Students Writing for Professional Practice: A Model for Collaboration among Faculty, Practitioners and Writing Specialists

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Abstract

This paper presents the principles, procedures, materials, and assessment of a new approach to improve the teaching of writing in engineering. The Civil Engineering Writing Project aims to improve students' preparation for writing in industry by developing new teaching materials that can be integrated into existing civil engineering courses. With collaboration among engineering practitioners, applied linguists, and engineering faculty at four universities, the project draws on multiple perspectives to analyze writing and develop teaching materials. Phase 1 of the project investigated differences between practitioner and student writing in a large collection of texts and identified the most serious student weaknesses. Phase 2 of the project, currently underway, develops materials to address those weaknesses and evaluates their effectiveness. Student writing after the use of the materials is assessed with multiple measures, including linguistic analysis of specific language features and holistic evaluation of effectiveness by engineering practitioners. After initial piloting with seven courses, all quantitative assessments have found significant improvement in student writing. Student comments suggest the materials also challenge their misconceptions about writing in engineering. Although the project focuses on civil engineering, the principles behind the project and the procedures for materials development and assessment are applicable to any engineering discipline.

1. Introduction

This paper describes a project that addresses a persistent problem in engineering education: the discrepancy between the writing skills of program graduates and the demands of writing in the workplace. The project is motivated by the belief that programs whose graduates primarily want to work in industry have a responsibility to introduce students to the concerns of practitioners. In fact, programs often are responsive to practitioner concerns in engineering topics, technical tools, and scope of design projects. However, in spite of the emphasis engineering practitioners place on communication, surveys of employers and alumni continue to find low satisfaction with the writing preparation students receive.[1,2] Some programs rely primarily on technical writing courses, but instructors of such courses cannot be expected to know the concerns of practitioners in specific disciplines. Furthermore, engineering faculty often reinforce an academic orientation; for example, some suggest making writing more meaningful for students by asking them to take on the "professional role" of a graduate student in a research laboratory.[3] In sum, few university programs place practitioner concerns with writing at the same level they place practitioner concerns with technical skills.

With funding from the National Science Foundation, we are addressing this problem with new teaching materials that incorporate writing instruction into undergraduate civil engineering courses. The approach is innovative because it integrates the expertise of engineering practitioners, engineering faculty, and writing specialists, and is empirically grounded in the analysis of a large collection of practitioner and student writing. Although our project focuses on civil engineering, the approach can be applied to any field.

In this paper, we provide a comprehensive introduction to the project – its foundational principles, collaborators and overall design; empirical results about student writing weaknesses; the new materials for teaching writing; and assessments of the materials' effectiveness thus far. In order to cover all areas, we provide only limited details about each aspect. Interested readers can find additional information on the project website (www.cewriting.ling.pdx.edu).

2. Overview of the Civil Engineering Writing Project

2.1 Principles Underlying the Project

The project implements five key principles: collaboration with practitioners, empirical analysis of writing, a functional perspective on language, direct instruction, and integration into existing courses.

Collaboration with engineering practitioners plays a central role. Most faculty know academic contexts better than industry contexts, so to maintain a focus on practitioner concerns, engineering practitioners provide input on all stages of the project. Besides helping with access to workplace writing, they participate in interviews about their own writing practices, contribute to interpretations of the project's findings, collaborate on teaching materials, and evaluate student writing.

Empirical analysis of writing is important because intuitions and anecdotes about language often do not accurately represent real use.[4] The project uses analyses of words, grammar, organizational features, and rhetorical functions to identify differences between practitioner and student writing, and to assess improvement in student writing. We use a "corpus linguistics" approach, compiling a collection of texts from numerous firms and courses in order to identify typical language choices and variation among them. Interviews, holistic evaluations, and surveys contribute to interpretations and supplement the language data.

A functional perspective on language means words, grammar, and organization are analyzed and taught for their impact on meaning and communication, not as purely stylistic concerns. Students often see writing as style decisions that are distinct from engineering. Grading rubrics – though helpful for faculty – reinforce this distinction. A "style" criterion such as "includes a variety of sentence structures"[5] is typically taken by students to mean that variety itself is a goal. Practitioners, in contrast, describe sentence structure as effective if it fulfills its function to facilitate clients' rapid comprehension of the intended meaning. A functional perspective ties effective writing to the accuracy and precision that are hallmarks of engineering and to the concern for clients' needs that is a hallmark of workplace practice.

The project also provides direct instruction with writing. Materials teach students about typical expectations for workplace genres and techniques for choosing effective words, grammar, and organization. While some writing instructors have argued that direct instruction can "prevent our students from enacting what they know tacitly"[6], most students have no knowledge of engineering genres as they are used in the workplace. Studies have found that, when tied to functions, direct instruction with language is effective[7] and that it is especially helpful for

students from non-traditional and second language backgrounds who are less likely to subconsciously "pick up" writing skills.[8,9] New engineers will always need mentoring in the workplace, but we believe they can graduate with tools, skills, and awareness that make that mentoring more effective.

