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WIP: Improving Writing Instruction, Practice, and Feedback in an Introduction to engineering course

Dr. Shazib Z. Vijlee, University of Portland

Dr. Shazib (Shaz) Vijlee is the Associate Dean for Academic Affairs and an Associate Professor of Engineering at the University of Portland's Donald P. Shiley School of Engineering. He has Bachelor's and Master's degrees in Mechanical Engineering from the University of Texas (Austin). He received his Ph.D. in Mechanical Engineering from the University of Washington (Seattle). He has held various positions in industry (Boeing Phantom Works) and government (Sandia National Labs and Air Force Research Labs).

Dr. Vijlee has been at the University of Portland since 2014.

Molly Hiro, University of Portland

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Introduction

This Work in Progress (WIP) project's motivation was to create stronger engineering writers in the Donald P. Shiley School of Engineering at the University of Portland (UP) and to infuse the curriculum with a healthy understanding of and respect for good writing as an aspect of a successful engineering graduate. UP is fundamentally a liberal arts university with a robust Core curriculum. Still, students in the School of Engineering often don't recognize the importance of the liberal arts in their personal and professional development and formation. We wanted to create a more direct link between their Core and engineering curricula. In this case, we have started by focusing on writing, but we are continuing this work to help our students see the value in the rest of their general education.

The project focused on the first-semester course required of all students in the Donald P. Shiley School of Engineering. Students typically take EGR 110 in the fall of their first year (which means that most have not yet taken the introductory-level Core writing courses). All engineering students at UP take two Core writing courses (one in the English department called "Thinking Through Literature" and one in the Philosophy department called "Engaging Philosophy"). Students may take these alongside EGR 110, but never before EGR 110. Later in their education, engineering students take two additional courses (known as 'Writing in Discipline') to practice writing for their professional contexts.

Engineering faculty members teach 7-8 EGR 110 sections of approximately 30 students each (around 200 students total). The faculty and students cover all four disciplines offered at UP – Computer Science and Civil, Electrical, and Mechanical Engineering. Students design and build a tabletop wind turbine while learning engineering via five overarching topics: design process, hands-on skills, teamwork, ethics/impact, and communication. The entire course focuses on a single project introducing essential concepts over the semester. Over the last few years, the technical portions of the course have entirely transformed, and results have improved dramatically. The hands-on portions of the course are taught via short instructional videos for conceptual understanding of the skills needed. The students must then work together to build the functioning wind turbine based on the skills they learn in the videos. Students are more engaged, interested, and skilled after the course. This project aims to create a similar engagement in the building of writing skills in this course.

The writing in EGR 110 is mainly geared toward communication. Throughout the semester, students write reports that build upon one another and culminate in a final design report. EGR 110 instructors use common writing assignments and should provide some instruction on discipline-specific writing. But students' writing in EGR 110 is often substandard, and engineering instructors generally lack training in teaching or responding to student writing. We want to develop a systematic methodology for improving the writing of first-year engineering students without appearing to replace engineering content with writing content.

Students in their first engineering course do not typically want to spend time improving their

writing. They want to design, build, test, and analyze. They want to solve problems. They think that is all their engineering careers will involve. They tend not to value writing, no matter how emphatically we tell them it matters. So our aim was to improve basic writing instruction for first-year engineering students by faculty who don't feel comfortable teaching or grading writing, but also to lead students to appreciate the central role of writing as communication in their future engineering careers.

This project aimed to analyze the current state of writing in EGR 110 and design new course materials to address some deficiencies. As a Work in Progress (WIP), there is interesting data that helped direct the materials we developed. Still, we have not collected data to determine if the intervention has had an impact.

Methods and Approach

As stated above, this project's goal was to assess writing in the first-year engineering design course and to design a curricular intervention to improve student confidence in writing for subsequent courses. We assessed writing with four methods: 1) faculty surveys, assignment reviews, student work reviews, and compiling resources.

Faculty Surveys

One of the most significant motivators for this project is the faculty's perception of student writing. In many meetings where we discuss student performance, faculty regularly mention various aspects of student writing being inadequate. While the conversations are informal, they occur often enough that we thought it was worth a systematic analysis of faculty perception of writing. In a sense, whether writing is inadequate or not, faculty perceive it to be.

