptions toward writing in engineering as a career and ask students to rate whether they think they will be writing many technical documents and whether they think writing is an important skill. Another question is composed of four parts and asks students about their perception toward technical writing and to rate whether they think writing is easy, boring, etc. Additionally, other questions ask about students' previous experience with writing and why they are taking a writing course. Follow-up surveys ask students about the effect of taking a writing course in their other classes in addition to questions listed above.

Samples of student writing will also be collected from all study participants. For the experimental group, we will collect their first major assignment after Unit 1 of the pilot course and their last major assignment of the pilot. For control groups, students will volunteer a sample writing from any technical course that they are currently taking.

Finally, an exit interview will be conducted at the end of the semester to supplement data from the surveys. The exit interview consists of seven questions and asks students about the amount of writing they do, their perceptions of writing, and their perceptions of the pilot course.

*Data Analysis*

Survey data will be analyzed via standard t-test. For writing assessment, a panel of faculty reviewers selected from both the English and engineering departments will assess students' proficiency in writing based on a rubric evaluating the content, organization, and citation usage. The rubric is designed from engineering-faculty feedback on what is important in technical writing for engineering fields.

**Preliminary Results**

The *Writing in Engineering Fields* course had 12 freshman students in its first cohort from a variety of engineering departments. The physics department[*] had the highest representation with

[*] Physics is administratively located in the College of Engineering at the University of Illinois at Urbana-Champaign.

four students, followed by representation from aerospace engineering, electrical and computer engineering, and civil engineering with two students in each.

The first survey conducted early in the semester reveals student attitudes and perceptions at the beginning of their classes (Table 4). Because no incentive was offered, obtaining survey participation was challenging. For the presurvey, *N*=2 for experimental and *N*=3 for control class. While limited, survey data suggest no difference between experimental (pilot) and control (traditional) courses in how prepared students feel regarding technical writing, and both groups agree that technical writing is a valuable skill. Both groups also agree that technical writing is neither boring nor interesting and that it is tedious. It is interesting, however, that students enrolled in the WAC course (pilot course) tend to believe that there will be much technical writing in their future careers and believe it is a useful skill to learn. This is in contrast to students in the traditional course who do not appreciate the amount of technical writing in an engineering career but do believe technical writing to be challenging and important to learn.

**Table 4: Average participant pre-survey responses indicating student attitude and perceptions regarding technical writing**

| Question No. | Survey Question | Likert Scale | WAC (experimental) | Traditional (control) |
|---|---|---|---|---|
| 1 | I am confident in my writing skills | 1-Strongly Disagree, 5 Strongly Agree | 2.5 | 3 |
| 2 | I feel prepared for any writing assignments in my future career | 1-Strongly Disagree, 5 Strongly Agree | 2.5 | 2.7 |
| 3 | I will be writing a lot of technical documents in my future career | 1-Strongly Disagree, 5 Strongly Agree | 4.5 | 3 |
| 4 | Writing effectively is a valuable skill in engineering | 1-Strongly Disagree, 5 Strongly Agree | 4.5 | 4 |
| 5 | The materials in this class is important to learn | 1-Strongly Disagree, 5 Strongly Agree | 3.5 | 4.3 |
| 6 | Technical Writing is: | 1-Easy, 5-challenging | 3 | 4 |
| 7 | Technical Writing is: | 1-Boring, 5- Interesting | 2 | 2.7 |
| 8 | Technical Writing is: | 1-Useless, 5-Useful | 5 | 4 |
| 9 | Technical Writing is: | 1-Tedious, 5-Exciting | 1.5 | 1.3 |

## Conclusions

We believe that engineering students, some of whom may have tested out of the first-year composition requirements before their arrival, will find the *Writing in Engineering Fields* course to be more relevant and engaging and will challenge the myth that engineers are poor or

disinterested writers. In the longer term, professors in the students' disciplines will be better able to address specific, highly technical engineering genres, as their students will have been introduced to many of them, as well as to rhetorical and genre principles of writing.

In summary, technical writing skills are of critical importance for engineering students. While its importance is widely recognized, technical writing is not considered a strength of UIUC COE students. Several college-level discussions have addressed these topics, and some departments have implemented change in upper-level coursework. However, no action has been taken on the college level. Freshman-level technical writing instruction will benefit student skill development and support and strengthen departmental efforts to improve technical writing in upper-level courses. In addition to improving student skills and attitudes about writing, piloting the course has fostered cross-campus collaborations and professional development for instructors. The pilot course offering will (1) provide data on efficacy of this strategy for external and internal review, (2) be UIUC COE's first step towards addressing writing concerns at a college level, (3) initiate effective change and foster collaboration between departments/colleges (English and Engineering), and (4) serve as a tested example for those interested in implementing a similar project.

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