The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
ASEE
Paper ID #43797

# (Re)visions: Approaches to Teaching Technical Communications and Professional Development in a Multidisciplinary Engineering Capstone Course

**Lynn Hall, The Ohio State University**

Lynn Hall is a Senior Lecturer and the Associate Chair for Academic Administration for the Department of Engineering Education at The Ohio State University. She received her Ph.D. in English from Miami University (Ohio). Her research interests include writing in the disciplines, technical communications, and diversity, equity, and inclusion.

**Mr. Bob Rhoads P.E., The Ohio State University**

Bob Rhoads currently functions as the Multidisciplinary Capstone Program Director for the Department of Engineering Education at Ohio State University. He has a Bachelor of Science in Mechanical Engineering from Ohio State University and Masters in Business from Regis University. He has 11 years of glass manufacturing industry experience and over 15 years of teaching experience in higher education.

**Tyler James Stump, The Ohio State University**

Tyler Stump is a first year Ph.D. student in the Department of Engineering Education at The Ohio State University. Tyler received his B.S.in Biosystems Engineering at Michigan State University in 2022 and received his M.S. from Michigan State University in 2023. His engineering education interests include first-year engineering student experiences, computing education, fostering mastery-based learning mindsets, and assessments.

# (Re)visions: Approaches to Teaching Technical Communications and Professional Development in a Multidisciplinary Engineering Capstone Course

## 1. Introduction

Integrating writing pedagogy-based practices and instruction into capstone curriculum demonstrates the interconnectedness of the disciplines. While engineering programs and alumni of those programs report a need for technical and professional communication skills as part of their career success [1]. Success in their careers will depend on their ability to clearly communicate their work in a variety of modes to a range of audiences. However, engineering programs are faced with challenges when it comes to agreeing on how, who, and when to teach technical and professional communication [1]. Further, there is a disconnect between engineering student perceptions of writing as "less important" or secondary to their technical skills and the alumni recognition of the importance of these skills [2]. Providing students with one to two college composition courses in their general education courses provides a foundation, but an added emphasis on writing in their disciplines prepares students more broadly to understand that different communities (fields) require fluency in the genres and conventions of that field to develop as a professional [1]. With this in mind, the authors embarked on a (re)vision to an existing multidisciplinary capstone course to develop a truly integrated approach to writing in the disciplines [1] with the development of sociotechnical engineers in mind.

This paper shares how the authors have found opportunities to meet these professional needs by integrating a faculty member with a Ph.D. in English and background in writing pedagogy and technical communication as a member of the instructional team alongside the course's existing engineering faculty. We will share the modifications made to the course, the rationale for those changes, and some of the preliminary data regarding student perception of the development of both their collaborative and technical communication skills throughout the two-semester course sequence. Our hope is to provide one model for the interdisciplinary future of engineering education because redefining multidisciplinary goes beyond simply enhancing the technical aspects of pedagogical courses; it involves harnessing knowledge and disciplines to elevate both teaching methods and collaborative efforts among peers. The authors' hope is that this effort serves as a model program for integrated, multidisciplinary instruction that can be adapted across engineering programs.

## 2. Background

An ever-growing need and interest in developing sociotechnical engineers who can communicate technical solutions in social contexts to diverse groups of people serves as a daunting task for engineering programs to accomplish [3,4]. Universities and colleges often employ interventions in individual courses such as team teaching and inclusion of communication modules as well as more program-wide interventions in the form of elective writing courses and/or embedded communication student outcomes across the program from first year to senior capstone [1]. Fundamentally, the approach of how to integrate such interventions into the classroom has been variable and grounded in the philosophical assumptions of the definition of the sociotechnical.

Smith et al. (2021) conducted a study to understand and provide taxonomy to the different approaches in which four unique models are considered for the integration of sociotechnical skillsets for engineering students [5,6]. The integration of communication into engineering is a common feature in all to better develop sociotechnical engineers [6]. The concept challenges traditional engineering culture that separates the technical engineering work from the social context, including the ways in which engineers communicate with broader audiences to solve problems.

