AC 2011-2579: AN ENGINEERING APPROACH TO WRITING: A PILOT PROGRAM FOR CIVIL ENGINEERING GRADUATE STUDENTS

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An Engineering Approach To Writing: A Pilot Program For Civil Engineering Graduate Students

Abstract

The engineering education literature is replete with discussions and recommendations on effective communication pedagogy for engineering undergraduate students. Further, organizations like ABET and ASCE stress the importance of technical communication as part of undergraduate curricula. Comparatively less attention is focused on graduate engineering communication development, which is the focus of this paper. A program was developed and piloted for civil engineering graduate students that will be of particular interest to faculty and graduate students. Faculty will benefit from models for improving the organization of thesis writing and teaching technical writing skills. Graduate students will be better equipped in terms of practical or professional skills that, in turn, will make them valued employees from day one. This paper presents the details of the program, preliminary assessments, suggestions for future research, and plans for future development.

Introduction

This paper describes a pilot program that promotes excellent communication skills for civil engineering (CE) graduate students through an extra-curricular pedagogy effort. Like other such efforts, the program rests on research in composition and composition pedagogy and a common understanding that writers learn by writing.[1,2,3,4,5,6] This program was designed to address what the authors and others[7] have identified as insufficient or uneven preparation for the level of communication skills required for success in graduate engineering programs and subsequent employment in academia or industry.

Engineering educators have incorporated various communication pedagogy strategies into the undergraduate experience, including working with writing centers housed in English departments, establishing writing centers in departments of engineering, requiring technical communication course work, support communication-intensive courses,[8,9] training upper-division engineering students to be writing tutors and mentors, and having students work with a faculty mentor.[10] Capstone courses have shown promise in helping engineering students improve their communications skills.[11,12] Other efforts have focused on developing critical process skills.[13] Despite these programs and approaches, many students still enter graduate engineering programs without adequate communication skills.[14]

Context for the Program

Many, if not most, of the curricula for undergraduate CE programs typically include communication coursework (e.g., composition or technical communication courses) to develop the skills necessary for proficiency in a variety of genres and for effective work on teams (e.g., a capstone course with writing and presentation components, research reports). These experiences should prepare CE graduates for the exigencies of the workplace. However, considerable concern about the communication skills of CE graduates is reflected in the significant attention devoted to studying and improving both the communication training and student proficiencies by faculty and researchers who publish in professional engineering education journals (e.g., *Journal of Professional Issues in Engineering Education and Practice*; *Journal of Engineering Education*) and present at conferences such as those sponsored by ASEE and Frontiers in Education (FIE).

We argue that despite this attention at the undergraduate level, focused attention given to graduate-level CE students will pay dividends by developing communication proficiencies that will lead to an improved workforce. Because there is seldom space in CE graduate engineering curricula for courses in communication, the pilot program discussed here employs a team- and experience-based communication pedagogy approach that is grounded in the student engineers' own research and documentation efforts.

The Problems and Opportunity

Too many graduate students produce documents where the prose distracts the reader and makes understanding the technical content more difficult. Time constraints for students and faculty advisors and lack of guidance in or resources for effective communication are some of factors that contribute to this problem. Further, despite the numerous approaches to teaching effective communication to undergraduate engineering students, many students manage to graduate with limited exposure to writing pedagogy (i.e., they take an elective statistics course instead of a technical communication course). Further, because graduate engineering curricula are crowded with requirements for technical coursework, courses in communication are not required, nor are they encouraged. The challenge is to take these students and the opportunity is to mitigate some of their communication problems thereby better preparing graduates for the demands for professional communication in the workplace.

An unfortunate organizational mindset—one that graduate engineering students take to heart—stresses getting just one more data point over crafting the documents that communicate the research results. Add to the situation resistance to allocating funding to support communication pedagogy and you have a system that falls short of adequately preparing these students for the rigors of writing at the graduate level as a precursor to professional practice.

The cumulative result is a pattern of faculty advisors attending to writing issues (e.g., mechanical, organization, and expression) at the expense of time assessing the student's work for technical accuracy and completeness. In fact, it is not uncommon for graduate advisors to "help" the student draft and polish the resulting document(s): *It's more work/takes more time to tell the student how to fix the writing than to just do it myself*. One product of this pattern is student work on the thesis does not accurately represent the student's actual writing proficiency.

Industry Perspectives and Performance Expectations

Although technical knowledge is essential for expert performance in any domain,[15] that knowledge alone does not ensure successful performance in industry. Rather, Hart argues that "to be an engineer is to be a technical communicator. Engineering is a problem-solving profession and clear communication leads to effective solutions."[16] In fact, most research in engineering education explicitly emphasizes the need to prepare students for professional practice.

Ressler[17] and others[18,19,20,21] discuss the importance of service learning, communicating with customers, and collaborating with colleagues and professional associates. Still others discuss partnering with industry as sources of problems for capstone and research projects for internships. These opportunities are intended to facilitate the transition from the classroom to the workplace and expose students to practitioners who, in addition to modeling technical expertise, also demonstrate the centrality of effective communication in the workplace.