Finally, the project integrates writing instruction into existing courses and existing assignments so that no programmatic changes are required. Other approaches that require curriculum revisions or staffing changes can be beneficial, but they are difficult to fund and sustain. Since writing assignments already abound in civil engineering courses, our materials seek to maximize the potential for students to learn from assignments that courses already include, providing enough flexibility so materials are adaptable to different programs.

2.2 The Collaborators

The project is based at Portland State University and also includes Cal Poly Pomona, Howard University, and Lawrence Technological University. All offer an ABET-accredited B.S. in Civil Engineering and seek to train students to become effective practitioners. Beyond that, the collaborating institutions differ in many ways so that the teaching materials can be piloted with diverse students. They are located in different geographic areas and include comprehensive and technology-oriented universities. One is a Hispanic-serving institution, one a historically Black university, and one has over 20% immigrant and refugee students who consider English their second language. The size of the programs varies from approximately 75 to over 1,000 majors. The programs also vary in whether they require a technical writing course, which further diversifies the piloting conditions.

The faculty on the project represent two disciplines: applied linguistics and civil engineering. The linguists are trained in discourse analysis, linguistic analysis, and the teaching of writing. Because of their conscious knowledge of language structure and functions, they supply the background engineers often lack for describing language use. The engineering faculty bring not only their engineering expertise but also knowledge of the course contexts. Many of the engineering faculty also have extensive previous industry experience.

Most of the collaborating civil engineering practitioners are located in the Pacific Northwest, where the project is based. Four practitioners provide the most consistent input although 15 have contributed in various ways, and the number continues to grow. Their positions cover a variety of specializations in private firms and public agencies. All are registered Professional Engineers. The four major collaborators are project managers who often mentor new engineers in the workplace.

2.3 Overview of Procedures

The project follows an iterative process of analysis, teaching materials development, piloting, and new analysis (Figure 1).

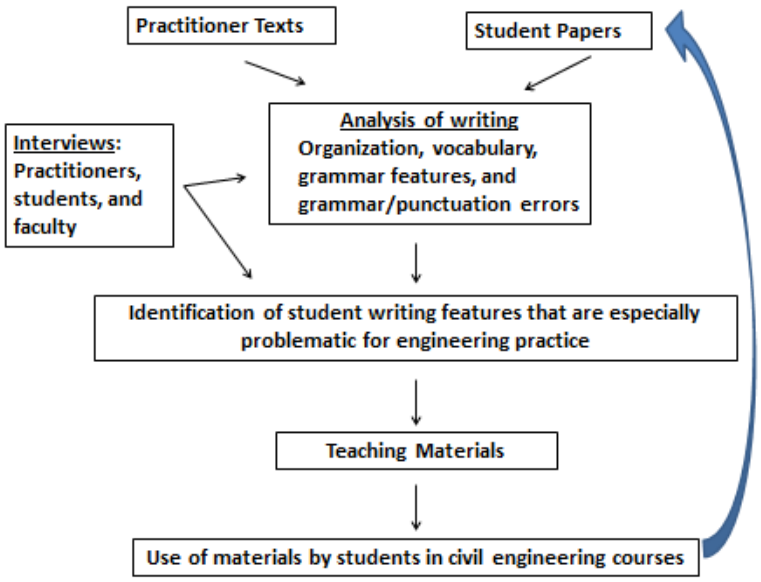

Figure 1. The Iterative Process of the Civil Engineering Writing Project

Phase 1 of the project focused on identifying features of student writing that are especially problematic in the workplace. We compared organization, grammar choices, and grammar and punctuation errors in a corpus of approximately 400 student papers and 400 practitioner documents from 50 firms and agencies, including ten genres (e.g. technical memoranda, reports, proposals, e-mail messages). To analyze the writing, we employed computer-assisted, quantitative techniques and functional interpretations of language in context. Interviews with 20 students, 20 engineering practitioners, and 10 faculty provided context for us to understand the concerns, beliefs, and constraints that shaped the writing. The interviews with practitioners were also used to identify which of the student writing differences were most detrimental for engineering practice. Findings that correspond to the teaching materials covered in this paper are described in the next section. More details of the procedures and findings have been reported elsewhere.[10,11,12]

Phase 2 of the project, currently underway, develops the new teaching materials and pilots them in courses. Papers written after the use of the materials – the "post-intervention" papers – are analyzed and compared to the pre-intervention papers, as described in section 5.