To support the call of moving towards the development of sociotechnical engineering, researchers identified that researchers and educators approached the definition of sociotechnical engineering in four primary ways that provides potential theoretical assumptions in the approach chosen to develop a "sociotechnical" engineer. The four forms of approaching the development of sociotechnical skillsets in engineers are: independence, mutual shaping, pervasive social context, and sociotechnical integration. The forms differ in how the technical and social components influence and are situated according to one another. Independence is the traditional form in which the social considerations are situated parallel and separate from each other, which is traditionally how the development of engineers has been instructed in the past. Mutual shaping is the second form that describes social and technical being distinctly separate considerations but influencing each other. The third approach describing pervasive social context is the concept that social and technical are two distinct lists of skills and considerations; however, the technical considerations are embedded within the social landscape. An example of this is in the integration efforts described by [7] where the author can be quoted as describing their integration approach as, "I am experimenting with a hybrid model of freshman composition, a situated writing class that has one foot in general rhetorical principles that cut across academic writing and another foot situated well within engineering." The author describes the considerations for communication and engineering to be distinctly separated with the writing being situated in engineering social contexts. The fourth approach, sociotechnical integration, considers the complex nature of problems that require not just the influence of skillsets to one another but a complete alignment in which social considerations are embedded and influence the technical solutions. Researchers have been exploring the intersection of these four approaches, intentional interventions, unique classroom contexts, and student outcome data to better understand how these interventions work to support student learning in technical communication and more broadly their sociotechnical development.

The use of student perception data to better understand pedagogical interventions for technical communication learning outcomes has been explored before in contexts such as freshman year writing courses [7], design courses [7] and laboratories [8] connecting theoretical lectures to hands-on practice. However, the context provided within this study aligns itself more with practices and norms found in industry for professional engineering workforce opportunities as opposed to academic, which have been found to have different technical communication demands. Craig et al. (2008) investigates three case studies for student experiences through iterating a communication assignment highlighting the need for iterative feedback in the course to support student learning [8]. The same study also leverages an understanding of collaboration and faculty perspectives on assessment alignment that also supports the guidance and development of courses with communication learning outcomes for students. This study also shows how student experiences and perceptions can be used to guide and drive pedagogical change. Faculty experiences in developing first year composition courses for engineers has also been considered in guiding the alignment with learning outcomes, assessments, and intentional pedagogy that confirm the need to be intentional in the activities selected, the assessments of technical communication outcomes, and the development of writing practices for students [7].

Despite laboratories and first year courses being considered heavily within the literature, the senior capstone has been identified as an area underexplored in its efforts to support such intentional pedagogical interventions for technical communications with unique opportunities to impact student workforce preparedness.

In recent years, studies have found that researchers have scoped the purpose of the engineering capstone design course to be the space in which to help prepare students for their careers, enabling smooth transition to professional practice [9-11]. Researchers have gone a step further in considering what the transition looks like for engineers as they move from a senior student to an entry level worker in the engineering field. Ford et al. (2019) provides a better understanding of the experiences that engineering students face in the introduction phase to the work phase by characterizing how and to what extent the design capstone course prepares students for engineering workplaces [12]. Technical work and teamwork/communication appeared as emerging themes from the qualitative analysis of student experiences. These findings also showcase barriers students face when entering the workplace in which students frequently leaned into their senior capstone design experience to navigate those complex challenges within the transition into professional practice [12]. The study reinforced previous concepts in which the focus for preparing sociotechnical engineers in their technical communication continues to be a priority while insufficiently preparing other students for the challenges experienced in the transition from student to professional practice [13]. As such, domestic engineering programs have integrated a senior design capstone course to provide authentic experiences and opportunities for students to engage with skills for sociotechnical engineers such as the ever growing need to improve engineering technical communication [14,15].

