

Using Existing University Resources: Integration of the University Writing Center into a Senior-level Laboratory Series for Improved Learning Outcomes

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Abstract

In this work, the lead instructors for fall and spring senior-level chemical engineering unit operations courses worked with the existing Writing Center (WC) on campus to develop assignments, rubrics, and activities targeted at specific technical communication skills. Writing assignments were redesigned to incorporate revision into the technical writing process based upon feedback at multiple levels including feedback from instructors, peers, and facilitated by WC tutors. In-class technical communication workshops were developed and given by WC staff, incorporation of in-class peer review and revision occurred, and undergraduate WC tutors were trained and assigned specifically to students in these courses to review the students technical writing documents. Faculty feedback was that the student reports were improved over previous years and that grading was more streamlined and uniform due to the improved rubrics.

Introduction

Professional skills, including problem-solving, project management, team management, and communication, are highly valued in industry[1-3] and yet difficult to incorporate effectively into the curriculum. Skilled communication is tied to higher levels of career advancement[4] and surveys indicate that practicing engineers spend a large portion of their work time writing or speaking; however, feedback from industry indicates a lack of communication skills in many engineering graduates.[5] Therefore, so-called “soft” skills, recently redefined as “professional” skills, need to be learned within the engineering curricula and be transferable to the engineering workforce. As expected, communication is recognized as a core transferable professional skill,[2] which is reflected in current ABET criteria[6] and publications such as *The engineer of 2020*,[7] prompting pedagogical changes in engineering curricula.[8, 9] At the author’s institution, feedback from alumni surveys and the departmental advisory council also indicate a need for improvement of communication skills in graduates. The purpose of this work was to incorporate evidence-based effective technical communication instruction into the curriculum through a two-part series of senior level unit operations laboratory courses.

Technical writing instruction has been part of engineering education for many years. Early efforts typically resulted in stand-alone technical writing courses and publication of technical writing texts for engineers.[10] However, these interventions were not particularly effective[11] and technical writing instruction alone does not adequately prepare engineering graduates for the workforce.[5] Engineers need a broader range of transferable technical communication skills, both oral and written,[2, 4] and need to be fluent across platforms and in different contexts, including data representation and visual communication.[12]

The movement towards more effective teaching of communication skills to engineers has resulted in opportunity for collaboration with communication experts[9, 13] and the launching of Writing Across the Curriculum (WAC) or Writing in the Disciplines (WID) programs.[10, 14, 15] Interdisciplinary collaborations have occurred in many forms, including creation of stand-

alone courses,[16] embedding of communication experts as consultants in engineering courses,[17] and training of student technical writing peer tutors to aid in courses.[18]

In addition, student learning of communication skills is tied to quality of feedback;[19] however, engineering faculty do not typically have training in how to effectively give feedback on technical writing.[3, 19] For example, engineering faculty may tend to focus on spelling and grammar, while effective feedback is higher level, corresponding to issues with organization, the use of arguments, or support of evidence.[19, 20] Collaboration with communication experts for training is one approach to educate engineering faculty[21] and expert input can help develop more efficient feedback. Rubrics can also be designed to reflect skills targeted in the assignment and effectively evaluate technical communication.[3] Standardizing grading using rubrics will also help to streamline grading[22] and allow for more consistent grading across the multiple instructors. Well-designed assignments and rubrics can produce higher quality writing and reduce grading load.[21] After receiving feedback, students benefit from revising their work; however, engineering faculty do not always build revision into assignments.[23] Peer review is a way to build in revision, which improves writing.[24] It also aids in student learning and has been shown to be beneficial even for the person doing the reviewing.[24] In this work, many of these activities were incorporated into chemical engineering, senior-level laboratory classes in order to improve undergraduate writing skills.

Background

At Montana State University (MSU), oral and written communication training occurs primarily through a senior-level two-part sequential unit operations laboratory course series (ECHM 442 and ECHM 443), required for all chemical engineering majors. The ECHM 442 course consists of eight 50 min lectures, covering the basics of report writing and a refresh on statistics. The students, in groups of 2-4, perform two lab experiment rotations on a 4-week schedule. They have one week to write an experimental plan prior to the experiment and two weeks to analyze data and write a final technical report or executive memo following the experiment. The ECHM 443 course consists of two 50 min lectures. The first is an introduction that covers course format, schedule and structure, while the second occurs later in the semester and provides instructor feedback on technical reports. In groups of 4, the students perform two lab experiment rotations on a 5-week schedule. As a group, they prepare a written experimental plan, orally present the plan to their instructor for approval and perform the experiment. Then, the students complete data analysis and write a technical report or executive memo as individuals. Students also provide peer feedback on rough drafts of the reports.

