The Use of Professional Technical Writers for Evaluating Capstone Student Writing

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Engineering capstone courses often include a number of writing assignments. The purpose of these assignments is typically to guide students through the engineering design process and provide means of evaluating their progress and performance. While the engineering content of these assignments is of primary importance, the quality of the technical writing is also deemed important to the course outcomes. However, effectively grading the individual student writing assignments can be challenging for course instructors and in large-enrollment classes it may simply be impossible to both effectively and thoughtfully grade the papers in time for prompt feedback. Also, capstone instructors may lack the writing skills to evaluate the quality of the writing and provide meaningful comments to the students for improvement. Alternatives such as the use of full-time writing co-instructors or graduate teaching assistants has been found to be ineffective as the workload occurs in surges that overwhelm the graders. Thus, the Oregon State University School of Mechanical, Industrial, and Manufacturing Engineering capstone course uses a pool of part-time professional technical writers as writing graders. This approach has been found to be an effective means of providing quality, timely feedback on capstone individual student and team written assignments. Scoring variation among the three technical writers is addressed using a common rubric and statistical correction of grades. Overall, the approach provides a good solution to the challenges of grading student writing in capstone.

Keywords: Capstone, Grading, Writing, Professional

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Introduction

Engineering capstone course assignments often include significant written content. This content can include short status briefs, several-page progress updates, and multiple-chapter final reports. Such content is appropriate since capstone has been shown to be a suitable venue for reinforcing student communication skills.[1] However it has also been shown that excessive written content can over-emphasize communication content, have unintended consequences[2], and detract from technical focus[3]. Regardless of whether a capstone course contains a large amount or a small amount of writing assignments, effective and timely grading of them is important and can be challenging.[4]\

Currently, a number of approaches are commonly used for grading capstone writing assignments. The most obvious is to simply have the capstone instructor grade the writing assignments. This can be a good solution for small-enrollment courses. However, even small-enrollment courses need an instructor with suitable expertise in technical writing for this approach to excel. An expertise in the technical aspects of capstone does not correlate to an expertise in grammar and other related knowledge needed to truly excel in grading student writing assignments. Large-enrollment courses sometimes use graduate teaching assistants to grade student writing. If engineering graduate students are used, then the problem of possibly deficient writing expertise remains. If non-technical (e.g. English literature) graduate students are used, technical expertise is typically lacking.[5] The use of research professorial faculty advisors in grading can appear to be an attractive option since both technical and writing skills are typically possessed. However, since it is highly unlikely that professorial staff report to the capstone instructor such an approach is likely to be unreliable and highly inconsistent. A final approach often pursued is the employment of a writing instructor to co-instruct the class with the technical instructor.[6] This also can work, but if the need is simply to grade student writing (i.e. a co-instructor is not needed for other aspects of the course) then the writing instructor will likely find they have too little work between assignment due dates and too much work when papers are submitted for grading.[7]

The capstone program in the School of Mechanical, Industrial, and Manufacturing Engineering (MIME) at Oregon State University (OSU) over the past 10 years has pursued each of the approaches described above. None have provided a truly excellent solution to the problem of

providing high-quality grading of student writing quickly in a large-enrollment course (i.e. return graded papers to students within a week of submission for a class of 100-150 students).

In response, the OSU MIME capstone course has pursued the approach of hiring a small pool of part-time professional technical writers for the grading of student-written documents. The remainder of this paper will describe the writing assignments of MIME capstone, the problem faced in effective and timely grading of them, how the hiring of part-time professional technical writers was implemented, and the results to date.

Writing Assignments in the MIME Capstone Program

The OSU MIME capstone course contains writing assignments to guide students through the engineering design process and evaluate their progress and performance. The primary writing assignments have varied between years, but typically include the Scope and Research Statement, Design Proposal (draft version), Design Proposal (final version), and the Final Project Report. These are formal technical reports and are rigorously graded for both content and the quality of the writing.

