

Technical Writing for Engineering Students: Using Tenets of the National Writing Project for Effective Writing Instruction

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Abstract – This article presents National Writing Project writing instruction techniques that address the growing demand for engineers to communicate in a clear, concise manner; provides a rationale for teaching engineering students to write effectively; and gives details about the GE 3513 Technical Writing course within the Mississippi State University’s Bagley College of Engineering. Topics covered include the importance of emphasizing the analysis of audience and purpose in technical writing; of spending time teaching writing skills and strategies rather than focusing solely upon corrective measures; of providing sample templates for writing assignments; of analyzing exemplary and non-effective student writing with students; and of using the iterative writing process and multi-disciplinary peer reviewing to inform student revising and editing practices. Quantitative and qualitative student feedback also is provided in this article.

Keywords: National Writing Project, technical writing, engineering, iterative writing process, peer review

INTRODUCTION AND RATIONALE

Professionals in all fields must be able to communicate effectively. The number of employers who value communication skills as much as, if not more than, other specialized skills is growing. John Johnson, senior program engineer for the Raspet Flight Research Laboratory and lead engineer for RFRL’s Ultra Light Sensor Platform UAV Program at Mississippi State University, addressed this trend during his Shackouls Technical Communication Program Speaker Series presentation in the spring of 2006. He commented to undergraduate engineering students enrolled in GE 3513 Technical Writing that engineers hired by Raspet must have the ability to communicate as well as being able to utilize their knowledge of engineering concepts. He emphasized that the most valuable employees at Raspet are the ones who not only excel in their particular fields, from mechanical to aerospace engineering, but also write clearly and present information effectively. The Accreditation Board for Engineering and Technology, Inc. (ABET) also recognizes the importance of successful communication practices, listing “an ability to communicate effectively” as one of its 2006-2007 Program Outcomes and Assessment criteria for accrediting collegiate engineering programs [ABET, 2].

The need for clear communication practices is one that prevails in engineering fields as well as in other professional fields in the United States.

According to a *USA Today* article discussing the need for clear writing in government offices, the National Commission on Writing supports the National Writing Project, which NCW Chair Bob Kerrey says offers “proven methods for improving writing instruction in classrooms” [The Associated Press, 2].

In the introduction to its September 2004 report, “Writing: A Ticket to Work...Or a Ticket Out,” the National Commission on Writing emphasizes the importance of being able to communicate clearly, announcing its belief “that much of what is important in American public and economic life depends on clear oral and written communication” [National Commission on Writing, 3]. The Commission continues, stating that its survey administered to 120 Business Roundtable human resources directors (64 of which responded) “confirms our conviction that individual opportunity in the United States depends critically on the ability to present one’s thoughts

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coherently, cogently, and persuasively on paper” [National Commission on Writing, 3].

In its report, the Commission announces a survey result that echoes the importance of strong writing skills for those involved in technical fields such as engineering: “More than half of all responding companies report that they ‘frequently’ or ‘almost always’ produce technical reports (59 percent), formal reports (62 percent), and memos and correspondence (70 percent)” [National Commission on Writing, 3].

This need for clear communication not only affects engineering students and professionals; schools across the nation have implemented various programs to improve writing instruction and consequently student-generated writing. One organization, the National Writing Project, strives to enhance writing skills of students in the United States and abroad. NWP is the umbrella organization that encompasses nearly 200 sites across the country as well as Puerto Rico, the U.S. Virgin Islands, Hong Kong, and Malta. According to the NWP, individual NWP sites conducted 7,288 programs in 2005 [National Writing Project, 4].

One individual site, the West Tennessee Writing Project, conducts a summer invitational institute for teachers from the West Tennessee region at the University of Tennessee at Martin, the host site for the WTWP since 1993. Interested K-12 teachers attend four weeks of intensive study at UTM, interacting with peer teachers, reading pertinent textbooks about educational practice (e.g. Katie Wood Ray’s *What You Know by Heart: How to Develop Curriculum for Your Writing Workshop*, Parker J. Palmer’s *The Courage to Teach: Exploring the Inner Landscape of a Teacher’s Life*, and Nancie Atwell’s *In the Middle: New Understanding about Writing, Reading, and Learning*), and participating in a daily writing workshop with fellow teachers. The objective of the WTWP is to better equip K-12 teachers with the tools necessary to provide more effective writing instruction in their classrooms.