In an analysis of communication skills in the engineering workplace, Nicometo et al. report that in their study, "above all other skills required to be 'an effective engineer' communication was ranked as 'essential' by more than 60% of [their] respondents." They call out three themes within the communication skills category: "[1] big picture awareness . . . being able to communicate with others outside of his [sic] discipline. . . . [2] willingness to proactively seek out discussion, clarification, or even debate. . . [and] 3] being a good listener.[16]

However, they conclude by suggesting a dissonance with these professional abilities and the communication practices presently assessed in engineering education.[16]

Approaches to Teaching Engineering Communication

To address the need for well-prepared engineering communicators, nearly every engineering school provides some means of teaching communication skills and strategies.[22,23] Alford, Bosley, and Rogers[24] and others[25,26] discuss program models and methods designed to build communication proficiency such as requiring technical communication coursework, including writing centers situated within and outside of engineering departments or colleges, training engineering students to be writing tutors, and creating effective assignments. Writing across the curriculum efforts (WAC) and learning communities also intentionally integrate communication and teamwork pedagogy—what some refer to as soft or process skills—with technical content. Universities that have adopted WAC or learning communities typically structure these programs so that students with the same major or focus are grouped. These allow engineering undergraduates to work with their peers and are intended to reinforce both communication processes and enhance the mastery of technical content.

These efforts are supported by technical communication textbooks[12,27,28,29] and handbooks,[30,31] some of which are designed specifically for science and engineering communication.[32] All of these handbooks deal to some degree with rhetorical issues as well as correctness, organization, and style issues and are designed to stand alone as resources or be used in conjunction with a textbook.

Engineering Education Standards

Both American Society of Civil Engineers (ASCE) Body of Knowledge II (BoK)[33] and ABET[34] stress the importance of both technical engineering skills and communication skills and the importance of preparing students for professional practice. The ASCE BoK "Outcome 16: Communication" states: "Fundamentals of communication should be acquired during formal education."[25]

Shuman et al.[12] suggest that the eleven outcomes included in ABET Criterion 3 consist of two sets of skills, five "hard skills" and six "professional skills." In professional skills, outcome 3.g concerns "the ability to communicate effectively."[26] It can be argued, however, that other professional skills, especially outcomes 3.d (ability to function on multi-disciplinary teams) and 3.i (ability to engage in lifelong learning) also require effective communication. In fact, Shuman et al.[12] proposed that one aspect of lifelong learning included the ability to "demonstrate reading, writing, listening, and speaking skills" (49). Employers in both industry and academic settings consistently rank technical ability and communication and teamwork skills as the most desireable proficiencies.[16]

Our Response to the Problem

Prior to organizing the Writing Support Program, some graduate students found technical writing assistance (outside of input from their faculty advisor) through the English department's Writing and Media Help Center[35] or, in some isolated cases, by hiring an expert writing consultant or consulting with peers. Although mostly helpful, experience with these methods proved to be inconsistent in terms of student improvement; cost was often an obstacle; timing was not in line with individual student's thesis writing needs; and the experience only benefitted the individual student. Organized department-level workshops also provided a resource, but were often too general in nature and not sufficiently funded over time.

In organizing the Writing Support Program, the goal was to improve on these traditional methods with a focus on providing one-on-one interaction, but to develop a program and mindset within a small group of students to grow the knowledge base and generate products (e.g., thesis outline, and template documents) that would be useful for future students. Establishing the Writing Support Program required a faculty mentor, a communication expert, graduate students, and funding. In this case, funds from the faculty mentor's professorship endowment were used to hire the communication mentor, set up an office, build the program, and start work with students.

Students

Students participated in the pilot program in two ways, in the Writing Support Program cohort group and in a series of workshops. Changes in students' performance based on services provided through the Writing Support Program were assessed by holistic qualitative means, and the workshops were assessed through two surveys. Findings from these assessments are discussed below.

Twelve students were in the Writing Support Program cohort: a PhD student, ten who were pursuing an MS, and an undergraduate research assistant. English is the first language of four students (including the undergraduate). Four students are non-native speakers of English (L2): Chinese is the first language of four students and Spanish, Turkish, and Russian are the first languages of the other three students. Eight students are male; four are female. Of these 12 students, 4 obtained an M.S., and 1 earned a Ph.D. during the first year of the program. Pseudonyms have been assigned to the students and those mentioned have read the relevant passages and given consent for their use.

A series of five workshops was presented in the fall 2010 semester. These workshops were open to all CE graduate students.

Implementing Communication Strategies for CE Graduate Students

The authors based the pilot program on the assumption that students would benefit from and understand the parallels between our approach to the writing process and the geotechnical Observation Method (OM) of engineering problem solving.[36,37] Because both communication and CE practices are complex and recursive, this program approaches the development of communication and engineering skills as parallel processes. Emphasizing these parallel processes was a starting point for developing the program and carries through all aspects of the program. Although other engineering problems-solving approaches could be used in this manner, the OM used in geomechanics was familiar to the students in the cohort.

Creating an awareness that engineering processes can be similar to writing processes creates a platform for applying engineering problem-solving skills to communication processes.