An occasional concern about the project is whether writing from practitioners represents effective writing. For quality control, we apply several selection criteria. The texts come from firms that have been in business for at least 15 years. The texts have undergone internal review and are final versions. Texts associated with projects under litigation and texts written by a P.E. with less than five years of experience are excluded. Each document is also reviewed by at least one linguist and one engineer before inclusion in the corpus. Finally, we run descriptive statistics on multiple language features and inspect potential outliers. However, while we want the corpus to represent effective texts, representing variation in practitioner writing is also important, so outliers are excluded only when they are clearly not representative of effective writing.

3. Findings about Student Writing Weaknesses for Civil Engineering Practice

Phase 1 of the project identified a number of weaknesses in student writing compared to practitioner writing. In this paper we concentrate on three areas to illustrate the findings and the corresponding teaching materials: genre organization, sentence structure, and word choice.

Genre organization: Practitioner texts of a particular genre followed the same basic organization, even across firms and states. Headings for sections in a genre often varied, but the function and sequencing of the material was consistent. In contrast, students displayed little knowledge of the expected structure of genres. They had many assignments that were modeled on practitioner genres, but – even when assignments specified the organization – students used widely differing organization and often undermined effectiveness by omitting needed information, repeating other information, and interspersing unrelated topics. Numerous students skipped entire sections that practitioners considered mandatory – most notably, an opening that provided context for the project and the document. Students' comments in interviews confirmed their lack of knowledge of genre expectations. For example, when faced with presenting the answer to an analysis problem as a technical memorandum for a client, they reported searching the internet or asking their friends' opinions. One student summed up the problem: "When you don't know what to do, you just throw up on the paper." Practitioners recognized the predictable sequencing in a genre as a consequence of several factors: expectations in engineering (e.g. observations come before discussion and conclusions based on them), a desire to make reading easy for clients (i.e. meet the readers' expectations for organization), the purpose of the genre, and, in some cases, limiting unintentional liability.

Sentence structure: Students used sentences with complex and embedded structures statistically significantly more often than practitioners did. Practitioner texts usually had simple structures conveying one main idea per sentence. Practitioners described making content as unambiguous as possible and facilitating fast reading for their clients. In contrast, students used more complex sentences that encompassed multiple ideas and conveyed vague or inaccurate information. For example, sample 1 from a transportation paper is not only difficult to follow, but the students actually claim that a variation in departure times accounts for the varying duration of class times (when they mean the opposite):

> Text Sample 1: Complex sentence from student writing
> Departures tended to have less pronounced localized peaks than arrivals, suggesting that departures are slightly less dependent on class time, as well as may account for the varying duration of class times (see Appendix Graphs A1 and A2).

In interviews, many students reported that they thought long, complicated sentences were better because they looked "fancy." Typical comments used to explain their choices were:

> "It looks better if it's longer. I think it's that simple."
> "Make it fancy."
> "You want to sound really knowledgeable about things, and it seems like the easiest way to do that is to be wordy."

In sum, the students' beliefs about sentences were the opposite of practitioners' target.

Word Choice: Students' word choices often conveyed inaccurate and imprecise information for two contrasting reasons: on the one hand, they used more superlatives and absolutes (e.g. *the **best** design to **ensure**...*), and, on the other, they used vague words (e.g. *at **really high** temperatures*). In contrast, practitioners used precise words and phrases. No student interviewees connected writing to precision or accuracy. Students usually equated engineering writing with formatting rules (e.g. "Do not put gridlines on graphs") and engineering content with calculations. Practitioners, in contrast, considered writing and engineering more connected: engineering requires accuracy and precision, so the ideas expressed in writing must be accurate and precise.

Other important findings about student weaknesses were the following: a greater use of passive voice, which often made responsibility ambiguous and contributed to ineffective complicated sentence structures; a lack of awareness of connections between ambiguous writing and unintentional liability; choppier content development due to the writers' failure to follow typical information flow in English, which moves from already-established information to new information; and a much higher rate of grammar and punctuation errors, often high enough to damage writers' credibility as detail-oriented engineers.

4. New Materials for Teaching Writing

The teaching materials being developed in Phase 2 of the project are based on the findings from Phase 1 and are designed to address the most common weaknesses in student writing.

4.1 Description of the Materials

The materials comprise free-standing units. They are drafted by engineering or applied linguistics faculty, commented on by collaborating faculty and engineering practitioners, revised, and then piloted with students. In addition to applying the principles underlying the project, we have two additional criteria for the materials based on student comments in interviews. First, the materials directly address common student misconceptions about writing, such as believing that effective writing comes from trying to be fancy, smart or wordy. Second, the materials use numerous examples of practitioner writing because most students reported having seen few examples of writing produced in industry.

The materials cover introductory concepts and then three major areas: genre-based units, language units, and grammar and mechanics lessons (Table 1).