In its objective, the WTWP operates under three guiding principles: (1) student writing will improve as writing instruction improves; (2) writing teachers should be writers themselves; and (3) the best teacher of a teacher is another teacher [West Tennessee Writing Project, 8]. The WTWP asserts that more qualified teachers provide better writing instruction [West Tennessee Writing Project, 8]:

Teachers who participate in a summer invitational institute become Teacher Consultants of WTWP. Their students write often during school and in a wide variety of genres. Students become better readers of their own writing, able to think more critically about what to say, how to say it, and who to say it to. With more opportunities to write and to write in a variety of ways, students become more fluent readers and writers in school and for their own personal growth.

The WTWP incorporates tenets of the NWP into its curriculum, including the following: teachers emphasize the importance of identifying audience and purpose for each writing assignment; teachers impart writing strategies and skills to their students in class; teachers provide their students with specific assignment requirements and goals in addition to models and strategies for each assignment; teachers encourage students to monitor their own progress in regard to their writing skills; and teachers encourage students to participate in all stages of the writing process, including revising and editing, and to work toward continual improvement [National Writing Project, 5].

This article details the curriculum for GE 3513 Technical Writing at Mississippi State University as well as exploring the incorporation of these NWP tenets into a writing curriculum for junior and senior collegiate-level undergraduate engineering students, including the importance of emphasizing the analysis of audience and purpose in technical writing; of spending time teaching writing skills and strategies rather than focusing solely upon corrective measures; of providing sample templates for writing assignments; of analyzing exemplary and non-effective student writing with students; and of using the iterative writing process and multi-disciplinary peer reviewing to inform student revising and editing practices. Quantitative and qualitative student feedback also is provided in this article.

OVERVIEW OF TECHNICAL WRITING CURRICULUM

The primary goal of the Bagley College of Engineering’s Shackouls Technical Communication Program, the department that houses the technical writing course required for all BCoE engineering students, is to help future engineering professionals hone their communication skills, as exemplified by the course objectives [Shackouls Technical Communication Program, 7]:

The course focuses on the broad steps of analysis, development, and revision: recognizing specific writing situations and the objectives that arise out of them; analyzing audiences and suiting format, content, and tone to these audiences; designing documents that are structurally and

mechanically effective; and writing and revising these documents to achieve clarity and correctness.

In its achievement of these objectives, the course requires that students write one document completed through an iterative process throughout the semester. Students may choose to write an ethics-based journal article or a research-based journal article. In both cases, students submit the article in three different steps: the first paper consists of an article abstract and introduction; the second paper consists of the entire body section through the article's conclusion; and the third paper consists of the entire document, including a revised abstract, introduction, and body, and adding the references and biographical information sections.

Before and throughout the writing process, course content directs students toward effective writing, including class discussions and in-class exercises that reinforce the importance of being able to analyze audience and purpose, the 12 basic guidelines for writing (as determined by technical writing instructors), ways to write a persuasive argument, ways to construct effective sentences and paragraphs as well as entire documents, how to effectively design a document, and how to properly incorporate and cite outside source material. During the writing process, students participate in one peer review session for each iteration of their journal articles. In addition, students have access to a sample template for their articles as well as sample peer-generated papers that the instructor reviews with them in class, discussing strengths and weaknesses of each sample paper.

The course also requires students to complete two collaborative oral presentations. The first presentation tasks students to redesign PowerPoint slides that were created and presented by NASA engineers prior to the *Columbia* shuttle disaster in 2003. Students must assess the slides based upon the soundness of the engineering principles presented and upon their graphical design principles. For the second presentation, groups collaborate to propose an idea relevant to their fields of study (e.g. mechanical or biological engineering). Their proposal must be persuasive and logically arranged, focusing on time and financial considerations as well as the soundness of their engineering concept. For the purposes of this paper, the presentations are not discussed.

USING WRITING PROJECT TENETS IN THE TECHNICAL WRITING COURSE

Bringing tenets of the National Writing Project into the technical writing classroom focuses on four major goals: helping students understand the importance of analyzing audience and purpose for any type of writing; focusing on teaching writing skills and strategies rather than strictly on corrective measures; providing students with templates and samples of writing to help guide them in their writing strategies; and helping students realize the importance of all stages in the writing process, including revising, editing, and proofreading.