Demonstrating the parallels to a specific engineering discipline or problem that is familiar to the students gives them insights into the recursive steps in the writing process. Helping students understand these parallel models of practice not only supports their development as technical professionals, but also helps them develop and practice professional communication skills.

In the same way that OM recommends that engineers plan for "most probable" conditions, the recursive communication process incorporated in the Writing Support Program is grounded in a rhetorical approach. Students are coached in analyzing their audience(s), their purposes for the communication, and the form or genre expectations of their final products. Figure 1 compares the recursive writing process and OM.

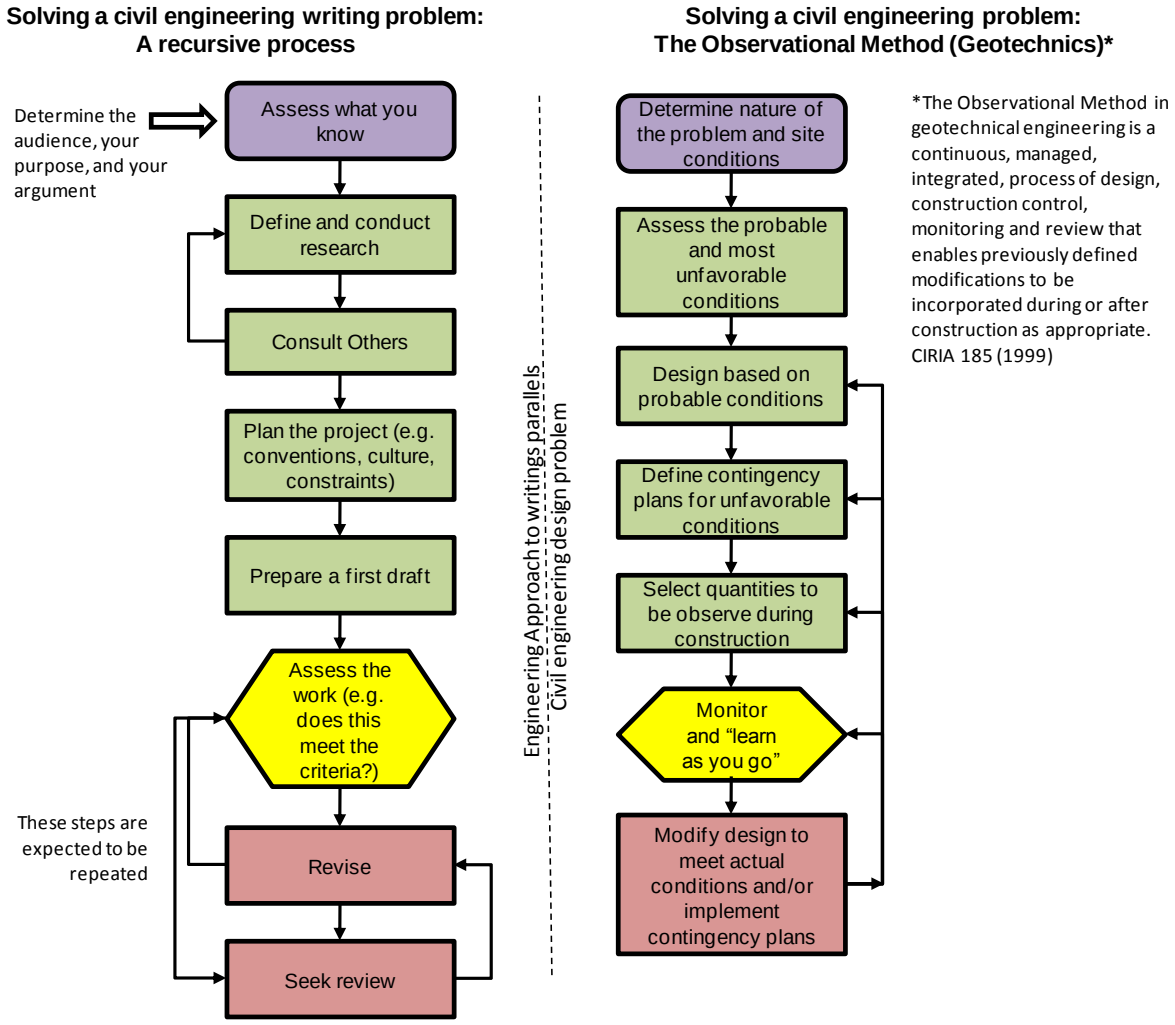

Figure 1. Parallels between the processes of solving writing and engineering problems

Assumptions

In addition to the core structure of the pilot program supplied by the parallel OM and recursive communication processes, these assumptions ground the program. We assumed that:

- the ability to communicate effectively is an essential skill for professional practice of civil engineering and that graduate engineering programs must ensure that their graduates will bring communication proficiencies into the next phase of their careers;

- it was important to provide writing support to students with urgent needs and that we could identify elements that we would use to reflect upon and evaluate the progress of the program and assess the changes in the students' communication practices and proficiencies;
- communication needed to be defined broadly, with a central focus on the thesis;
- we could break down the tasks related to conducting and reporting research in ways that would prepare students to communicate effectively, demonstrate leadership, and bring effective teamwork skills to the workplace;
- students would recognize their needs for and potential benefits of writing support in the shape of one-on-one writing coaching, participating in peer review, learning and applying new approaches to communications tasks, and attending group writing instruction sessions;
- when a pattern of errors was identified in more than one student's work (without regard for the students' native language), most or all of the other students would benefit from information and strategies related to that pattern of error; and
- students would benefit the most through instruction based in the various phases of their work that targeted the specific needs as they occurred.