The challenges of adequately preparing students for this demand in sociotechnical skillsets has been studied by researchers both for general capstone design courses for engineers only and for those that are multidisciplinary beyond engineering disciplines [9,16,17]. The "2015 Survey of Capstone Design" [16] not only highlighted the ever-growing focus on technical communications within capstone courses, but also outlined the ubiquitous challenge of intentionally modeling capstone design courses to prepare students. In the survey however, the concept of multidisciplinary is one that refers to the diverse kinds of engineering majors and how they interplay with one another in capstone projects but does not include capstone design models that serve students beyond engineering disciplines in true multi-disciplinary experiences. The survey also exposed growing interest in co-teaching capstone design courses suggesting that exploring how diverse faculty expertise can be leveraged to better support student learning and professional preparation [16]. This aligns with other studies that state, "there is a strong need for faculty themselves to have such experience or to integrate industry partners or elsewhere who can provide perspective" [18]. Even upon developing a class, the consideration for what pedagogically to prioritize becomes an ever-growing call to action to better support engineering capstone design contexts, especially with the growing need to work in *true* multidisciplinary teams of expertise beyond engineering. The context of engineering capstone design courses has been studied and postulated with potential mechanisms of support such as guidance on providing quality feedback to students and considerations for how to develop students as complete communicators [16,19]. Studies have investigated secondary mechanisms to better equip students with authentic opportunities to engage in design and technical communication such as leveraging sponsored projects from industry [16,20]. Goldberg et al. (2014) suggests best practices for opportunities to manage industry participation and support when constructing pedagogical activities for students to engage with invited guest lectures. However, the study focuses more on strengthening those partnerships and does not speak much to the pedagogical model or mechanisms within it for student learning [20]. A systematic review recently published on the current state of multidisciplinary engineering education. Researchers investigated programs that provided opportunities to authentically engage in multidisciplinary teams; however, the study found that instructional strategies and pedagogies were understudied compared to other thematic categories. The study also showcased that program and course design was a priority for ASEE papers but lacked clarity in guidance for innovative models to construct these classrooms [21].

Thus, this study presents a pedagogical model that investigates an industry-project motivated senior capstone design course that leverages collaboration with both engineers and non-engineers. The model presented in this paper is an attempt to better understand student experiences with pedagogy guided by sociotechnical integration. The social consideration of technical communication is taught by being embedded with technical problem solving within a senior design multidisciplinary team-taught capstone course.

## 3. Multidisciplinary Model

At The Ohio State University, the Multidisciplinary Engineering Capstone implemented an interdisciplinary teaching model beginning in autumn 2020. The model includes three co-instructors for the two-semester capstone course sequence. The instructors are the Director of the program with a mechanical engineering background, a senior lecturer with a civil engineering background and a senior lecturer with an engineering technical communications background who was also the Director of the Engineering Technical Communications team. All three instructors are part of the Engineering Education Department within the College of Engineering where the Multidisciplinary Engineering Capstone is offered to students from across the College. The course is taught as an instructional team where the co-instructors attend all classes and share the class lecture delivery based on their expertise. This model is an example of a team with different backgrounds working together with a common goal for the students as they themselves work in teams with other students from different majors and experiences. This adds value to both enriching the student experience and providing expertise to the course success. The instructors also provide feedback on student written work and oral presentations from an integrated technical and writing/communication perspective. The instructors meet to discuss their individual assessment of student work to consolidate and give cohesive comments to students. Grades are also determined jointly by the instructional team, considering a sociotechnical approach by embedding technical communications into engineering design.

The Multidisciplinary Engineering Capstone course learning outcomes (Table I) include topics from technical design to technical communication to professional practice.

Table I: Multidisciplinary Engineering Capstone Learning Outcomes

| **Learning Outcome** |
| --- |
| 1. Perform Professionally |
| 2. Produce Quality Designs |
| 3. Establish Team Relationships for Quality Performance |
| 4. Manage Project Schedule and Resources |
| 5. Apply Knowledge, Research and Creativity |
| 6. Make Decisions Using Broad-Based Criteria |
| 7. Use Contemporary Tools |
| 8. Test and Defend Design Performance |
| 9. Communicate for Project Success |
| 10. Pursue Needed Professional Development |

The instructional team divided lecture content based on their respective expertise. For example, the engineering faculty lectured on the engineering design process and technical aspects of the course while the technical communications faculty lectured on written and oral communication as well as professional practices within the workplace. In addition to lectures, the instructional team developed in-class activities for the student project teams related to the day's lecture topic. These activities were related to the progression of the respective team's project. Some of the activities included the creation of a problem statement, identification of user needs, development of design requirements, writing for different audiences, scoring of conceptual design, creation of a project schedule and identification of project risks.