Audience and Purpose

As part of its focus on effective writing instruction, the National Writing Project encourages teachers to emphasize the importance of analyzing audience and purpose for all writing endeavors, stating that “[a]udience and purpose for papers [should be] specifically identified in assignments” [National Writing Project, 5].

Two of the most important considerations for any type of writing are audience and purpose, and technical writing is no exception. In GE 3513 Technical Writing, instructors emphasize the significance of being able to appropriately identify who will use the document and in what way the document will be used. Using information presented in Mike Markel's *Technical Communication*, 8th edition, I explain to students that the different types of audiences can include experts, technicians, managers, and laypeople. I also ask students to identify intended audiences for excerpts from two separate articles about tsunamis, one written in a peer-reviewed journal and one written for a Web site. Students point out that the journal article excerpt uses elevated and technical language and does not provide explanations for complicated scientific terms. They also identify the less formal, less technical language in the article excerpt from HowStuffWorks.com. If students can identify features of writing that indicate the audience for whom the writing was crafted, they can more easily employ those features into their own writing for their intended audience. Before beginning writing the document they create for this course, students must first consider their readers. I tell them they should write with a combined audience in mind, meaning that they must write in a clear, concise manner so that they do not confuse a lay reader and they also must use formal language befitting a professional expert. We also discuss potential audiences for other types of writing we practice and discuss in class, including formal reports (e.g. lab reports), memos, business letters, and e-mail correspondence.

In addition to identifying audience, technical writing students also must consider the purpose behind their writing, whether that purpose be to inform, persuade, demonstrate, or explain how to accomplish a task. Reading the same

passages about tsunamis, students then identify the purpose of these articles as related to their intended audiences. For the more formal passage, students state that the article's purpose is to inform experts in the field of tsunamis about a particular point revealed by recent research. For the Web site passage, students state the purpose as to provide a brief, informal, low-level description of a tsunami wave. We also discuss the purposes for other types of writing, and we collaboratively write a technical report in class and then analyze its strengths and weaknesses. Since many engineering students and professionals write technical reports, I emphasize the importance of knowing the intended audience and purpose of the report before writing it, reinforcing the significance of always considering audience and purpose for any type of writing.

Writing Skills and Strategies

The National Writing Project suggests that in order to support effective writing instruction teachers should spend time teaching writing skills and strategies rather than focusing solely upon corrective measures [National Writing Project, 5].

In an effort to help students form a solid base for their writing for the course, I spend a week at the beginning of the semester discussing effective writing in terms of cohesive, unified paragraphs and document sections; traits of effective sentences (e.g. using transition elements and focusing on active voice rather than passive voice verbs); and grammatical and mechanical conventions of American Standard English.

Before offering this type of instruction, however, I use writing diagnostic samples that students write on the first day of class as topics of discussion in class. I cull issues I notice as prevalent in the diagnostics, such as the use of contractions in formal writing. I pull examples directly from the students' diagnostics and compile a document that I discuss in class and post on my course home page. In class, I show students the example, point out the error, and discuss options for correcting the problem. Typical grammatical issues include subject-verb and pronoun-antecedent agreement errors, misplaced and dangling modifiers, and awkwardly worded passages.

Following the discussion of diagnostic issues, I discuss writing and revising effective sentences with students. Using information from Markel's *Technical Communication*, 8th edition, I review basic concepts such as placing known information at the beginning of a sentence and new information at the end. To encourage students to review this material, I use a PowerPoint slide show to play a review game in class. Each slide poses a question about writing and revising effective sentences or the slide presents a problem that needs a solution (e.g. a misplaced modifier that should be placed closer to the word it modifies). I also use a jigsawing technique to review these concepts; students divide into home teams and expert groups. In their expert groups, they review a certain portion of the material with each other; then they return to their home teams and "teach" the concept on which they have become experts to all members of their home teams.

Finally, I invite students to schedule appointments with me so that we can discuss specific strategies, such as document design and organization, for their writing assignments for the course.

Writing Models and Examples

In addition to encouraging students to consider audience and purpose and to write using specific strategies and skills, the National Writing Project also asks teachers to provide students with "writing models, assignments, and strategies to guide each of their different writing tasks" [7].

For the fall 2006 semester, my colleagues and I discussed the usefulness of a template to provide a basis for students for their writing assignments. I designed the template with the goal of providing students with a model for design elements as well as the goal of giving students direction about the criteria each section of their document needed to meet to be considered successful (e.g. an abstract previews the content and structure of the document). The sample template, which corresponded with the three-part iterative writing process, is provided in Figure 1. For purposes of inclusion in this article, the sample template has been condensed to single-spaced text, but the original displays double-spaced text. For this assignment, students had a choice of writing an ethics-based journal article or a research-based journal article.