The Writing Support Program

The Writing Support Program is grounded in two central concepts. First, our approach defines communication broadly, and second, our approach intends to prepare graduates by equipping them with habits, tools, and strategies they can use immediately in professional practice.

Defining communication broadly means that we took a holistic view of the graduate engineering process and intended to address professional skills such as practicing effective time management, gaining familiarity with ethical issues and practices, and learning strategies for attending and leading meetings. We addressed these skills through articulating and modeling behaviors that may not, at first, seem to belong in a communication framework. For example, it might sound obvious, but we told students to bring their calendars and a notebook and pen to every meeting. We also created a form that incorporated both writing milestones and task-related milestones to track progress and completion of task components and the entire task. Beginning in the second semester of the program, both the writing coach and the faculty mentor set up a weekly meeting with each student and used the form to track progress. Of course, the students were encouraged to ask for help with communication or technical matters during the week as needed.

The second concept, equipping students with tools and strategies, means that we focused on several aspects of effective communication, including, of course, writing, but also designing effective slides and making effective oral presentations; producing quality figures and tables and writing effective captions for them; and preparing rhetorically sensitive reports, emails, resumes, and letters. All of these communication skills are valuable in the workplace. We implemented this concept by training students on the use of non-technical tools (e.g., Microsoft Word, PowerPoint, dictionaries); this kind of tools education is supported in the literature.[38]

We decided to include this kind of tools training based on the notion that student engineers are carefully taught to use laboratory, field, and analysis tools and techniques—to not do so would be unthinkable. However, we don't bat an eye at the lack of parallel training on the ubiquitous tools—notably Microsoft Office programs—that are installed routinely on computers the students use to report the results of their research. Training students to use powerful features (e.g., styles, views, shortcuts) of these programs effectively and efficiently helps them feel

confident and capable. Students routinely report that this training has helped them focus on their composing processes.

In line with instantiating these two concepts and focusing on the parallels between OM and the writing process, we structured the Writing Support Program by promoting teamwork within the cohort and developing and collecting the tools and processes to complement the program's activities.

Teamwork

Just as engineering is not a solitary endeavor, professional writing isn't—or shouldn't be—a lonely pursuit. Just as engineers share ideas to solve problems and work on teams of engineers from other engineering specialties, it is logical that the same kinds of collaboration would take place for written work. Both engineering processes and writing processes provide opportunities for collegial networking and friendships and enhance the quality of outcomes. We encouraged the students to work together both formally and informally in peer reviews and in conversations. We stressed that building a professional network begins in undergraduate work, but for graduate students, their cohort will form the core of their professional networks.

We understand that social support is essential for writers who are undertaking the most complex research and writing project of their careers to date and, in some cases, in their entire careers. We sought to provide social support and at the same time help the students develop and practice the professional skills outlined by ABET and the ASCE BoK in these ways:

- participating in peer review,
- encouraging students to talk among themselves about their projects and professional interests
- working with the writing coach, and
- preparing and presenting research results to industry and government sponsors.

Tools and Processes

Several tools and related processes underpin the pilot program. Some of these tools were developed by the authors specifically for this program, while others were adapted from other, existing sources. Table 1 summarizes these tools. Three tools, the thesis outline, the Record of Decisions (RoD), and the writing coaching process, are discussed below in more detail.

Table 1. Tools and processes

Tool/Process	Original product	Adapted material*	Process
Thesis Outline	X		
Record of Decisions	X		X
Electronic feedback system	X		
Research Proposal Template	X		
One-on-one writing coaching	X		X
Progress Tracking Form	X		X
Problem Statement Worksheet	X		
The Differences Between Goals and Objectives (handout)		X	
Writing Effective Figure and Table Captions (handout)	X		
Coherence and Cohesion (handout)	X	X	
About Writing a Thesis	X		X
Category Matrix for Comments Intended to Guide Revision	X		X

Tool/Process	Original product	Adapted material*	Process
Structured Peer Review			X
Preparing an Annotated Bibliography	X		
Matrix for Deciding Authorship on Collaborative Works	X		X
Syntax (handout)		X	
Verb Issues for ESL Writers (handout)		X	
ASCE Writing Guidelines		X	
ASCE Quick Guide to Common Types of Referenced Material		X	
Online Search Engines/Libraries for Geotechnical Publications		X	
Strategies for Simplicity (handout)		X	
Purdue University Writing Lab Workshop Series for the Indiana Department of Transportation		X	
Chicago Manual of Style, Proofreaders' Marks (handout)		X	
TRB Information for Authors		X	
Writing a Paper for the *Transportation Research Record*		X	
Transportation Research Board Reviewer Instructions		X	

* Full citation information for these resources is available on request.