We surveyed the faculty of the Donald P. Shiley School of Engineering, with the following four questions:

1. In which areas of writing for engineering do you think students need the most improvement?
2. In which areas of writing instruction would you (as a faculty member) appreciate training and guidance?
3. Please rank the following topics for a first-year writing for engineering module:
    a. basic writing (sentence structure, grammar, etc.)
    b. concrete, clear, and concise sentences
    c. formatting using MS Word
    d. outlining and organizing writing
    e. proper use of tables and figures
    f. technical letters
    g. technical memos
    h. technical reports
4. Do you have any general comments about our writing for introduction to engineering project? (i.e., additional topics, ideas, etc.)

Questions 1, 2, and 4 were 'text-entry' used to gather open-ended feedback from respondents. Question 3 was 'rank order' and was used to determine each respondent's order of preference for the list of items.

Review of Writing Assignments

In EGR 110, there are four writing assignments – the Research Paper, the Project Plan, Design Report 1, and Design Report 2. The intention is that the Research Paper and Project Plan become the first two major sections in Design Report 1, and then Design Report 1 becomes the first portion of Design Report 2 (see Figure 1). We reviewed the four assignments systematically from two perspectives. A student reviewed the assignments to look for confusing instructions or unclear expectations, and a faculty member reviewed the assignments to look for pedagogical intentions and gaps in objectives. The student was an engineering major and an assistant in the UP's Writing Center. The faculty is a member of the UP's English department and the director (at that time) of the UP's Writing Center.

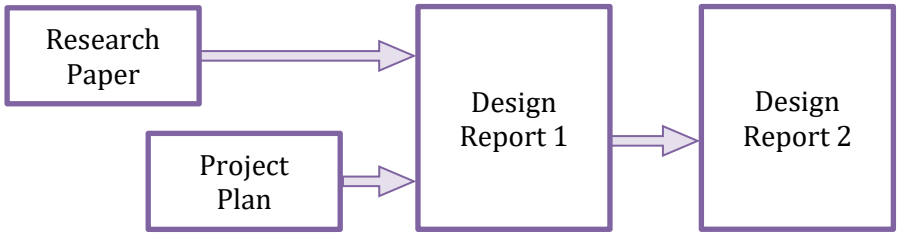

Figure 1: Writing Assignments in EGR

We taxonomized the systematic review output into categories of possible assignment improvements. We will discuss these improvements in the Results, Outcomes, and Discussion section below.

Review of Students' Submissions

As mentioned above, there are four writing assignments in the course. The Research Paper is submitted individually. Teams submit the Project Plan, Design Report 1, and Design Report 2. Table 1 shows the sample sizes for each assignment review.

Table 1: Sample Sizes of Student Submissions

Assignment	Sample Size
Research Paper	6 individuals
Project Plan	15 groups
Design Report 1	15 groups
Design Report 2	15 groups

We gathered student submissions from two EGR 110 sections with approximately 60 students. We reviewed all submissions for the Project Plans and both Design Reports. We reviewed a subset of the total Research Paper submissions and selected 1-2 at the high, medium, and low range of final scores. The undergraduate student completed the submission review.

Review of Resources

The faculty director of the Writing Center reviewed and compiled an annotated bibliography of approximately 20 print and online sources, including general writing guides, writing guides specific to technical or engineering writing, and pedagogical guides specifically for writing

instructors. Table 2 shows the categorized writing guides, with the full details available in the Bibliography. The goal here was to better understand norms of effective writing in engineering and to create a resource that could be used by engineering faculty who wished to learn more.

Table 2: Categorized Writing Guides (full details available in the Bibliography)

General Guides	**Pedagogical Guides**
Booth et. al., 2016 Graff & Birkenstein, 2017 Trimble, 2011 Warner, 2019	Bean, 1996 Giroux & Moje, 2017 Reynolds & Vogel, 2007 Smelser, 2001 Warner, 2018
Engineering Guides	**Online Guides**
Hart, 2005 Paradis & Zimmerman, 2002 Rosenberg, 2005	Kowalski, 1994-2023 Monash, 2022 Purdue, n.d. University of Iowa, n.d. University of Toronto, n.d.

Some of the most useful resources were:

- (Giroux & Moje, 2017) – defines "engineering literacy" and suggests ways for engineering faculty to design assignments to help students reach this goal
- (Reynolds & Vogel, 2007) – describes a concrete exercise that teaches students the importance of linguistic precision in engineering writing
- (Smelser, 2001) – introduces best practices for using peer review in engineering writing instruction
- (Rosenberg, 2005) – is an accessible guide to technical writing that focuses on concision, tables and graphics, and other "professional secrets."

These resources provided a foundation for the project outcomes, especially the student and faculty-facing writing reference sheets.