In the Fall of 2018, the use of the on-campus Writing Center (WC) was incorporated in a senior-level laboratory class in the chemical engineering curriculum (ECHM 442). Extra credit was offered to teams and individual students if they attended a tutoring session at the WC prior to turning a report in. At the end of the course, an extra credit survey was given regarding the students' experiences with the WC, and the results were overwhelmingly positive. Of 120 students in the course, 92 completed the survey and 72% of the students agreed with the statement "Overall, the visits to the Writing Center made me a better writer overall." Additionally, 91% of respondents felt that the WC improved the quality of their lab report (Figure 1). From the instructor's standpoint, the WC was able to help students submit a more

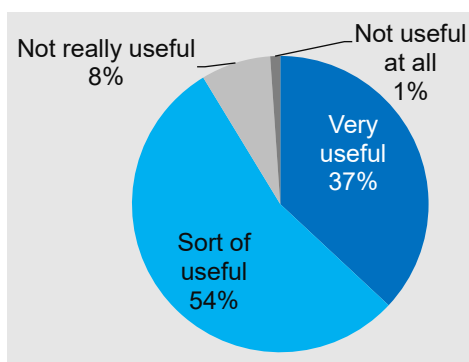


Figure 1: Student responses of 92 to the question “On a scale from 1 (not useful) to 4 (very useful), please rate the usefulness of the Writing Center to improving your lab reports.”

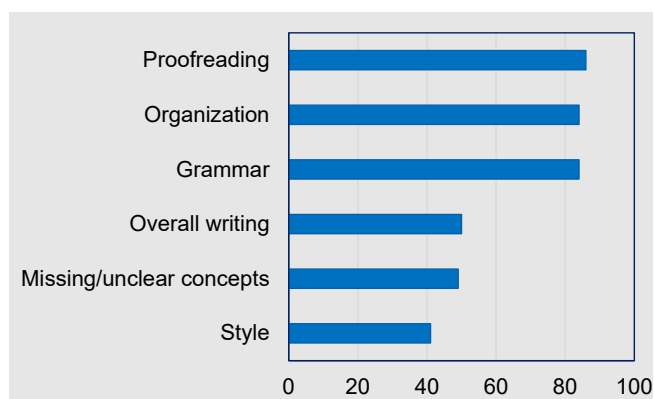


Figure 2: Student responses of 92 to the question “What did the Writing Center help you with? (Check all that apply)”

complete final product. The students also felt that the WC helped in this regard, as 90% of respondents said the WC helped with proofreading, organization, and grammar (Figure 2). Based on the positive experiences with the WC, the laboratory instructor sought out a more formal relationship with the WC.

During the same semester (Fall 2018), the lead instructors of both senior-level laboratory course applied to the WC’s “Writing Across [the University]” program. The goal of the program was to provide \$5,000 grants to STEM faculty in order to develop curriculum that integrates writing and, in particular, the WC into their course design. As part of the grant, a collaboration with the WC was formed, which included a three-day Teaching Writing Workshop and monthly workshops hosted by the WC.

Our rationale for submitting a proposal was to improve integration of writing into the chemical engineering senior laboratory courses through collaboration with the Writing Center. We were interested in integrating more effective technical writing assignments into the senior-level ECHM 442/443: Unit Operations course sequence in order to better meet our ABET assessment outcomes, which includes “Develop technical writing and oral communication skills.” *More importantly, we wanted our students to be better prepared for the demands of their careers. As seniors, they will soon enter the workforce. Based on quality of the current required lab reports, we felt there was room for improvement in the students’ technical writing skills and in the effectiveness of the writing assignments themselves to target what engineers really need – an ability to do clear, concise technical writing. Our goal was to collaborate with the Writing Center to develop writing assignments and rubrics as well as support writing throughout the course using Writing Center tutors and guest lecturers.*

Writing Center collaboration

The Writing Center hosted a cohort of STEM faculty in a three-day writing workshop, as well as monthly lunches, resulting in mutual learning about engineering writing process and what is valued in discipline specific technical writing. Following group discussion, each faculty worked with Writing Center staff individually. For the laboratory series, specific course rubrics were developed to more accurately assess identified values and associated learning outcomes. The

courses and assignments were scaffolded to build student skills in technical communication. Homework assignments and in-class workshops, facilitated with the Writing Center and with Writing Center tutors, were targeted towards the different aspects of technical communication.