Thesis outline

The primary tool developed for the program is a thesis outline that is both a template with elaborations and a starting document to guide students as they work through the proposal and on chapters of their theses. Because the thesis is a genre that students have not encountered before—and may never prepare again—this template ensures that they include required information and helps students begin the thesis preparation process. Figure 2 shows the thesis outline.

ABSTRACT

CHAPTER 1. INTRODUCTION
Industry Problem
    Industry concerns
    Impact on industry
Technical Problem
Goal of the Research
Objectives
Significance of the Research
Organization of the Document

CHAPTER 2. BACKGROUND/ LITERATURE REVIEW
Relevant Research and Literature
    Major contributions to the field
    Present practices/current fieldwork
Preliminary Work
Context for this Project

CHAPTER 3. METHODS
Research Design
Objective 1
    Task 1 associated with objective 1
    Task 2 associated with objective 1

CHAPTER 4. MATERIALS
Material A
    Laboratory test results
    Field test results

CHAPTER 5. RESULTS AND DISCUSSION
Objective 1
    Major point 1
    Major point 2

CHAPTER 6. CONCLUSIONS
Objective 1
General Conclusions

CHAPTER 7. RECOMMENDATIONS
Immediate Impact
Long-term Impact
Implications for the Future

Figure 2. The example thesis outline and template

Because of the parallels between the geotechnical engineering OM and the recursive writing process, we have students work on chapters and submit them for review individually rather than waiting until the entire thesis is "finished" to seek feedback.

We adopted this approach for three reasons. First, ongoing review of chapters provides opportunities to intervene early and, if necessary, redirect the student. This review prevents problems as the students move toward the defense and helps the faculty mentor avoid being presented with a complete thesis that requires substantive revision as deadlines approach.

Second, the students are not faced with the daunting task of writing *The Thesis*, but instead can address the larger task in more manageable chunks. This approach, which is supported by others who offer advice on approaching the process,[39,40,41] fosters a sense of accomplishment and builds confidence because students can see progress as they receive feedback and coaching support as parts of their work are approved. We encourage each student to use work from the research proposal (e.g., literature review; methods) and begin by placing those sections in the related chapters of their thesis. This line of attack is consistent with the OM and the way engineering professionals develop engineering products.

Third, this approach helps students benefit from regular writing coaching sessions that address each student's particular writing issues so the faculty mentor can focus on technical content.

To facilitate this process, each student has an account on a mainframe drive where a master folder is placed. This master folder contains a thesis template with subfolders for each part of the thesis process from the proposal and an annotated bibliography, and abstract to individual chapters, works cited, and the record of decisions (RoD).

The documents in these folders ensure adherence with the format and content requirements of the university graduate college. In addition, the thesis template represents the structure and content that the faculty mentor wants his students to follow. Providing the template at the beginning of the students' tenure builds on their prior writing experience while enculturating them in the discipline. Figure 3 shows sample text from the beginning of the methods chapter.

CHAPTER 3. METHODS

The purpose of this chapter is to describe the methods used in the study.

Describe the contents and organization of the chapter. Your subsequent first-level headings should match your description of the chapter. For example:

> The methods (e.g., specific tests or activities) used in this study were selected to address these objectives: <to verb objective 1>; <to verb objective 2>; and <to verb objective 3>.

Provide a brief overview that explains why you chose this approach and include some background that led you to conduct your research in this way. For example:

This chapter describes the research design and the research tasks in the context of the objectives.

Figure 3. Sample text from the beginning of the methods chapter in the thesis outline

Rather than having the student wait until all the data has been collected to begin preparing the thesis we encourage them to begin composing with what they know. For example, the students must prepare and present to their committee members a research proposal that includes a

representative literature review, a methods and materials section, statements of goals and objectives, and schedule. Each of these proposal elements feeds into respective chapters, so students can experience some satisfaction by having made progress with the thesis.

In addition to supplying the elaborated chapter documents, the file structure is designed as a model for organizing and a process for managing multiple revisions of works-in-progress. Students are instructed to open the most current version of a document and change the file name by increasing the trailing version number (e.g., ch-03-04.docx would be ch-03-05.docx). This process accomplishes three objectives. First, it documents the student's attention to the work, and second, it allows the writing coach to determine at a glance which file is the most current. Third, using this file-saving protocol keeps filenames consistent and avoids filenames such as thesis_final_final-jwreview.docx or uploadthisone-real.pdf.

Record of decisions

We also developed a tool called a record of decisions (RoD) that also is included as a subfolder. The RoD is essentially a style guide derived from elements from the university research institute's style guide, the *Chicago Manual of Style*, and ASCE author requirements.

The students are instructed to keep their copy of the RoD open while they write and update it as they make writing choices. We collect the students' RoDs at intervals to review their decisions and decide which decisions will be included in the updated master RoD for in-house use and that we distribute to new and current students.