Introductory Units: The introductory units review principles that students are expected to know from previous writing courses, such as how audience and purpose shape writing and that writing is an iterative process that includes review and revision. The principles are situated in a civil engineering context and examples are provided from civil engineering practitioners' documents. Students are also introduced to the difference between unacceptable plagiarism at school and the acceptable workplace practice of using previous documents as a template for a new document.

Genre-based Units: The genre-based units cover the typical purpose, audience, organization, and format of specific document types (Table 1, part II). The goal is to make students aware of

Table 1. The New Teaching Materials

I. Introductory Materials

1. The writing process
2. How audience, purpose and content shape writing
3. Plagiarism at school vs. in the office

II. Genre-based Units

1. Technical Memoranda: Field Observation Memo, Forensic Analysis Memo, Geotechnical Memo
2. Letter of Transmittal / Cover Letter
3. Reports
4. Proposals
5. Specifications

III. Language Units (building judgment about effective language choices)

1. Word choice for precision and accuracy (nontechnical information)
2. Precision and accuracy in technical information (most applicable to lab reports and senior-level design)
3. Effective sentences: Simple sentence structure (one idea per sentence)
4. Connecting ideas in effective complex sentences
5. Using active and passive voice effectively
6. Effective information flow: The sequence of information in analysis and design documents
7. Information flow in sentences: Moving from known to new information
8. Special language considerations for e-mail
9. Liability and language choices

IV. Grammar and Mechanics Lessons (addressing common errors with standard written English)

1. Sentence punctuation
2. Verb tenses: reporting methods, discussing observations and data, describing options and making recommendations
3. Modifiers in sentences
4. Commas
5. Parallel structures and lists
6. Semi-colons
7. Pronoun reference
8. Using “the,” the definite article
9. Apostrophes
10. Proof-reading

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expectations that are common for certain types of documents in civil engineering workplaces. Each genre-based unit makes explicit comparisons between the student version of the genre and practitioners' use of the genre. Each unit highlights at least one specific writing skill that is useful in the genre.

Even a first-year course can introduce students to a professional genre and an associated writing skill. For example, we use a Field Observation Memorandum unit in first-year introductory courses where students visit engineering offices and construction sites, or make observations of structures on campus. Students do not have the background to conduct a site visit at a practitioner level, but they can start developing an important skill: stating observations before making interpretations or drawing conclusions based on those observations. Appendix A displays the opening of the Field Observation Memo unit, showing the comparison made between the student context and practitioner context. The unit does not ask students to pretend they are professional engineers; for example, it tells them their interpretations and conclusions should focus on what they learned from the visit. However, it is consistent with engineering practitioners' writing in emphasizing that the interpretations and conclusions need to be tied to the previously stated observations. One practitioner who collaborated on this unit reported that he was initially very skeptical that a first-year "field trip" writing assignment could be a useful exercise for engineering practice – but that the final genre-based unit made him a believer.

The genre-based units also include annotated examples of effective and ineffective student papers, and – for more advanced units – annotated excerpts of practitioner work. Annotated examples for the Field Observation Memo unit, for example, point out how the less effective paper combines interpretations into the observations and mixes new observations into the discussion section. The annotations also point out effective and ineffective features related to the language units that are most useful for this level; for the Field Observation Memo, simple sentence structure and effective word choices are highlighted.

Language Units: The language units address effective language choices in civil engineering contexts (Table 1, part III). These are features for which multiple choices are grammatically accurate, so writing effectively requires using judgment, not just applying grammar rules.

The language units include the following components:

- A statement of research findings about the feature in practitioner and student writing, and why the feature is important for engineering practice, including quotes from practitioners. The information ties the language to its function in civil engineering workplaces. For example, the word choice unit ties words to accuracy and precision. Rather than a rule such as "don't use colloquial language," the unit connects the need for precise, accurate words to the practice of engineering.
- Explanations about how to use the feature effectively, exemplified with samples of practitioner writing. For example, in the unit about simple sentence structure, extracts of practitioner documents illustrate the use of simple sentences that convey one main idea and have a subject close to the verb (Figure B1).

- "Myth buster" boxes that addresses common misconceptions. For example, the word choice unit counters students' belief that they should pick words to try to sound sophisticated or smart (Figure B2).
- Specific techniques for students to apply in revising writing, using examples from previous student writing. For instance, one technique in the nontechnical word choice unit is to use quantities rather than vague terms such as *a lot* and *a few* (Figure B3). Although such advice might seem obvious, many first-year students simply do not understand why these terms are vague and, before this project, many continued to use them even as juniors and seniors.
- Practice exercises. Practice begins with relatively straightforward items for a specific technique and then moves to integrated practice with more complicated chunks of discourse. The exercise items are drawn from real papers, sometimes modified slightly to make the context or content more understandable.