Template for Sample *JEE* Article

Title of Your Article (no quotation marks)

YOUR NAME

Year/Name of Department/Position (e.g., Junior Mechanical Engineering Student)
Bagley College of Engineering
Mississippi State University

Abstract

This section of your document should meet five basic criteria. Your abstract should be brief and technical in nature. Generally, your abstract will not extend beyond 200 words, and you need not define technical terminology in this section. You may assume that your reader is an expert (for this section only). Your abstract should describe the kind of information contained in your document so readers can decide if they want to read your article. You also should list specific topics covered in your document and give readers an indication of the order in which these topics appear in your article. When referring to your document, you should use present-tense verbs (i.e., “This document analyzes ...” instead of “This document will analyze ...”). Your abstract should present your document’s major or significant findings in the form of a thesis statement, and it also should indicate how you support your argument in your document (what key pieces of evidence will you use to persuade readers of your viewpoint?). Finally, if appropriate and necessary, you may list and/or define key terms in your abstract (or you may choose to do this in your Introduction section, in a Glossary section, or within the document itself as the terms appear). Most importantly, you should view your abstract as the one chance to provide readers with key information about your document; it should provide a brief summary, or snapshot, of the entire document. For more information about writing effective abstracts, see pp. 467-468 in M. Markel’s *Technical Communication*, 8th ed.

Introduction

A successful introduction exhibits seven basic characteristics. Your introduction should explain your document’s subject and purpose. Note that the purpose mentioned here does not mean the purpose of your research; rather, this means the purpose of your document. Your introduction also should establish background and context, providing your reader with an overview of your subject and its relevant history. After reading your introduction, readers should have an idea of the scope of your document (what information you include and what information you do not include). You also should list references used as evidence in helping you make your argument or present your major findings in your document. You should be specific in this list, but you need not be as exhaustive in your listing as you are in your References section citations. For example, if you use Mike Markel’s eighth edition of *Technical Communication* in your paper, you do not have to list publication information, etc. You may simply state that you use M. Markel’s *Technical Communication*, 8th edition. In addition, your introduction should provide a structural preview of the rest of your document. Readers should know specifically what topics your document discusses and in what order they appear in the document. The introduction also is an appropriate section for defining key terms, but this characteristic is optional, not required. For more information about writing effective introductions, see pp. 464-465 in M. Markel’s *Technical Communication*, 8th ed.

Body Headings (Depend on Choice of Ethics-Based or Research-Based Document)

Regardless of your choice of topics, your individual headings should be informative and descriptive rather than generic (i.e., “Communication” or “Results”). For example, “Rogers Commission Report Disregarded Detail” is more informative than “Rogers Commission.” Your readers should be able to tell from your heading exactly what type of material is contained in that particular section, and material in each section should be relevant to that section’s topic. In addition, when considering design elements, you should never widow a heading (separate it from its body text). An example of a widowed heading is one that appears at the bottom of one page even though the body text that accompanies it does not begin until the top of the following page.

Another consideration within the body of your document is the proper incorporation of graphics.

You always should refer to a figure before it actually appears in your document – without the use of imperative mood (i.e., see Figure 1). An appropriate inclusion of graphic material follows:

The current replicator is eight years old and has now been out of warranty for five years. Figure 1 demonstrates the current replicator's exceeding the predicted run times for the four major enzymes.

Figure 1. Replicator performance [1]

Enzyme	Actual Time	Predicted Time
1	47 min. 19 sec	36 min.
2	76 min. 16 sec	59 min
3	92 min. 35 sec	70 min
4	> 100 min.	80-85 min.

The current replicator can no longer handle the current workload of 8-12 replications in eight hours.

Conclusion

In this section, you should re-emphasize your key points your document makes, illustrating the significance of your findings/argument. Introducing new material in this section is inappropriate. For the research-based option, this section reports the implications or interpretation of your results. For the ethics-based option, this section serves as a brief summary of your most significant points to your readers so that they do not place too much emphasis on the final body section of your document.

References

You should adhere to the Shackouls Technical Communication Program Documentation Guidelines (available in PDF form on the course homepage).