One-on-one writing coaching

The authors suggest that the best way for individual students to address and improve their writing problems is to work on documents that are meaningful to the student in one-on-one writing coaching sessions and small group meetings with cohort members who are working on parallel documents. Some who are involved in graduate engineering education argue that, "It's not my job to teach them to write." We disagree and suggest that although this approach requires considerable time and financial commitment, the benefits for the students are substantial. Others agree. Single,[32] an experienced academic writing coach who specializes in doctoral students and faculty members, asserts that,

> although the cost for [hiring a writing coach] may seem exorbitant now, you will realize later that it was a good investment. . . . A writing coach helps you set long- and short-term goals, improve your writing habits, assess your progress, and prevent writer's block. . . she identifies trends that you can work on as you write (161).

Two of the elements that make coaching effective are targeting and helping students identify their own specific patterns of errors and responding in real time to the students' real work-in-progress. It takes time to build trust and gain an understanding of each student's needs. The process requires repeated contact, accurate identification of patterns of errors, and sensitivity to the best approach to take with each student in terms of prioritizing and presenting information in the way(s) that will work best with each student.

This process is *not* editing nor is it simply a series of explanations. Instead, the coach points out one issue at a time, asks about what influenced that choice, and shows the student a strategy for making different choices later on. Often the coach will identify several instances of an issue, explaining on the first occurrence. Then, on subsequent instances the student practices the strategy. This process offers time for students to reflect on their process, their product (i.e., the

document at hand), and their progress, and it provides opportunities for encouragement based on the coach's and faculty mentor's perceptions of progress.

Assessment of the Writing Support Program

This pilot program was designed to evaluate student progress and monitor their understandings of their writing weaknesses, strengths, and improvement as well as the technical accuracy of their work. The authors assessed student work at several stages to ensure that they were on track with project deadlines and that they understand their research and communication tasks in a CE context. This was accomplished through the coaching process and implementing the review process whereby the faculty advisor assesses the thesis chapter-by-chapter rather than reviewing the thesis as a whole as deadlines approach.

Observations of Students

Over the past year the authors had opportunities to interact with the students and their documents. As such, from seeing first drafts early on and subsequent revisions, we observed how their writing and their approaches to writing shifted. In most cases, presentations of technical material were more coherent and meanings were clearer as the result of participating in the program. What are sometimes considered minor details such as formatting, using styles guides, figure captions, file numbering, and ways to identify areas in works-in-progress that needed attention were vastly improved and contributed to improved clarify. A secondary benefit was that early student drafts were more easily reviewed and the quality of the faculty mentor's feedback was improved.

Although some students may have been skeptical at first and resisted some aspects of the program, as time went on, students seemed to discuss their experiences and talk about the resulting success and their growth as writers, which encouraged others to adopt recommended processes and use the program's tools. The following are some examples of our observations.

One student resisted the program to the extent that she prepared her research proposal and, without review by the faculty mentor, distributed it to her committee at 1 AM on the day of her proposal defense. Although this runs counter to the program's review process, to some extent, it reflects business as usual in the department. The authors note that it is difficult to break from established practices.

Alan enthusiastically adopted nearly every tool and engaged in every process. His approach to writing seemed to change, and he reported that he liked the material and that it helped him organize and complete his thesis work. We observed positive changes in his writing, especially the way he not only used the outline but also in the way he integrated his own strategies. For example, as he worked on each chapter, he made notes to himself in blue and notes about what he wanted to ask his advisor in red, which facilitated the review process.

Rhonda had a solid background in traditional composition; she was a competent essay writer and wrote frequently. She initially had some difficulty understanding the conventions of the academic genre, but she persevered by working with the coach and seeking regular feedback. Like Alan, she was able to generalize her understandings to other work. For example, she sought advice from the coach when one classmate on a team project presented text as a list of mixed sentences and sentence fragments that she recognized was incoherent. She returned the first draft to that student and asked for a revision, but the second revision, too, was unsatisfactory. After

consulting the communication mentor, she and another team member took a different approach to the group report.

One serendipitous moment revealed how Rhonda and Alan had come to value and integrate the peer review process. The coach happened to walk by as they were exchanging drafts of their resumes for an upcoming career fair. They sought advice about formatting and style, then reviewed each other's work. Rhonda reformatted her resume as Alan had, and based on the review, Alan included an activity that he previously had thought wasn't important.

Another student, Ling, had difficulty in establishing and enforcing deadlines; she admits to "not thinking English was important in middle school and high school." Ling overheard a conversation between a staff member and a student who had participated in the early stages of the pilot program and graduated in spring 2010. The staff member commented, "This thesis is too good. How did it get so good?" to which he replied, "The [coach and the professor]." Based on this interaction, Ling stated that she "is going to buckle down and work on communication skills."

The Writing Workshops

Beyond working with individuals in the cohort, the writing coach developed and presented a series of five biweekly writing workshops that took place twice, once off campus and in the CE department building on campus. A total of 97 students attended at least 1 of the 10 workshops.

Decisions about the content of the workshops were based on the assumption that when a pattern of errors is identified in more than one student's work, most or all of the other students would benefit from information and strategies related to that pattern of error. Further, we assumed that native speakers of English would benefit from presentations of material about problems commonly identified in the work of L2 students: even native speakers have trouble with verb tense and articles.

