Capstone Design CONFERENCE 2024
JUNE 3–5, 2024 ▶ KNOXVILLE, TENNESSEE

Expanding the Use of Technical Writer Evaluators for Writing Intensive Course Requirements in Multidisciplinary Capstone

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In previous papers, Oregon State University has outlined their work using Technical Writing Evaluators (TWEs) in the grading process of individual reports required in the School of Mechanical, Industrial, and Manufacturing Engineering (MIME) Capstone Program. In short, TWEs provide technical writing expertise at a part-time hire opportunity, reducing the personnel requirements needed to support capstone grading. This paper serves as a follow-up to those efforts, emphasizing the use of the TWEs in the addition of a Multidisciplinary Capstone Program (MCP), an alternative course progression for MIME students and other Engineering majors, as well as another interdisciplinary capstone program within the University's College of Engineering: the Civil and Architectural Engineering (CE & ARE) program. This paper presents the results of adding a new TWE to the cohort, distributing their efforts between multiple sections of MCP, and what training was required to normalize the scores between all three evaluators. Insights into similarities and differences between the capstone programs in relation to the grading procedures are discussed.

Keywords: writing, grading, multidisciplinary, transdisciplinary

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Introduction

The decision by Oregon State University (OSU)'s College of Engineering (CoE) to create a Multidisciplinary Capstone Program (MCP) was born out of the desire to create an additional opportunity (but not a requirement) for students to participate in an experiential learning course, that sought to tackle broadly scoped problems which require both discipline specific technical experience and perspective. For this program, Multidisciplinary is defined as a team comprised of students from different majors (e.g., mechanical engineering, computer science) offered within CoE.

The benefits of multidisciplinary problem solving are well documented both in peer reviewed and popular literature[1-3]. In addition, multidisciplinary teams are positioned to explore possible solutions to highly complex, often unsolvable issues. At a large scale, some call them "grand challenges", for example, the problems associated with the Global Issues defined by the United Nations[4]. When problems defy one's ability to develop simple solutions, or are unsolvable due to their complexity, they are sometimes termed, "wicked problems"[5]. However, challenging students to consider, at least, a component of a solution may cause unexpected challenges during the course, as this type of multi-dimensional thinking is likely different from what they're used to in earlier curriculum, providing the students with unique problem-solving opportunities.

OSU requires that each of their baccalaureate degree programs includes a Writing Intensive Course (WIC). The stated motivation of a WIC is that "students need to learn to write as members of the discipline or disciplines in which they have chosen to major … through inquiry-based writing in the discipline, students gain understanding and knowledge of disciplinary goals and concepts.[6]" For example, through the chemistry program's WIC, students majoring in chemistry learn to write like chemists. The OSU CoE has chosen to designate capstone senior-project classes as the WICs for all engineering majors.

All WICs must satisfy three learning outcomes, including developing critical thinking in the discipline through practice of writing, understanding convensions and audience expectations in communication within the discipline, and documenting multiple aspects of the writing process through multiple revisions[6].

The intent is that, in satisfying these additional WIC learning outcomes, the underlying engineering course's technical learning outcomes are neither reduced nor compromised. However, in practice this can be challenging. An overly zealous pursuit of WIC learning outcomes can compromise technical excellence. This occurred in the OSU School of Mechanical, Industrial,

and Manufacturing Engineering's (MIME's) capstone course particularly in the 2015-16 academic year as described in detail in a 2018 Capstone Design Conference paper[7]. For example, the 2015-16 MIME course contained eleven written papers graded by a staff of five people requiring up to five hours for each of 50-60 papers. In addition to drawing resources away from the pursuit of the technical learning outcomes, this burden of writing also directly affected student design decisions. The considerable written documentation required to describe design changes strongly discouraged students from making design improvements following prototype testing.

In response, the MIME capstone course was significantly changed in 2016-17 to restore the focus on technical excellence. It was acknowledged that the pursuit of WIC requirements had been compromising the technical content of the course. It was accepted that while the WIC learning outcomes would be met, they would not be greatly exceeded as had been the case. For example, the number and length of written assignments was reduced to meet but not greatly exceed WIC requirements. Staffing changes also occurred.

At the peak, MIME capstone employed a writing graduate teaching assistant, a Capstone Writing Instructor (a full-time position) and a Communication Curriculum Director (also a full-time position) for the grading of papers (in addition to the course instructor and an engineering graduate teaching assistant). With the reduction in writing assignments and the restored focus on technical content this staffing was excessive. A better solution was needed. The solution chosen was to replace the teaching assistant and two full-time writing positions with part-time Technical Writing Evaluators (TWEs).