The Report Grading Problem

Grading the Scope and Research Statement, Design Proposal (draft and final versions), and Final Project Report for content and quality of the writing is a significant undertaking. The Scope and Research Statement contains a description of project requirements and relevant background in addition to related designs. It is individually written (i.e. each student submits a unique document) and must contain at least 1000 words. The Design Proposal contains a description of the proposed solution and is also individually written. It consists of a draft and final version each containing at least 2000 words. Both are formally graded. Grading of the draft version provides feedback to be incorporated into the final version. The Final Report provides an overall description of the project with results. It is team written (i.e. each team submits a unique document) and contains at least 4000 words. The Scope and Research Statement and Design Proposal are individually written so that MIME capstone qualifies as an OSU Writing Intensive Course. Effectively grading each of these four documents typically takes 30 to 45 minutes for each submission. In Fall term 2019, one section had an enrollment of 129 students and a 79 students, which are typical enrollments. Combining these enrollments with the estimated grading times results in total grading times of 40 to 100 hours each for the individually-written reports (Scope and Research Statement, Design Proposal Draft, and Design Proposal Final). Experience has shown it is highly desirable to perform this grading and return the papers to the students within a week of submission. It is simply not possible for the instructor alone to be responsible for performing all of this grading.

Professional Technical Writers as a Solution

In several ways, professional technical writers are an ideal solution to the problem of grading capstone reports. They have the needed skills, are accustomed to working on deadlines, and often do copyediting. Furthermore, many are part-time and/or self-employed and can readily adapt to the irregular work schedule typical of a capstone course (i.e. a significant number of billable hours in some weeks, as well as long periods with no billable work).

However, professional technical writers typically do not have experience in teaching a college-level course. Thus, they require training in the use of grading rubrics and other details associated with a senior-level engineering course with formal writing assignments. Research has shown that without focused training even experienced industry engineers grade differently than university engineering faculty.[8] This lack of teaching experience and training is also addressed through the current practice of having the technical writers only grade papers via electronic submissions, and thus have no direct, in-person student contact.

In order to provide a consistent framework for grading, detailed rubrics were created for each of the reports graded by the technical writers (i.e. the Scope and Research Statement, the Design Proposal, and the Final Project Report). Each rubric consists of five sections: Assignment Fit, Organization, Focus, Audience, and Writing Convention. Assignment Fit evaluates the extent to which required specific content for a particular report is provided (e.g. a description of the existing designs and approaches is included in the Scope and Research Statement). For the Design Proposal (final version) this section also includes an evaluation of the extent to which feedback provided through grading of the draft version was implemented. Organization evaluates the inclusion of introductions, conclusions, and transitions between topics. Focus evaluates clarity and conciseness. Audience evaluates tone and technical level. Writing Convention evaluates adherence to standard technical writing conventions. Full-text copies of the currently-used rubrics can be obtained by contacting the Corresponding Author of this paper.

The report grading process was further simplified through the creation of the MIME Capstone Writing Style Guide. The technical writers participated in the creation of this Style Guide. It contains a number of sections describing proper technical writing conventions and guidelines. When grading papers, markup largely consists of simply highlighting an error using digital editing tools within an Acrobat Reader file or through the

use of embedded grading rubrics within the course's Canvas Learning Management System (LMS). Additonally, a number is provided that references a section within the Style Guide that describes the error. It is the students' responsibility to reference the style guide and determine the error and correct it throughout the paper.

The technical writer hiring process followed normal OSU procedures. A position description, summarized in Table 1, was created through the required administrative approval process. A hiring committee was formed, the position was posted, interviews were conducted, and offers were made and accepted.

Table 1: Summary of the position description posted on the OSU website for the hiring of technical writers.