The workshops were open to any CE graduate student, although attendance was recorded, attendance at the workshops was not required or reported to anyone, no books or fees were required, no assignments were given, and students had no opportunity to work on their own documents. Although the material was delivered in a classroom setting, each workshop included at least one small-group activity and a handout.

The five workshop sessions had the same seven elements:

- a general writing concept (e.g., touch your work for [at least] ten minutes every day; all writing is revision: be comfortable with ugly drafts);
- quick coverage of one writing issue framed as a question (e.g., To hyphenate or not to hyphenate? Is conflict in collaboration always a bad thing?);
- two general topics (e.g., the IMRD structure of engineering discourse; classes and functions of words; subject/verb and tense agreement);
- one topic having to do with coherence and cohesion with explicit strategies for ensuring cohesion (e.g., parallel structure as a cohesion strategy;);
- a hands-on, small-group exercise (e.g., identifying prepositions in text); and
- a handout (e.g., identifying prepositions in text).

Assessment of the Writing Workshops

After each session, at least one person approached the instructor with comments. For example, one student enthusiastically reported that she had successfully used a writing strategy—Touch

your work for (at least) 10 minutes every day—on a project she had been dreading. Another student reported that he was very happy with what he was learning and asked for attention to a specific topic—verb tenses. That topic was included in the next session. Two other students visited the instructor's office and asked for information about obtaining a guide that was mentioned in a workshop, *The MIT Guide to Scientific and Engineering Communication*.[21]

Two surveys were conducted to assess the series of writing workshops, a hand-administered survey administered to the students who attended the final workshop. The second survey was created in and administered through Survey Monkey.[42]

Responses from students who attended the workshops, especially the students who attended all five sessions, indicated that they found the workshop content useful.

The first survey was administered at the end of the last session of both sections of the fifth workshop. Three students attended the fifth on-campus workshop and completed the survey. Five students attended the fifth off-campus workshop at the institute and completed the survey. These eight students only ranked the workshop content for the workshops they attended.

This survey was designed to assess the how the students valued the elements of each workshop they attended. Responses were recorded on a Likert scale from 1–4, where 1 = not very useful and 4 = very useful. The possible score for each workshop session were computed by multiplying the highest rank (4) times the number of elements presented at each workshop (7) times the number of students who attended that workshop. The scores are shown in Table 2.

Table 2. Student responses to questions about the usefulness of workshop elements

	Respondents	Possible Score	Usefulness Score	Rating
On-campus	3	388	351	89.5%
Off-campus	5	562	441	78.5%
Combined	8	950	792	83.3%

Although this rating is based on a small N, the students reported that they thought the workshops were useful. All eight students indicated that they would attend writing workshops in the spring 2011 semester if the workshops were offered again.

An 11-question (10 content questions and a question about the number of workshops attended) Survey Monkey survey was distributed through an email to all CE faculty and graduate students. Students who completed the survey were entered in a drawing for a copy of *The MIT Guide to Scientific and Engineering Communication*. The survey announcement and the third reminder came from the writing coach, while the second reminder came from the CE director of graduate education. There are approximately 125 CE graduate students; 65 students responded to this survey. Of these, 31 students attended one or more workshops. Figure 4 shows the attendance distribution.

Figure 4. Distribution of workshop attendance

Respondents were asked to check all the choices that applied to complete the sentence, *I did not attend all of the workshops because . . . .* Eighteen (66.7%) students reported schedule conflicts; 11 (40.7%) reported research workload as a cause; 6 (22.2%) reported course workload as a cause; and 6 (22.2%) reported that the workshops were not what they expected.

Respondents were asked to check all the choices that applied to complete the sentence, *I might have attended all of the workshops if . . . .* In addition to the available responses, 9 students (33.3%) also commented. Comments included, "I was busy with field work during one of the workshops," "if I didn't have schedule conflicts," and

> I felt that in some instances the materials included things I already knew. At the time of the workshops, I had already written 60% of my thesis. Perhaps different workshops could be offered, one for students just entering the graduate program and one's [sic] near the end or in PhD work.

The distribution of responses to this question are shown in Figure 5

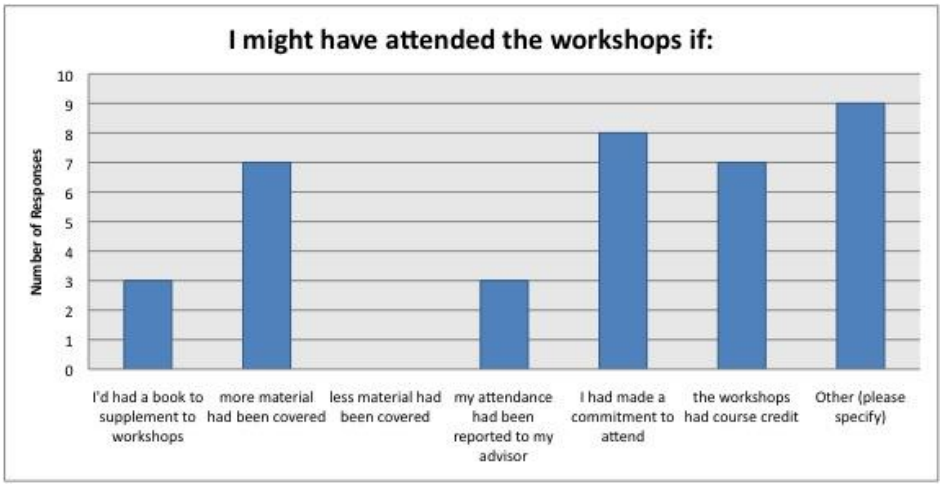

Figure 5. Responses to "I might have attended all of the workshops if . . ."