The TWEs are professional technical writers for whom MIME capstone is typically just one of many clients. This approach retains highly competent graders, with expertise in a relevant domain (e.g., mechanical engineering), but provides only the hours needed and specifically when they are needed. The use of TWEs in the MIME capstone course is described in detail in a 2022 Capstone Design Conference paper[8]. As described in the paper, the approach is highly effective.

A key aspect of the TWE approach is their participation in creating and maintaining the MIME Capstone Writing Style Guide. This document, entirely written by the TWEs and fulltime MIME personnel, specifically and concisely covers the writing guidelines and conventions appropriate for mechanical, industrial, and manufacturing engineers. It embodies the goals of a WIC.

Since it was first implemented in the 2017-18 academic year, the TWE approach at OSU has expanded and evolved. While it remains a key part of the MIME capstone course, it is also used by the college-level MCP course and the Civil and Architectural Engineering (CE & ARE) capstone course. In MIME, some of the original TWEs have moved on to other positions and replacements hired. The purpose of this paper is to provide an update on the OSU CoE TWE approach. Specifically, it will describe the process for on-boarding a new TWE, address the challenges of adapting the MIME TWE approach to multiple sections of a college-level MCP course and a CE & ARE course, and normalization of grading.

Training of New Technical Writer Evaluator

The increase in capstone student numbers (49% growth from Fall 2022 to Fall 2023) in the School of Mechanical, Industrial, and Manufacturing, led to the need for an increase in the number of TWEs. In the previous paper[8], the authors outlined how two current TWEs had very similar grading results across their work in over 100 students each. It was therefore important to ensure that the additional TWE added to the cohort would be able to produce similar results. The following subsection outlines the steps taken to train the new TWE so that anyone interested in bringing on their own TWEs have an opportunity to visualize the onboarding process.

The newly hired third TWE completed all general onboarding training required by the university at large in order to be added to current capstone courses within the Learning Management System (LMS) used by Oregon State – Canvas. The third TWE was added to one of the capstone courses mid-way through the Spring term with no pressure to start grading that term. The expectation was that training would be done during Spring term, with follow-up during the summer before using them to their full extent in the upcoming Fall term. This allowed a low-pressure learning environment to acclimate to the grading process. Most TWEs hired for this position are not familiar with grading, which allows the ability to teach them according to the program's specific expectations (meaning no bad habits to break here).

The new TWE spent approximately two weeks in Spring term familiarizing themself with the LMS, Canvas, through unstructured exploration in the course Canvas website and by taking numerous Canvas tutorials that specifically taught how to use the embedded grading system. Several example papers from the Spring term's capstone were identified and given to the new TWE as good training opportunities – an example of an A/B-level paper and B/C-level paper were given to the new TWE. No information was given to the TWE regarding the level of the papers given to them so they would not be biased towards any expectation of how much to comment/grade (i.e. they did not know that one was an A/B-level paper and one was a B/C level paper). This proved to be very beneficial in the learning process based on feedback from the TWE – they specifically noted that they appreciated not having any initial bias in grading expectation. The

new TWE was given two weeks to review and mock-grade the two papers, then a Zoom call was arranged to debrief on the results of the mock grading exercise. In this particular case, the new TWE trended towards harsher grading and much more in-depth comments in the grading than the current TWEs. This was expected since they only had two papers to grade over a two-week period. By comparing the new TWE's grading to the current TWE's official grades for each paper, the new TWE was able to understand expectations for using the grading rubrics and the Writing Style Guide.

The training process was fully completed during Spring term and the new TWE joined the current two during the subsequent Fall term. During the fall term, the TWEs grade two major assignments, each of 1,000-2,000 words. After the grades for the first assignment were completed halfway through the term, one paper was selected to be reviewed by all three TWEs to determine if their grading was aligned like previous years. Via email exchange, the TWEs and lead capstone instructor confirmed their grading practices aligned. This is further proven in the grading averages between all TWEs presented later in this paper.

Addition of Multidisciplinary Capstone

MIME capstone in Fall 2023 fielded 21 teams with 107 students in its capstone program. The two sections of MCP (that utilized the same TWEs as MIME) were comprised of 119 students, and 17 different projects. One section, "MCP Aero", contained projects that fall within a top-level classification of aeronautical and astronautical engineering. These teams focused on a combination of collegiate competitions, exploratory research, and industry sponsored directed research. The second section, "MCP Multidisciplinary", primarily focused on both exploratory research and industry sponsored directed research, along with a single collegiate competition team.

Because of the similarities of the MIME and MCP student/course learning outcomes, the common WIC requirement, and the project timelines (i.e., a two-quarter course progression in series), the addition of TWEs was a logical next step. And, as the TWEs all had experience reviewing content outside of CoE (e.g., chemistry), it was hypothesized they could assess multi-author papers who have been trained in writing styles that align with their major. However, there were concerns that, because of the increased scope of work and problem complexity (including so-called wicked problems with no singular solution as mentioned in the Introduction), MCP teams would incur additional challenges when documenting their efforts, possibly failing to coalesce their individual contributions into a single document. To ensure that all students were set up for success in writing convention expectations, the MIME Writing Style Guide was adapted slightly to represent an MCP Writing Style Guide.