When assessing student assignments, the instructional team modified existing or created new rubrics that addressed both the technical and the communication aspects of the project. The instructors focused on their respective expertise when grading assignments. As mentioned earlier, the instructors would then meet to discuss their assessment of the assignment and collectively determine rubric scores. This provided the students with a well-rounded view of assessing their work and providing feedback to improve their technical design approach and the communication of their design work.

The Multidisciplinary Engineering Capstone is offered to many engineering disciplines from across the College of Engineering. In addition, the course is offered to non-engineering majors who are completing an Engineering Science Minor where students need to collaborate with an engineering capstone project. This collaboration is typically completed through the Multidisciplinary Engineering Capstone course sequence. For this paper and distributed survey, 68 respondents completed the first survey, representing seven engineering majors and fourteen non-engineering majors as demonstrated in Figure 1 and Figure 2.

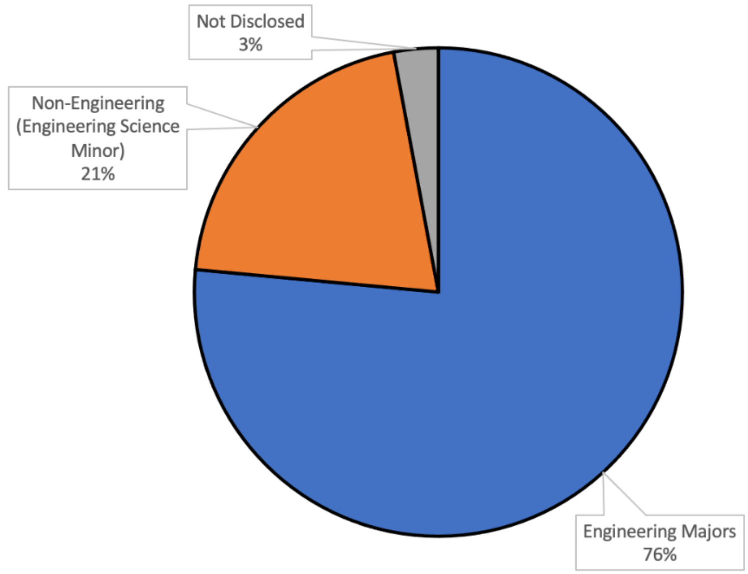



Figure 1. Identified Academic Major of Survey Respondents

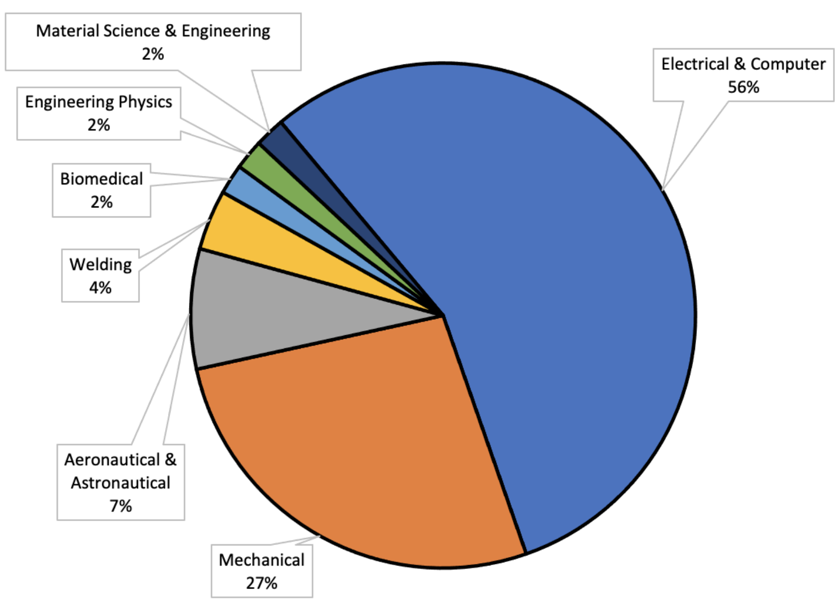



Figure 2. Identified Academic Engineering Major of Survey Respondents

## 4. Writing Specific Pedagogical Changes

The need for technical writing and professionalism instruction in capstone courses, especially with the transition from academics to early career engineers is well documented. The novel approach in this capstone course was to embed a co-instructor whose focus was to make interventions specific to improving student writing outcomes and to work with students throughout the year-long course specifically on technical and professional communication outcomes. An added layer of urgency to this model, was the University's modification of its general education curriculum which effectively reduced the number of writing courses students are required to take as part of a focus shift to embedded literacies, including advanced writing. This change, along with availability of AP English courses in high school, meant that once the new general education curriculum was fully rolled out, some students could reach their degree capstone courses without taking a college-level writing course with disciplinarily focused instruction and feedback.  This became an added challenge in teaching writing in engineering contexts, in addition to those outlined in [1].