Students were asked to rank the topics covered in the workshops on a three-point scale, *not enough*, *just about right*, and *too much*. For each topic, the *just about right* responses were higher than the other ranks. Responses to this question are shown in Figure 6.

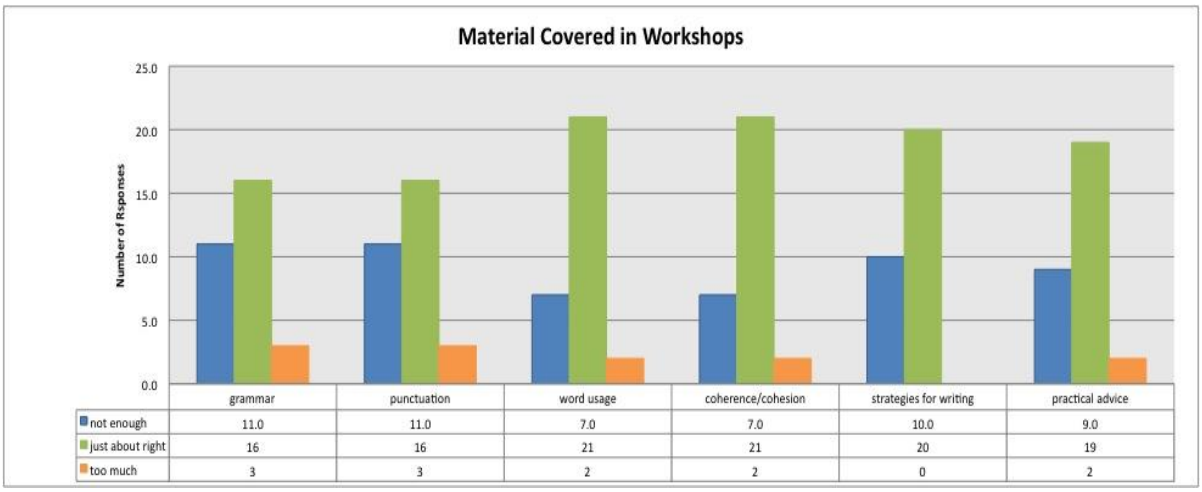

Figure 6. Assessment of the amount of attention to the six content categories

Analysis of the data from the two surveys resulted in some changes for subsequent workshops.

- Administer pre- and post-tests to assess student's progress.
- Require a book for readings that support the syllabus and that students could retain as a resource, such as *The MIT Guide to Scientific and Engineering Communication*.
- Provide a syllabus that will reflect how the content builds on core ideas (e.g., improving coherence) and addresses both global issues (e.g., organization and adherence to genre conventions) and basic, local issues (e.g., use of articles and agreement).
- Provide the opportunity to help students with individual or group writing projects.
- Publically recognize students who complete the workshop series.

We believe that opening attendance to any CE graduate student with no commitment or accountability diminished perceptions of value. In addition to this list of changes, we plan to limit enrollment to 24 students and ask for firm commitments from those students.

Pilot Program Outcomes

Because the program has been in place for a year and part of that time was devoted exclusively to tool development and writing coaching primarily for students who graduated in spring 2010, it is premature to provide a comprehensive assessment of the program. However, we plan to implement pre- and post-tests and to conduct structured exit interviews with students when they graduate. We also plan to contact these students after a year to find out whether and how they incorporated what they learned in the program into their professional practice, whether they pursue the Ph.D. or obtain employed in government or industry. We also plan a rubric-supported, discourse analysis study that will examine drafts to trace changes.

Research Recommendations and Plans for Future Development

Although we believe that one-on-one writing coaching is the most effective means of helping students improve their writing skills, we recognize that it is probably unrealistic to fund—and it would not be easy to provide—such efforts on a larger scale. As such, we sought to translate program materials and integrate them into a workshop or course format. We view an analysis of this transfer process and studies of the development of effective communication pedagogy for graduate engineering students as areas for future research. To that end, we plan to implement a system for collecting data at the end of each workshop session and at the end of the sessions.

One of the challenges that remains involves convincing advisors that it is in their best interest to set aside resources, both financial and human capital, to help graduate students improve their writing skills. Why? Students' communication skills will improve and their work in graduate school will more accurately reflect their abilities. As such, faculty mentors will benefit because, as they will no longer have to focus on local, mechanical distractions, they can focus instead on technical matters. Research sponsors will benefit from clear, concise reports. Also, the students will be better equipped with practical/professional/soft skills and their proven abilities and subsequent success will enhance the legacy of their universities. Finally, well-trained technical professionals who can communicate effectively will be valuable employees from day one.

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