Grammar and Mechanics Lessons: The grammar and mechanics lessons address 10 common student errors in the use of standard written English (Table 1, part IV). These are features of writing that have prescriptively correct choices. As in the language units, each lesson includes examples and explanations of effective and ineffective writing from civil engineering, comments from practitioner interviews, techniques for revising, and practice activities. Although these errors are often addressed in writing handbooks, even handbooks for engineers often illustrate points in non-engineering contexts. One handbook for engineers, for example, demonstrates comma use with phrases such as "authentic, early Inca art."[13] Students often cannot make the jump to punctuate phrases such as "a large deep-seated landslide" or "improved local stormwater runoff controls." Our materials help students make that jump.

4.2 Use of the Materials

Piloting of materials is currently taking place. Instructors are free to select materials and use them as they deem appropriate for their courses. This flexibility has the potential to make assessment results difficult to interpret since many variables may have an impact – amount of class time spent with the materials, other writing-related activities and writing feedback in the course, and the size of the class, to name just a few. Nevertheless, we want to assess effectiveness in realistic conditions, which include differences in instructor time and preferences. We record major differences in implementation and track whether they correspond to differences in assessment results.

Piloting of some materials is occurring at the same time that additional materials are being written. At the time of writing, about half the materials are still in development. We are also undertaking two additional steps to make the use of the materials easier: short screencasts that introduce the main ideas for each unit and sample answers for the revision practice, which instructors can post for students if they choose.

5. Findings about the Effectiveness of the Teaching Materials

5.1 Assessment Measures

The materials' effectiveness is judged from multiple perspectives. More specifically, we conduct four main assessment measures, as follows:

1. Genre Analysis. We analyze the presence, sequencing and effectiveness of functional units of texts within a particular genre. These functional units are identified by the purpose they serve (e.g. "provide context of project"). Trained raters code the effectiveness of each functional unit on a 0 to 3 scale with targets consistent with practitioners' use of the genre. The total score for each paper provides a general measure of how well the student achieves the functions that are required in the genre, how well the text follows the expected linear organization (without, for example, introducing new data when stating conclusions), and how well the formatting conforms to major genre expectations such as including a memo header for a technical memorandum. We compare pre- and post-intervention papers statistically with Mann-Whitney U or Wilcoxon Matched Pairs tests (non-parametric tests since the scores never have a normal distribution).

2. Linguistic Analysis of Individual Language Features. Each linguistic feature requires different analysis techniques. For sentence structure analysis, we categorize sentences as complex or not, compare the proportions in pre- and post-intervention papers with a χ^2 test, and examine a sample of sentences in context to see if sentences are used effectively. Assessing the use of accurate and precise words presents more of a challenge. Any word has the potential to be used inappropriately, but examining every word in context is too time-consuming for a large-scale study. For the results reported here, we compiled a list of 37 words that are often vague, absolute, unnecessary or inaccurate, based on previous analysis of student papers and faculty input. Occurrences of the words were examined in context. For example, *you* is accurate when referring to the reader (e.g. closing a technical memorandum to a client with *It was a pleasure serving you*) but inaccurate when it does not refer to the reader (e.g. *Using the graph, you can calculate...*). In the future, we plan to expand the list. (Other language features with other analyses are used in the project but are not included in this paper.)

3. Holistic Evaluation of Effectiveness. Engineering practitioners rate a sample of student papers using a simple 1 to 5 scale from "not effective" to "effective" - or, as translated by one practitioner, from "horrible" to "hire this person!" They are given basic information about the task and asked to evaluate based on what they know to be effective writing in workplace practice. Scores for pre- and post-intervention papers are compared statistically with Mann-Whitney U or Wilcoxon Matched Pairs tests.

4. Perceptions of Usefulness. Students are asked to complete a short survey about their perceptions of their learning and the materials' usefulness, or – if instructors prefer – to write open-ended reflections on their learning. The survey includes Likert-scale items for students' perceptions of the materials' usefulness and their learning, plus one open-ended

question requesting other comments and ideas for improving the materials. Trends in the quantitative and qualitative data are described but not compared to any pre-intervention data.

At the time of writing, the first full term of piloting was complete. Seven courses at three universities had piloted materials, using genre-based units and language units. (No grammar lessons had yet been piloted.) The courses included first-year introductory courses and senior-year courses in traffic engineering, geotechnical engineering, civil engineering project management, ethics, and the capstone design course. Class sizes ranged from 12 to 70.

The next section summarizes results for each assessment category. We also analyzed results for each course, but no patterned differences were found.

5.2 Results

The quantitative assessment measures consistently show improvements in student writing (Table 2). Every statistical measure was significant. Below we discuss a few noteworthy aspects of the assessment.