Biographical Information

In this section you should include information relevant to your educational and professional development (e.g., memberships in professional organizations, relevant work experience, etc.).

Fig. 1. Sample Template for Writing Assignment

In addition to providing a sample template for students for their writing assignments, I also posted online examples of previous student-generated papers for the course. Although the papers did not address the exact same topic, the nature of the papers (ethics-based or research-based journal articles) was the same. Before giving students the first writing assignment, I discussed one sample from each choice (ethics-based and research-based) with students in class, indicating the strengths and weaknesses of each paper.

Finally, after I graded each class's papers for each step of the iterative process, I selected two to three sample papers written by peers from another class. I used those samples in class to discuss with students what parts of each paper worked well and what parts needed improvement.

Informing Student Revising and Editing Practices

The National Writing Project purports that students should be encouraged to "revise, edit, and improve – and to correct drafts and then resubmit" [National Writing Project, 5]. The NWP also asserts that students should be given the opportunity to reflect upon their growth, or lack of it, in reference to their writing skills. Two such processes in the technical writing course help students achieve these goals: the iterative writing process and the peer-review process.

First, the iterative writing process allows students to benefit from specific instructor comments and suggestions for improvement. In the technical writing class, students write one document throughout the semester, submitting the document in three installments at three different times in the semester. For the first assignment, students submit their abstract and introduction sections of their papers; for the second portion, they submit the body sections of their papers, beginning with the first section after the introduction and ending with the conclusion section; for the final installment, students submit the document in its entirety – revised abstract, introduction, body, and conclusion sections as well as references and biographical information sections. The final document's length requirement is 12-16 pages.

Because of this multi-stage writing process, students are forced to re-examine their own writing at least twice. They receive extensive commentary from the instructor on papers 1 and 2 and are instructed to use those comments and suggestions in their revising and editing process before submitting paper 3. This process, then, encourages students to revise, edit, improve, and resubmit their writing. Students also must evaluate their own growth as writers throughout the writing stages involved in the iterative process. When they receive the graded version of paper 3, they see firsthand in what ways their writing has progressed since the first writing assignment.

In addition to requiring students to write one document in three separate stages, technical writing also asks students to participate in peer-review sessions before submitting final drafts of each document. Students are placed into groups of three or four members by the instructor according to students' majors; students of the same major are not placed in the same group when possible so that all group members bring different viewpoints to the session. During the peer-review session, one student reads aloud his/her rough draft while the other group members follow along on the copies provided by the author. Peer reviewers make written comments on the draft, and when the author finishes reading aloud the draft, group members offer verbal suggestions and commentary as well, giving the author an opportunity to ask questions of his/her peer reviewers. This process is repeated until all members have had the opportunity to read aloud their drafts and receive peer feedback. While students indicate that this process is not as helpful for their writing development as the iterative writing process, this technique does offer authors the chance to receive focused feedback from multiple reviewers so that they may better revise and edit their papers before submitting a final draft for grading.

RESULTS

Students enrolled in GE 3513 Technical Writing for the fall 2006 semester responded to an anonymous survey distributed in class. Fifty-four (96 percent) of the 56 students enrolled responded to the survey. Responses indicate that overall students' confidence in their writing abilities increased throughout the semester. Student responses also signify that the majority of students (51 percent) felt the iterative writing process was the most beneficial aspect of the course in terms of improving student writing. Survey results also show that most students felt that because of completion of the technical writing course they felt better equipped to write about engineering concepts in their respective fields.

The survey included nine quantitative questions based on a traditional Likert scale, with 1 representing "not at all/strongly disagree" and 5 representing "always/strongly agree"; three qualitative questions; and six items students were asked to rank in order of significance in relation to their learning experience in the course. The survey is provided in Fig. 2.

GE 3513 Technical Writing Student Survey

I. Please circle the number that corresponds most closely with your answer, where 1=not at all/strongly disagree, 2=disagree, 3=don't know/no opinion, 4=agree, and 5=always/strongly agree.

1. Rate your confidence in your writing abilities before completing this course.

1

2

3

4

5

2. Rate your confidence in your writing abilities after completing this course.

1 2 3 4 5

3. I understand the importance of analyzing audience and purpose in every writing situation.

1 2 3 4 5

4. My instructor spent adequate time reviewing writing strategies and skills in class.

1 2 3 4 5

5. My instructor spent adequate time sharing exemplary and non-exemplary samples of student writing that pertained to the writing I was asked to complete for this course.