Results, Outcomes, and Discussion

The first goal of this work is to systematically analyze the writing instruction and student submissions in EGR 110 at Donald P. Shiley School of Engineering. We describe the analysis in the Methods and Approach section above.

The second goal of this work is to use the information collected from the analysis to design curricular interventions to improve writing outcomes in the first-year engineering course.

Results

We've organized the results into three categories: the faculty survey, the assignment review, and the student work review.

Faculty Survey

This work's first result was the engineering faculty survey about their perceptions of student

writing. Indeed, engineering faculty are not experts in writing, but they are experts in engineering and the professional norms of writing for that discipline. Regardless of their expertise in writing, they have opinions on student writing that we wanted to analyze systematically. When formalized, their opinions become graded feedback in our series of 'Writing in Discipline' courses.

Question 1 of the survey asked, 'In which areas of writing for engineering do you think students need the most improvement?' Three elements stood out in the comment-based responses. First, many mentioned that students need help understanding the differences between writing in the humanities and writing in the technical disciplines. Second, several comments focused on content organization at the paragraph and paper levels. Last, many commented on the specific skill of citing sources (ensuring they see the importance of doing it regularly and often, as well as following specific citation formats).

Question 2 of the survey asked, 'In which areas of writing instruction would you (as a **faculty** member) appreciate training and guidance?' Three elements stood out in the comment-based responses. First, the faculty would like help with how to grade writing and provide useful feedback, especially around the uniform use of rubrics. Second, the faculty would like help creating effective writing prompts and assignments. Last, faculty notice challenges around what to do when students start with varying writing proficiencies.

Question 3 of the survey asked faculty to rank several topics for the first-year writing for engineering module according to importance (8 = high importance and 1 = low importance). Figure 2 shows the mean results with the highest-ranking topics being 'outlining and organizing writing' and 'concrete, clear, and concise sentences.' Figure 2 also shows the standard deviations (SD) of the importance scores.

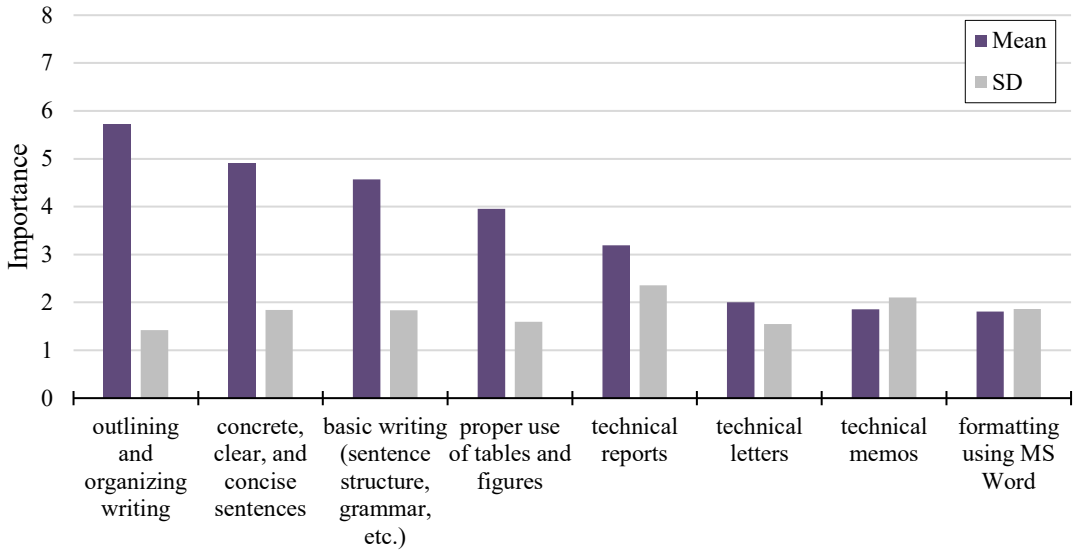

Figure 2: Faculty's Importance of Various Topics in the Course

Assignment Review

The second result of this work was categorizing common issues and problems in the assignment prompts and their instructions. Overall, the common issues in the writing assignments deal with

clarity of instructions and anticipating the ability of a first-year student to follow instructions and not necessarily being able to go beyond the instructions on their own.