Table 2. Summary of Quantitative Assessment Results

Assessment Category		No. of courses (and levels)	Quantitative Results
1	Genre Analysis (Field Observation Memo and Forensic Analysis Memo)	4 courses (first year and senior level)	statistically significant improvement in effectiveness of rhetorical functions (p <.001)
2	Linguistic Analysis: Sentence Structure	4 courses (first year and senior level)	statistically significant reduction in complex sentences (p <.01)
	Linguistic Analysis: Word Choices	2 courses (first year)	statistically significant reduction in vague or inaccurate terms (p < .05)
3	Holistic Evaluation by Practitioner	4 courses (first year and senior level)	statistically significant improvement in scores (p < .05)
4	Perceptions of Usefulness	4 courses (first year and senior level	Mode = 3 (on 1-4 scale) "The materials were moderately useful. I learned a few new things and found some practice useful."

Genre Analysis: In the genre analysis, a particularly important improvement concerned describing the context and purpose in the opening of the memoranda. In pre-intervention papers, these functions were often omitted even though the assignments asked for an introductory paragraph. As illustrated in text sample 2A and 1B, students often jumped into information without giving readers any context or they gave an overly general topic introduction more typical of an academic paper. In contrast, most of the post-intervention papers opened with a concise

statement reporting who, what, where, why, and the purpose of the memo. As illustrated in text sample 2C, the post-intervention papers were not perfect, but they were far more effective than the pre-intervention papers.

Text Sample 2: Field Observation Memo Opening Sentences

Pre-intervention

A) Our hosts at the site were Lisa Wang, Doug Jones, Luis Fernandez, Sally Johnson, Tracy Carroll, Jeff MacIntyre, and Samuel. Lisa is a Civil Engineer for the Bureau of Environmental Services (B.E.S.) with a Professional Engineer (P.E.) license. Doug is also a P.E. and works for the Portland Water Bureau. ...

B) Within the field of civil engineering, there are many different types that go into the field, each different and unique in its own way. Some of these include structural, transportation, environmental and water resources. This Wednesday, October 23rd, I visited Anderson Engineering...

Post-intervention

C) Team Delta from the CEE101 Introduction to Civil and Environmental Engineering class visited Mercy Hospital at 4298 NW Franklin Park Rd on Thursday November 10th, 2014. The purpose of the visit was for students to learn about what Mercy Hospital has done to create and save their own energy and get an inside look on what makes a building sustainable. Tran Nguyen , the Chief Engineer for Mercy Hospital, gave our group a tour of the facility from roof to basement. Observations and discussion of the visit are presented below.

Sentence Structure: Besides a reduction in the frequency of complex sentences, there was an improvement in their use: no sentences stated the opposite of the intended meaning as occurred in pre-intervention papers. Despite the encouraging general results, however, some students continued to use complex sentences often and produced needlessly complicated ideas. A common problem was over-explaining information, perhaps in an attempt to demonstrate knowledge for the instructor. For example, this sentence from a senior-level paper uses an unnecessary dependent clause (in bold) containing an embedded relative clause (in italics) to define what "average" means:

Text Sample 3: Complex Sentence Structure in a Post-intervention Paper

Currently, the Manual of Uniform Traffic Control Devices (MUTCD) recommends that pedestrian clearance time should be based on the average walking speed of 4.0 ft. / sec **so that it may take in consideration pedestrians *who move more quickly or more slowly***.

In the future, student interviews might help clarify the motivation of students who continue to overuse dependent clauses.

Word Choice: The frequency of almost all the vague, absolute, unnecessary, and inaccurate words decreased. Particularly large changes occurred in the use of quantities and sizes (rather than vague descriptors like *a lot, many, warm*) and a reduction in *actually* and *great*.

The increased use of more specific and precise words had a positive impact on the meaning expressed in many post-intervention papers, as exemplified in these contrasting conclusions from field observation memos:

> Text Sample 4: Field Observation Memo Conclusion: Word Choice
> ***Pre-intervention*** (vague words underlined)
> The field trip was an overall success I think because it had amazing weather, great tour guides, and a lot of knowledge about engineering. This field trips [sic] are a lot better than sitting in the classroom and you learn a lot more actually going out and seeing how things are done.
> ***Post-intervention*** (more specific words underlined)
> This trip to the Tilikum Crossing was informative about the construction and planning portion of civil engineering. Also, it offered me a look at the engineering work being done in the city.

Despite the improvement in word choices overall, however, the results are disappointing from another perspective. Post-intervention papers continued to have high frequencies of certain vague or inaccurate words, especially *really* as an intensifier (*it is **really** helpful for us*) and *you* to refer to people or engineers generally. These words are already used as examples in the unit, but we plan revisions to give them more emphasis.