In this context, the newly embedded technical communications faculty began with a review of all course materials and curriculum, including all existing lecture slides, assignments, and rubrics. The revisions discussed here were made beginning with the first year of implementation and have been continually reviewed and modified as needed to align with the instructional team's overarching goals of (1) creating opportunities within the existing class structure for students to iteratively practice their written and oral communication skills in a range of common professional genres, (2) embedding peer feedback, (3) providing revision opportunities based on instructor feedback, and (4) improving course outcomes through transparent assignments and rubrics.

*Course Materials*
The course's Design Guide was revised from PDF to an online textbook format using PressBooks with the goal of creating a reference that guided students through the goals and expectations for documentation at each stage of their design process. Additions included expanded descriptions of requirements and callout boxes to support student process. For example, chapters begin with an explanation of the goal of that chapter of their design report (Figure 2a) and end with "important notes" (Figure 2b) as reminders or items to be considered. Finally, "connections" boxes (Figure 2c) were added to encourage connections and connectedness between the design guide, class assignments, and the corresponding stages of the design process.

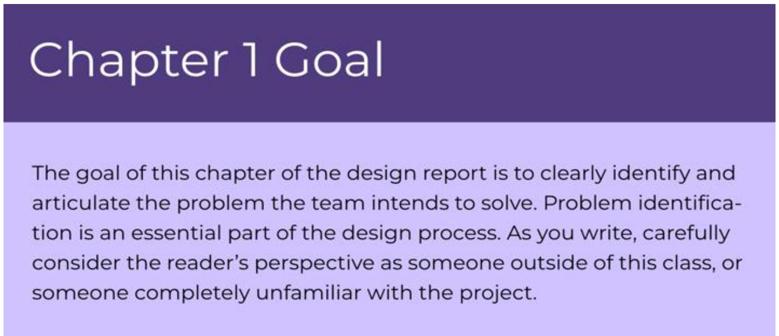
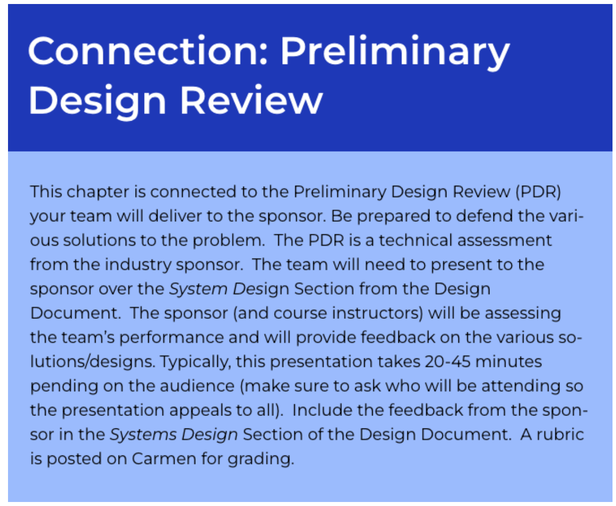


Figure 2a. Sample Chapter Goal in Course Design Guide


IMPORTANT NOTE

All teams are required to discuss the social, environmental, and global issues associated with the potential solution. Having a well-researched grasp of these things at the problem definition stage will help inform the project **and** make it easier to discuss these things later in the project and report.

Figure 2b. Sample Notes Section of Course Design Guide


Connection: Preliminary Design Review

This chapter is connected to the Preliminary Design Review (PDR) your team will deliver to the sponsor. Be prepared to defend the various solutions to the problem. The PDR is a technical assessment from the industry sponsor. The team will need to present to the sponsor over the *System Design* Section from the Design Document. The sponsor (and course instructors) will be assessing the team's performance and will provide feedback on the various solutions/designs. Typically, this presentation takes 20-45 minutes pending on the audience (make sure to ask who will be attending so the presentation appeals to all). Include the feedback from the sponsor in the *Systems Design* Section of the Design Document. A rubric is posted on Carmen for grading.