1 2 3 4 5

6. The sample template provided by my instructor was helpful to me in writing my own journal article this semester.

1 2 3 4 5

7. The iterative writing process (completing one document in multiple stages throughout the semester) helped me to grasp a better understanding of the need for revising, editing, and proofreading in the writing process.

1 2 3 4 5

8. The peer review sessions benefited me by helping me revise, edit, and proofread my own writing.

1 2 3 4 5

9. After completing this course, I feel better equipped with the tools necessary to write about engineering concepts in my field in a clear, concise manner for combined audiences (including a lay reader).

1 2 3 4 5

II. Please answer the following questions in your own words.

1. What has been the most beneficial part of this course for your writing?
2. What is one suggestion you would offer to the instructor about this course?
3. What did you learn about your own writing abilities (strengths and weaknesses) during this course?

III. Please rank the following from 1 to 6, using each number only once, where 1 is the most helpful and 6 is the least helpful (as the issue applies to you and your

learning experience in this course).

- _____ Learning to analyze audience and purpose
- _____ Participating in peer review sessions
- _____ Completing one document through a three-part iterative process
- _____ Listening to/participating in discussion about exemplary and non-exemplary peer writing for each writing assignment
- _____ Seeing a sample template of the writing assignment
- _____ Reviewing key grammar concepts after completing the diagnostic writing sample

Fig. 2. Technical Writing Student Survey

Quantitative Student Feedback

Quantitative feedback is provided in Table I. The quantitative results indicate that students' confidence in their writing ability increased after completing the technical writing course. In addition, students expressed a strong understanding of the importance of analyzing audience and purpose. Students also implied in their survey responses that their instructor spent adequate time reviewing writing strategies and skills in class and sharing exemplary and non-exemplary samples of student writing that pertained to the writing they were asked to complete for the course. The majority of students (95 percent) agreed that the iterative writing process helped them in their understanding of the need for revising, editing, and proofreading, while only 61 percent of students thought that the peer-review sessions were helpful. Finally, survey results show that an overwhelming majority (89 percent) of students in technical writing felt that the course's content will be beneficial to them as they encounter future writing endeavors in their respective engineering fields.

Table I. Quantitative Technical Writing Student Feedback

Quantitative Question	Percentage (Number) of Respondents					Likert Scale Average Rating
	Not at All/Strongly Disagree	Disagree	Don't Know/No Opinion	Agree	Always/Strongly Agree	
Confidence in writing abilities before course	1.9 (1)	14.8 (8)	35.2 (19)	44.4 (24)	3.7 (2)	3.33
Confidence in writing abilities after course	0.0 (0)	5.6 (3)	13.0 (7)	61.1 (33)	20.4 (11)	3.96
Understanding analyzing audience and purpose	0.0 (0)	0.0 (0)	0.0 (0)	55.6 (30)	44.4 (24)	4.44
Instructor reviewed writing strategies and skills	0.0 (0)	1.9 (1)	14.8 (8)	20.4 (11)	63.0 (34)	4.44
Instructor shared enough writing samples	0.0 (0)	1.9 (1)	9.3 (5)	27.8 (15)	61.1 (33)	4.48
Template's usefulness	0.0 (0)	3.7 (2)	18.5 (10)	38.9 (21)	38.9 (21)	4.13
Iterative writing process's usefulness	1.9 (1)	3.7 (2)	0.0 (0)	35.2 (19)	59.3 (32)	4.46
Peer-review sessions' usefulness	5.6 (3)	13.0 (7)	20.4 (11)	42.6 (23)	18.5 (10)	3.55
Course improved skills	0.0 (0)	3.7 (2)	7.4 (4)	55.6 (30)	33.3 (18)	4.19

Qualitative Student Feedback

The three qualitative survey questions elicited a variety of responses. In response to the first question, all 54 students indicated that at least one aspect of the course had been beneficial to their writing. Some stated that the comments they received on their graded documents (from the instructor) were the most helpful. For example, one student stated, "The commentary that is supplied on my papers was very beneficial. It showed me specifics about my writing." Another student wrote that "critical analysis of my writing by instructor" was the most beneficial to his/her writing. One other student responded, "The plethora of comments on each paper helped me realize what was good and bad."