The first key problem was the way assignments often include a numbered or bulleted list of questions students need to consider or topics they might cover in their papers. The intention of a list like this is to offer an array of questions or topics to think through in the prewriting process, but the (unstated) expectation is that students will end up with a focused idea/topic for the paper itself. Instead, students tend to just respond to the questions or topics, one at a time, in their writing. Therefore, this process of thinking, prewriting, and arriving at a focused topic needs to be explained more clearly. For example:

- in the Research Paper, the students answered our prompts as specific questions without thinking about which might be best for the task at hand or how they might change them as they form their ideas.
- in Design Report 1 and Design Report 2 the students largely used the outlines we provided, so the organization and readability of their writing improved because they were not mapping it out on their own.

The second key problem was the potential for disconnect between an assignment prompt and a rubric for evaluation. Ideally these should be crafted together, and the rubric can then be used as a tool for instruction in helping students understand how their writing will be evaluated. The best rubrics will empower students to craft well-written and well-organized papers without overly constraining their ability to organize it themselves. Ultimately, students at this stage in their technical writing careers need help in organizing their writing. Therefore, we felt that the rubric would best be used as an element in the scaffolded instruction on how to organize their papers.

Student Work Review

The third result of this work was categorizing common issues from student writing samples.

The first noteworthy issue was a lack of utilizing formatting rules that could help the audience. Specifically, students were not using conventions for citing works throughout the text or in an organized bibliography at the end of the document. The assignments explicitly asked for it, but the instructors assumed that the students had learned how to do it in high school. Another example is the improper use, or absence, of headings and subheadings to define the topic of discussion. Similarly, figures and tables were rarely captioned, labeled, or called out correctly (if at all). These were all included in the assignment instructions, but it is apparent that more work needs to be done to explain to students *how* to meet these guidelines.

The second noteworthy issue is the general lack of organization, flow, and focus in the students' writing. The students' writing was often a single long narrative with no signposts to aid the reader in understanding the organizational flow and focus. In many cases, the students did not use headings and subheadings to provide the reader with an overarching organizational indicator. Several examples considered the reader's knowledge base and assumed they were in our class. The writing would often jump from topic to topic within one paragraph.

The third noteworthy issue, which could be the overarching problem, is that students are not doing

technical writing yet. They are not aware of how challenging it is to describe an engineered system. They are not thinking about how to convey complex technical concepts in a clear, concise, and concrete manner.

One inspiring outcome of the student work review is that students improved their writing over the semester, even in the specific areas described in this section. Since the writing assignments build upon one another, the students (with instructor feedback) often made changes to improve their formatting, organization, flow, and focus.

Outcomes

This work resulted in three outcomes – revised writing assignments, instructional modules, and a reference sheet for writing in engineering for faculty and students.

The first significant change was an improvement in the assignments based on the analysis performed from the student and English faculty perspective (as described above). We revised the four assignments to improve clarity and provide more guidance for self-review before submission. Instructors should teach the new assignments alongside the revamped course webpages to help the students complete the assignment with more details, examples, and tutorials.

The second and most significant change was the creation of five short video modules to help students with writing-related issues. The video modules continued the asynchronous format used for the hands-on technical skills in the wind-turbine design project. The videos covered the following topics in this order:

1. Writing and the Design Process: It is a big-picture overview to help the students understand how writing our writing assignments are the same as our design process. The goal was to help them understand why writing was critical in this course.
2. Clear, Concrete, and Concise Sentences: It is an example-based video to help students notice bad sentences and improve them to write with more focus and be more direct.
3. Organized Writing: It is an example-based video to help students create organized paragraphs and subsections and use topic sentences to help the reader understand the flow of ideas.
4. Technical Writing: It is an introductory video on how to use visual aids, word choice, and audience awareness to improve the communication of technical material.
5. Common Formatting Issues: It is an introductory video about using page numbers, captions, citations, and headings/subheadings to aid the reader in understanding the content more easily.

The third improvement was the creation of a 'Principles of Writing in Engineering' reference sheet for students that will highlight the most important things to consider when writing in engineering. We also created an addendum to this sheet for engineering faculty to help them through the most common issues in teaching writing in this discipline.

Discussion and Conclusion

This work in progress aimed to improve writing in an Introduction to Engineering course. The project began by systematically and methodologically analyzing the course's current state and perception of writing. The second step was redesigning course materials as a curricular

intervention to improve writing outcomes.

The next step in this work will be two-fold:

- study if the interventions produced noticeable results in student writing outcomes.
- contextualize how the work is situated in the literature about first-year education in engineering and writing

Supplementary Materials

If you want to view the video modules or reference sheet, please contact Shaz Vijlee at vijlee@up.edu.

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