Holistic Evaluation by Practitioner: In the practitioner evaluation, the post-intervention papers as a group were judged significantly more effective than the pre-intervention papers. Nevertheless, there were pre-intervention papers that received a 5 and, more disappointingly, post-intervention papers that received a 2 or 3. The variation appeared dependent on the individual writer; that is, there was no sign that papers from a particular course or university received lower scores. A useful extension of the current study, which focuses on groups, would be an intensive study of individual students whose post-intervention papers receive low scores to investigate how materials can be more helpful to them.

Perceptions of Usefulness: In the survey about usefulness, in addition to the results shown in Table 2, 17 of the 20 respondents assessed their knowledge of writing in civil engineering as having improved at least one point on a five-point scale (none-poor-fair-good-excellent), and five of those rated themselves as improving two points from "poor" to "good." Only two students had suggestions: to include even more examples and more explanation.

The open-ended reflections provide additional positive feedback for the materials. After working on the sentence structure and word choice units and doing additional class activities concerned with standard grammar and proofreading, students were asked what had made the greatest impression on them and what they thought would be their greatest challenges in writing. About 90% of the comments reflected on the importance of writing, the conciseness of practitioners' writing, or the challenge of word choice. Typical excerpts include:

> *The information in today's class that made the biggest impression on me was...*
> - *how one little error can change the whole meaning of the idea you are trying to say.*
> - *how precise engineering writing has to be.*

- *that professional engineering writing had such simple sentences.*
- *that we don't need to be wordy to be a good writer.*
- *how different CE writing is than what I have learned in my English classes last year.*

I think the biggest challenge for me in writing for civil engineering will be...

- *eliminating flowery phrases and sentences. I used to think that longer, more elaborate sentences were better and would help me be good at technical writing. Now I have to work at getting rid of those extraneous words I tend to put into my writing.*
- *using precise, effective and concise language....I am usually too vague.*

Overall, the materials appear to challenge students' misconceptions and stimulate useful thinking about writing, in addition to promoting actual changes in students' texts.

6. Conclusion

There are several limitations to the current assessments. Only a small number of the materials have thus far been piloted. We also have not yet tracked students beyond the term in which they used the materials to see if there are lasting effects. More piloting and longer-term tracking of student writing is underway. Nevertheless, the initial piloting of the materials is encouraging. The evidence suggests that the materials help to improve student writing in ways that are important to civil engineering practitioners and they raise students' awareness of concerns typical in the workplace.

Faculty in the project also have had generally favorable reactions to using the materials. Some instructors have noted a striking improvement, especially after using genre-based units. Post-intervention papers were significantly better quality; the information was organized in a more coherent fashion, and the analyses and recommendations were clearer and more thoughtful. Grades were also considerably higher. Even when improvements are more gradual, instructors are pleased to see the development of students' professional writing skills, and they also find the project to be an effective way of incorporating alumni and industry feedback into existing courses. Faculty's anecdotal evidence for long-term improvement is also encouraging. At Portland State, where preliminary drafts of some units were introduced in courses four years ago, current seniors are perceived as having stronger writing skills than their predecessors, and faculty have received positive comments from practitioners about students' writing in internship applications.

As with many supplements to classroom instruction, the main challenge with the materials has been allocating time in a course schedule. We expect that the degree of improvement in student writing is proportional to the time spent with the materials (and any other writing instruction in the course). As the project continues, we hope to include more assessment of the impact of class time versus out-of-class work. For instance, do students who complete the materials outside of class improve as much as those who spend class time with the materials and exercises? Another challenge is handling students who transfer from community colleges or other programs. They have not had the more basic units that are typically used in lower-level courses, and already at one institution faculty perceive the transfer students to have weaker writing skills. We continue to work on how best to use the materials as transition tools for transfer students.

Finally, although it was not a specific goal, the project may also have some favorable consequences in industry. One project manager reported that, as a result of collaboration on the project, he was trying new reviewing techniques to help his junior engineers develop their writing skills. Another has started to consider writing-focused training workshops for all the junior engineers in the firm. All stakeholders – students, faculty, and practitioners – are reporting some initial benefits from the project.

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Appendix A: Excerpt from a Genre-based Unit

Opening of the Field Observation Memorandum information for first-year students

What is a Field Observation Memorandum (FOM)? Why do engineers use them?

Memoranda are used to convey engineering and technical information on a specific subject or design element. A Field Observation Memorandum reports and discusses observations from a visit to a specific site. Memoranda differ from reports in that they are usually short, 1- 4 pages, and focused on one particular subject. Typically, the audience for a memorandum is familiar with the project and has requested specific information. In some cases, memoranda are being replaced by emails. However, the information that is conveyed, particularly for a site visit, is the same.

Notice how your FOM assignment compares to the writing of a professional engineer.