Still other students responded that learning how to tailor their writing for specific audiences (particularly a combined audience that includes a lay reader) and learning how to write more concisely and clearly were the greatest benefits of the course. One student stated that "learning how to write clear, technical documents" was helpful; another wrote, "The practice writing the technical documents. Before this class, I had only had experience with the traditional english [sic] papers. The change in writing style was a welcomed challenge." Finally, one other student stated, "It [the course] has taught me what an appropriate style of writing about a technical subject looks like."

The second question brought about the most disparate answers from students, ranging from suggestions to begin the writing assignment and presentations earlier in the semester to having teaching assistants grade students' papers. While 11 respondents (20 percent) wrote that they would offer no suggestions for change, four students (7.4 percent) suggested sharing even more exemplary and non-exemplary examples of student writing in class.

In response to the third question, most students (28 respondents) indicated that they learned their writing needed improvement and they needed to proofread more thoroughly, paying more attention to grammatical and mechanical conventions. One student wrote, "I understand that you can never revise enough. I need to review my work several times." Another respondent stated, "I need to proofread a lot."

Other students expressed that they had learned to write more clearly and concisely, two goals of the technical writing program. One respondent stated, "I learned that there is never too much detail when writing technical documents," indicating his/her understanding of the importance of clarity in writing. Demonstrating his/her grasp of the importance of conciseness in writing, one student wrote that he/she "learned how to be more effective as a writer with fewer words." Finally, one student stated that he/she "learned to be clear and concise. No need to be wordy."

Student Feedback on Ranking Helpfulness of Course Topics

The third portion of the survey asked students to rank in order of helpfulness six topics covered in class, with 1 being the most helpful and six being the least helpful. The six topics include learning to analyze audience and purpose for technical and professional documents; peer-review sessions, in which students participate in a workshop and provide feedback on each other's draft writing; the three-part iterative process used to produce one final document for the course; class discussion regarding exemplary and non-exemplary peer writing for each writing assignment; having a template of the writing assignment provided by the instructor; and reviewing key grammar concepts in class at the beginning of the semester. Quantitative feedback is provided in Table II.

Survey results for this section show that most students (51.1 percent) agreed that the iterative writing process was the most helpful learning experience in the course while the majority of students (57.5 percent ranked the experience fifth or sixth) felt that the peer-review sessions were the least helpful. Beyond completing a document through the iterative writing process, students indicated that seeing a sample template of the writing assignment was most helpful.

Table II. Quantitative Technical Writing Student Feedback for Ranked Items in Survey

Item	Percentage (Number) of Respondents						Average Ranking
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	
Audience and purpose	8.5 (4)	14.9 (7)	38.3 (18)	10.6 (5)	23.4 (11)	4.3 (2)	3.38
Peer-review sessions	0.0 (0)	12.8 (6)	12.8 (6)	17.0 (8)	14.9 (7)	42.6 (20)	4.62
Iterative writing process	51.1 (24)	8.5 (4)	8.5 (4)	12.8 (6)	6.4 (3)	12.8 (6)	2.53
Samples of peer writing	10.6 (5)	27.7 (13)	12.8 (6)	17.0 (8)	14.9 (7)	17.0 (8)	3.49
Assignment template	19.1 (9)	12.8 (6)	17.0 (8)	23.4 (11)	21.3 (10)	6.4 (3)	3.34

Grammar review	10.6 (5)	23.4 (11)	10.6 (5)	19.1 (9)	19.1 (9)	17.0 (8)	3.64
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CONCLUSION

The professional world demands people who can express their ideas effectively. Too often engineering students question their need to be able to write in a clear, concise, effective manner for a combined audience, one comprised of both experts and lay readers. Therefore, future engineering professionals need to understand why and how they should develop stronger technical writing skills.

By integrating certain tenets of the National Writing Project (NWP) initiative into their course curriculum, science and technology teachers can provide writing instruction that aims toward helping students adopt effective writing practices, which include developing logically arranged documents that adhere to conventions of grammar, punctuation, and spelling. Specifically, students exposed to these strategies indicated that the iterative writing process, which encourages revision and editing, is especially helpful in their growth as writers and in helping them understand the importance of these stages of the writing process. Students also expressed that being provided a sample template and peer-generated examples of the type of writing they were asked to complete in the course helped them succeed in their own writing more readily.

Because of the success of these NWP measures in the technical writing classroom, I plan to incorporate more tenets of the NWP program, such as teachers writing with their students and students being given the opportunity to select writing topics that are of value to them.

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