Additionally, student teams that participated in collegiate competitions were allowed to submit project reports that were mostly derived from their respective competition written documentation requirements.

No issues in the different types of teams were noted within the individual reports graded by the TWEs for the WIC requirements, providing evidence for a successful implementation of TWE grading within MCP. Anecdotally, conversations with the TWEs and capstone course instructors showed no outlying concerns between courses to address. The quality of writing in all the assessed courses (MIME and MCP) were on par with each other based on average grades for the last major individual assignment, called the Design Proposal. This analysis of averages in presented in the next section.

Comparison of MIME and MCP grading

To ensure fair equity among grading between the three TWEs in the MIME and MCP sections of capstone, basic statistical analysis was completed between the three TWEs. These results are presented in Table 1 below based on each TWE's overall average grade for the first WIC writing assignment submitted halfway through the Fall term.

The data between the three TWEs in Table 1 show that all three are aligned in their grading efforts in the first graded assignment. These averages include all three sections combined – two sections of the MCP capstone and one section of MIME capstone. Further analysis was done based on whether there were differences in the average scores between the three sections, as can be seen in Table 2. The values represent the average of each TWE's grades for the individual writing assignment for that section of capstone.

Table 1: Grading Averages between TWEs in MIME and MCP Capstone

TWE	Papers Graded (n)	Average	Standard Deviation
A	77	92.0	5.3
B	75	89.4	5.7
C	75	92.3	5.9

These basic results show initial evidence that the three TWEs provide consistent grading between multiple types of multidisciplinary capstone students and projects. It also provides interesting initial evidence of high-quality output in the MCP teams compared to the established MIME program. This could potentially be because of several factors such as higher motivated students pursue the challenge of multidisciplinary projects or the MCP

project teams are selected first based on preference forms and could potentially get the highly motivated students before other projects are teamed. Future analysis may investigate the differences in motivation between MIME and MCP teams.

Table 2: Grading Averages between three Capstone Sections in MIME (n=35-37 per TWE), MCP Aero (n=23-24 per TWE), and MCP Multidisciplinary (n=16-17 per TWE)

TWE	MIME		MCP Aero		MCP Multidisciplinary	
	Ave.	St. Dev	Ave.	St. Dev	Ave.	St. Dev
A	90.5	5.2	92.5	5.6	94.8	3.8
B	88.7	6.1	91.1	6.3	93.6	2.8
C	92.2	5.1	92.3	7.1	92.7	5.5

Addition of CE & ARE Capstone

The interdisciplinary Civil and Architectural Engineering (CE & ARE) capstone expands on the use of a TWE with technical writing support and instruction for students, faculty, and graduate teaching assistants. Project teams include students working in three or more of these disciplines: water resources, geotechnical, structural, transportation engineering, lighting, mechanical systems, and building envelope design. CE & ARE capstone faculty adopted MIME's model for TWE grading of key assignments and worked with WIC program staff to adapt and further develop the TWE's role in the two-term capstone experience. Grading typically includes two or three assignments each term. These writing assignments are focused on non-technical topics such as leadership, teamwork, and conflict resolution. The TWE also supports the rest of the instructional team in their grading of design reports and other design development work. A revised CE & ARE Capstone Writing Style Guide and improved rubrics provide greater clarity for students and graders. TWE-guided discussions in instructional team meetings help graders with consistent interpretation and implementation of the rubrics. Student support includes TWE office hours and instruction. Each term, two weeks of recitation sessions are devoted to TWE technical writing instruction and help sessions.

The use of a TWE in the CE & ARE capstone shows a somewhat different, but equally valuable use of TWEs in writing intensive capstone course requirements. The TWE in this case provided numerous other roles within the mentorship and assessment of capstone students. Due to the differences between the CE & ARE TWE and the TWEs used in the MCP and MIME capstones, comparative statistical data was not included here. However, anecdotally the CE & ARE TWE's contributions strengthen the students' capstone experience with respect to WIC learning outcomes.

Conclusions

This paper presents the efforts by three different capstone programs within the College of Engineering at Oregon State University to use Technical Writer Evaluators in the grading process. An additional TWE was onboarded successfully for the MCP and MIME capstone program and results show equity among the grading between similar course writing requirements. The CE & ARE capstone program uses another TWE in a different, but equally important role within the writing intensive course requirements for the university. The use of technical writer evaluators has been very successful within these capstone programs.

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