	CE 111 Course Assignment	Similar Writing in Engineering Practice
Name of document	Field Observation Memorandum	Site Visit Observation Memorandum Field Observation Memorandum Field Report
Purpose	• To document your observations and learning in class field trips • To provide recommendations for the field trip in the future or feedback to the hosts	• To provide accurate and thorough documentation of pertinent observations at a project site, serving as the firm's or agency's "eyes in the field" • To document pertinent discussions with site personnel • To document issues and provide recommendations for the project
Audience	• Instructor for the course • Yourself (if you later need to refresh your memory) • Field trip host (potentially)	• Project manager, department manager or principal of a firm • The client • Regulatory authorities (potentially) • Attorneys, judges, juries (potentially)
Typical content & organization	• Has a memo heading specifying addressee(s), writer, date, subject, date • Opens with a concise statement of context and purpose • Contains a main body of text divided into Observations and Discussion • Often uses chronological organization for observations (what was observed first, second, etc.), but may need to follow other organization for greater coherence • Closes with reflections on learning and may include recommendations for the trip	• Has a memo heading specifying addressee(s), writer(s), subject, date, and project name and number. Some organizations may include other information (e.g. arrival and departure time, weather). • Opens with a concise statement of context and purpose • Contains a main body where observations (or test results) are clearly distinct from analysis, discussion, and recommendations. Exact organization may vary with a firm or agency's template. • Usually has chronological ordering for observations.

		• Concludes with a summary statement that addresses the reason for the site visit. If observing construction, concludes with a definitive statement concerning whether contractor was performing work consistent with recommendations. • Often closes with an offer to answer any additional questions.
Formatting	• Uses headings, header/footer, font, margins, and other formatting as specified by the instructor (below).	• Uses formatting specified by the firm or agency. May use a table, but most write a memo with format similar to the class.

Appendix B: Excerpts from Language Units

What do effective sentences by engineering practitioners look like?

A) Simple sentences have one subject and one verb phrase. (If you do not understand these terms, use Grammar Lesson #1 – Sentence Punctuation.) The subject and verb are close together.

Effective Simple Sentence Structure

Examples	Explanation
1. **The rainfall depth** was obtained from the City of Granson, County of Wilson. For the 25-year storm event, **24-hr rainfall depth** is 4.0 inches for the site. *(Report)* 2. **The south leg of the Sawyer Road/Matson Road intersection** provides access to a shopping center. **The appendix** contains the existing turn movement counts. *(Report)* 3. **The existing embankments and subgrade soils** consist of predominately cohesionless sand. Therefore, **temporary slopes** should be no steeper than 1.5(H):1(V). *(Tech Memo)*	Each sentence has one main idea. It has a subject (purple) and a verb phrase (red). The verb is close to its subject.

Figure B1. Practitioner writing examples in Unit 2: Effective Sentences - Simple Sentence Structure

Shouldn't words show how smart and sophisticated the writer is?

Some novice writers choose words because they want to "sound smart." If you have this urge, resist it. Usually, these writers lower the effectiveness of their writing because they choose words that are made up, inaccurate or imprecise. Consider this description of a visit to an engineering firm:

> Jenson-Smithford Engineering is one of the oldest and most proliferous firms in the industry... The fact that the entire presentation took place in the company's meeting room and not on its working floor lent a somewhat advertisemental feel to the visit.

In modern English, *proliferous* refers to plants' methods of reproduction and growth. *Advertisemental* is not a word. Instead of sounding smart, the writing sounds artificial.

Sometimes writers include words they think sound legal or official. Consider this use of *said*:

> Countries will begin to deplete their own sources and seek water elsewhere. Other countries will stand to profit from said needs.

Instead of providing an accurate description, the writer never states what the "needs" are. If anything, the use of *said needs* sounds like a parody of legal language. The writer sounds less professional rather than more competent.

When writers try to pick "smart-sounding" words, they usually obscure their ideas and damage their credibility. For effective writing, instead concentrate on expressing accurate content with precise, unambiguous words.

Figure B2. A "Myth Buster" from Unit 1: Word Choice for Precision and Accuracy (nontechnical information)

Technique 2: Refer to quantities and measurements.	
Original Sentence Needing Revision	Revision
The presenters showed us how to clean up a dirty site, which included a few steps with a lot of procedures. The first one was… (*Field Observation Memo*)	The presenters described how to remediate a contaminated site. They covered five steps, which each included six to eight procedures. The first step was...
Explanation. The original is vague and ambiguous. *A few* and *a lot* can mean many different numbers. The revision specifies the quantities. To increase accuracy, the revision also applies Technique 1, choosing a specific word for the intended meaning: • It replaces *showed* with *described*. There was a presentation, not a demonstration. • It also replaces *clean up* with *remediate* and *dirty* with *contaminated.* The original could mean sweep, straighten stacks of materials, or many other ways of cleaning a dirty place. In fact, the presenters discussed remediating contaminated sites.	

Figure B3. Example of a revision technique from Unit 1: Word Choice for Precision and Accuracy (introductory level)