Figure 2c Sample Connections Section of Design Guide

In addition to the design guide revisions, the following topics were added to the course schedule:

- Writing for audience and purpose
- Using common professional genres (emails, memos, reports)
- Writing in technical communications style
- Preparing and delivering presentations
- Creating research/project posters
- Designing documents for end users
- Providing peer feedback
- Developing effective graphics
- Using the 5 C's of technical communication (Concision, Clarity, Coherence, Correctness, Confidence) to improve writing

These communications-focused lectures were added either as dedicated lectures or as part of existing lectures focused on the engineering design process, including problem identification, user needs and requirements, concept design development, detailed design creation, prototype build/test plans and implementation, and final design.

All lectures were made available to students as reference materials, along with a new Communications Hub resource repository, in the course learning management system. Materials were designed to align with student progression in the year-long course. For example, students learn about writing for audience and purpose at the beginning of the first semester and cover best practices for common genres as they will encounter them for their project documentation and presentations.

Similarly, lectures were supplemented with individual activities like writing problem statements and evaluating communication scenarios (for example, reviewing an important PowerPoint slide related to the Columbia space shuttle disaster and two reports that were produced after the fact for two different audiences) to provide active learning and low-stakes practice opportunities and to foster team building.

*Assignments and Rubrics*

As part of the review of existing assignments and course structure, the embedded technical communications faculty member assessed where writing interventions could be added to the flow of the course without adding too much additional work for students or faculty. This resulted in:

1. Adding status memos where each team member, in rotation, took turns sending out weekly agendas, leading meetings, taking minutes, and communicating project status via the memo genre.
2. Embedding points in assignment rubrics dedicated to revision to incentivize students to review and incorporate changes based on previous instructional feedback.
3. A peer response activity for student presentations where each student in the class was guided in providing feedback to other teams' problem identification presentations.

Additionally, assignments and rubrics were revised to be in alignment with the transparent methods provided in M.A. Winkelmes' Transformation in Teaching and Learning framework [22]. These interventions include aligning the assignments with the newly revised Design Guide, creating assignments in the learning management system that include providing a purpose, instructions/tasks for each assignment (Figure 3), and a rubric that clearly identifies and explains the grading criteria for each assignment (Figure 4).

**Design Document Chapter 1: Problem Identification**

**Purpose**

The goal of this chapter of the design report is to clearly identify and articulate the problem the team intends to solve. Problem identification is an essential part of the design process. As you write, carefully consider the reader's perspective as someone outside of this class, or someone completely unfamiliar with the project. Treat every chapter of your design document as an artifact for future readers.

**Instructions/Guidelines**

1. Start by reading Chapter 1: Problem Identification in the Design Guide for guidance on what to include in Chapter 1 and as a checklist when you have a draft.
2. Use the work your team has done thus far and course resources (lectures, activities, etc.) to develop your content.
3. Incorporate feedback received from presentation as needed.
4. Every person on the team must have a hand in drafting and editing each chapter of the design document.
5. Draft FIRST, revise/edit second.
6. Use technical communication style and best practices for content.
7. Your document design is an important part of facilitating audience understanding and building/maintaining credibility with that audience.
8. Check your drafted chapter against the rubric as part of revision.
9. Complete final polishing and editing.
10. Upload PDF version here.

Figure 3. Assignment Instructions Revised for TILT

**Design Document (PI) (1)**

You've already rated students with this rubric. Any major changes could affect their assessment results.

| Criteria | Ratings | Pts |
|---|---|---|
| CH1 PI: Technical Writing & Document Design<br>The Problem Identification is written with audience and purpose in mind. In addition to members of the instruction team, the PI is a permanent part of the final documentation for the course and will be seen by advisors and industry sponsors.<br><br>Writing and document design attend to needs of busy reader by using appropriate sentence length, accurate headings, and bullets/lists in order to effectively aid readability and comprehension. Transitions between paragraphs and sections should be logical and easy to follow. All graphics and tables are appropriate to context, are well integrated, and are labeled correctly.<br><br>All research, whether primary or secondary, is effectively incorporated and cited in either APA or IEEE citation style.<br><br>Writing and document design follow 5Cs of Technical Communication (concision, clarity, coherence, correctness, confidence). Demonstrates careful attention to spelling, punctuation, and grammar. Word usage is correct. | This area will be used by the assessor to leave comments related to this criterion. | 10 pts |
| CH1 PD: Project Management<br>The problem identification includes explanation of project milestones achieved thus far and planned. Specific areas of concern are addressed for upcoming work (think next month or so), including any associated recommendations | | |