Position Title:
Technical Writing Evaluator (Unclassified Faculty)
Minimum/Required Qualifications:
- Experience as a technical writer in industry, government sector, or related setting. - Demonstrated mastery of standard written and spoken English. - Demonstrated ability to provide constructive feedback and attention to detail for reviewing student work. - Demonstrated interest in encouraging and facilitating discipline-specific writing skills development. - Ability to work within an established course/curriculum structure. - Ability to meet deadlines, set priorities, and work independently. - A demonstrable commitment to promoting and enhancing diversity.
Preferred (Special) Qualifications:
- Current or recent employment as a technical writer for industry, government, or related setting. - Master's degree (or higher) in technical writing, engineering, or related field. - Experience with teaching writing in classroom and/or industry setting. - Prior experience with college-level instruction and assessment.
Working Conditions / Work Schedule:
Position is part-time and off-campus. Primary duty of grading must be completed by the required deadlines but no other schedule is required. Secondary duties of attending meetings and communicating must be performed promptly and as scheduled. All work can be conducted online.

The Results

The approach was first implemented in Fall term 2017 with the hiring of three professional technical writers. The only problem which has occurred that has required corrective action regards the grading variability among the three graders. Despite using the same grading rubric and participating in the same training, there is unavoidable variability in the scoring among graders. The first approach taken in OSU MIME capstone was to randomly distribute the student papers among the pool of graders. However, since each paper was graded by only one of the three graders, variability in grading can lead to unfairly high or low scores for students. This problem was addressed in two ways. First, if one grader's mean report grades were consistently significantly greater or less than the others then that grader was provided with individual additional training. Second, for each report submission, the mean assignment grade and the corresponding standard deviation were calculated for each grader and a statistical correction was made, as needed, to student scores. The course instructor determined the specific method of statistical correction used, however the z-score approach was recommended. Example statistics for the Fall 2019 Scope and Research Statement report for one section of MIME capstone are shown below in Table 2.

Table 2: Example grading statistics for the Fall 2019 Scope and Research Statement report for the three technical writers employed by OSU in MIME capstone.

Grader	**Mean [%]**	**Standard Deviation [%]**	**Number of reports graded**
One	82.4	6.4	40
Two	87.1	6.7	40
Three	87.6	13.5	46

Experience indicates that the use of professional technical writers has long-term sustainability. In terms of staffing, replacements have been readily found and hired when needed. In terms of cost, due to their part-time status the professional technical writers are collectively considerably less expensive to employ than the previously-used full-time writing instructor.

Beginning in Fall 2021, a new capstone instructor was hired, bringing several changes to the course structure. However, the professional technical writers and the critical writing assignments remained the same. This provides a means to compare the data from the technical writer evaluations between course changes to determine if they remain statistically similar. For the Fall 2021 term, two of the previous three technical writers were still employed to evaluate the same assignments as before. The results of their grading, presented in Table 3, show

that over time the technical writers have become quite familiar with normalizing their grading of the assignments.

Table 3: Example grading statistics for the Fall 2021 Scope and Research Statement report for the two technical writers employed by OSU in MIME capstone.

Grader	Mean [%]	Standard Deviation [%]	Number of reports graded
One	91.00	7.83	104
Two	90.97	6.41	105

Student response has been positive. Prior to implementation of this approach, student complaints about report grading were common. Since implementation these complaints are greatly reduced or eliminated. A MIME capstone instructor stated "*I don't recall seeing a single anonymous comment from end-of-the-term evaluations where the grading process was an issue. In fact, the entire writing part of the class has settled down to a point where the students seem fine with it*." Three other current or prior MIME capstone instructors, each with extensive capstone teaching experience, stated this was the best solution to report grading they had experienced. In some cases, students are expressing appreciation for the noticeable time and effort put into grading their papers. Students have also expressed appreciation for the timely grading and returning of submitted reports.

Conclusions

The hiring of part-time professional technical writers for the grading of student written documents in the OSU MIME capstone course has been a success. It provides high-quality and timely grading of capstone student writing. While training is required and statistical correction of scores is needed to address grading variability, the use of part-time professional technical writers is now the preferred approach in OSU MIME capstone. The authors recommend other capstone programs consider this approach.

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