In the first course, students learned about communication with different audiences and writing in discipline specific genres. Lectures and in-class iClicker questions focused on different parts of reports, how audiences differ, and experimental design. Additionally, the WC staff gave two workshops focused on “Concision and Clarity” and “From Idea to Final Draft: A Writing Process for Chemical Engineers.” With the second course, the focus shifts to precise and concise technical communication and sorting through information for relevance. WC staff hosted two workshops on “Revising for Relevancy and Organization, Accuracy and Precision” and “Preparing an Executive Memo”. Two undergraduate WC tutors were assigned specifically for the 442 and 443 courses. The tutors helped facilitate workshops and worked directly with students in tutoring sessions. In 442, extra credit was offered for a group meeting with a WC tutor. Peer feedback was integrated in the 443 course in order to build revision into the writing process and improve student learning. Students from different groups exchanged rough drafts of reports and WC tutors facilitated feedback sessions between the students. Integrating existing university resources of writing experts into a writing-heavy course benefited both the instructors and the students.

Results

Firstly, the WC helped the lead instructors in terms of professional development and improving the way the instructors looked at their courses. Lunch topics such as “How we Talk about the Writing Process” and “Writing in Your Discipline” and the discussion that resulted brought to light many writing considerations that the instructors had not considered. For example, ensuring that the homework and reports align with the learning outcomes and goals. Although the discussions with other faculty was beneficial, just having discussions with experts on writing greatly improved the course and could be done at any institution.

Additionally, the expertise of the WC greatly improved the grading rubrics for the course. With the help of the WC, we were able to determine what each report focused on (e.g., audience, purpose, results) and develop a rubric that had a point distribution that match the goals of the report. With targeted rubrics intentionally designed, course continuity was improved and student learning of progressive skills was more easily scaffolded. Instructor perception was that the rubrics improved grading times, and future work includes grading reports from previous years with new rubrics and comparing scores to confirm learning was improved.

Workshops presented by WC staff explicitly included writing instruction and emphasis on what was important in technical writing and the process of writing. The workshops also included time in-class for students to work on and revise work, with the help of WC staff, designated WC tutors and the course instructors. This structure therefore incorporated active learning and explicit technical communication instruction that was not included in the course previously. Future work will evaluate the impact of these workshops on the quality of writing.

In 442, the students worked in groups of four and received extra credit for setting up a group meeting with a WC tutor prior to submitting their report. They could receive extra credit for the tutor reviewing their experimental plans and corresponding final reports for each of the two labs, for a total of four extra credit opportunities. Of 99 students, an average of 74 students received extra credit for the first three opportunities. For the fourth, and final, opportunity, only 34 students visited the WC tutor, likely because grades were somewhat finalized as that was the last assignment. Student feedback of the WC tutors was overwhelmingly positive and feedback from instructors indicated improved technical writing by the students.

The required WC tutor-facilitated feedback sessions in 443 gave the students the opportunity to give and receive oral feedback, facilitated by a tutor, and then to further provide and receive written feedback. The facilitated session was intended to keep student feedback constructive and at a higher level, i.e. focused on organization, clarity and reasoned arguments rather than grammar and spelling. One student confirmed to an instructor that this was the case and higher level comments were observed in the WC tutor summaries and written feedback graded by instructors. In previous offerings of the 442 and 443 courses, students had not received guidance on how to give feedback and comments tended to focus on the easier to fix errors such as grammar and spelling. Teaching the students how to provide feedback to other should not only benefit the other students, but also will benefit them in evaluating their own writing.

Conclusions

The engineering faculty involved in this work greatly benefited with the WC collaboration discussed in this paper. Assignments were better designed, rubrics were improved to make grading reports faster and more standardized, and the writing-intensive courses involved were scaffolded as to not repeat learning outcomes and enhance student learning. Although the time and cost commitment may be prohibitive to many faculty, the “Writing Across [the University]” program was greatly beneficial to the instructors from the Chemical Engineering department. Some takeaways that are less time intensive would be to encourage faculty with writing intensive assignments, but not a writing background, to have a discussion with writing experts. Even just one hour of discussion made a surprisingly large impact on assignments and the course objectives. The WC had resources on topics such as rubrics, feedback guidelines, and the writing process that instructors may not be aware of. Advertising the resources available to faculty on campus through guest speakers at department meetings, within their courses, or even through email may improve utilization of the resources and improve their teaching.

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