Figure 4. Assignment Rubric with Added Descriptive Grading Criteria

Modifications to the course materials, assignments, and rubrics were made based on research done on the benefits of transparency in teaching and learning in improving student outcomes [16].

## 5. Student Commentary

*Data Collection & Analysis*

In the Multidisciplinary Engineering Capstone course, a survey tool was developed and implemented by the researchers. The survey was given three separate times during each academic year for three years (2020-2021, 2021-2022, & 2022-2023). The survey was designed to capture student perceptions specifically contextualized within a primary learning outcome of the course, technical communication The survey probed students to consider three domains of knowledge, the first question asked students to describe their experience (past/present) with technical writing generally. The second question asked student to detail how their technical writing and professional skills might improve in hopes of identifying what aspects of technical communication students saw the largest room for improvement in. The third question for student perceptions asked student to detail how, if at all, their technical writing and professional skills *have* improved since the beginning of the course sequence. Students complete the survey during the first week (of the first semester), fifteenth week (of the first semester), and final week (of the second semester) of the course sequence to identify student perceptions throughout the 2-semester capstone project. To identify preliminary results, the data from most recent offering of the course (2022-2023) was analyzed to identify student themes that were emerging for the experiences impacting and preparing students, the items student hope to improve on, and what items of technical communication were perceived as improved by students.

Generalized shared perceptions were the goal of the data analysis in hopes of understanding common perceptions impacting students regarding technical communication. Thus, student responses qualitative data was analyzed to identify themes, or shared topics of categorizes, as described by through thematic analysis methodology [23]. Descriptive coding was leveraged in the analyses in which this schema of coding assigns labels to data that summarize words or phrases to take inventory of the topics described [23, pg. 65]. Descriptive coding was conducted through two analysis passes of the collected survey data. The researchers collected 188 unique responses achieved between the beginning survey (68 responses), the mid-survey (62 responses), and the end survey (58 responses). These responses were analyzed deductively to investigate how students perceived technical communication within the Multidisciplinary Engineering Capstone course. The qualitative coding was done using Microsoft Excel by a single researcher. However, this study serves as the initial stage of the study investigating the (re)visions to the course in which data collection in this stage is focused on student perceptions of their communications ability over the year. The findings will later support further investigation into student activities being analyzed for their technical ability in their student design reports prior to the model being redesigned as well as the reports post the implementation of the (re)envisioned model. The preliminary findings of student perceptions in response to the survey can be seen below.

*Results*

As seen in Table I, there is no explicit learning outcome for technical/professional communications; however, technical communication is embedded within these outcomes such as "Manage Project Schedule and Resources". This requires students to consider how to disseminate writing within a team and organize team meetings to support the project's goals. The findings of this analysis have been able to showcase how technical communication is perceived by students as well as the forms of technical writing in which students are exposed to prior to the course. The first question probing students to describe their prior and present experiences with technical communication highlighted the shared experiences of students and their prevalence within the students taking the course. The emerging themes of this first question showed that students are primarily exposed to email, technical reports, and presentations in which these were the most frequently discussed forms of technical communication. Others include more niche forms that align with career goals such as a student talking about their publications in hopes of pursuing a career in academia. Students were dominantly exposed to these forms of classes through the classroom in which the students pre (68 respondents), mid (62 respondents), and post (58 respondents) spoke in classes providing them experience within technical communication 105 times. Other experiences such as Co-Ops and Internships also were frequently discussed by students in responses such as, "I have held internships in which I had to write technical reports based on financials. I am very experienced in writing professional emails and other forms of communication." In this response, a student specifically focused on financial technical reports as it relates to their career interest. These insights provide course instructors with an understanding of the forms of experiences students have entering the course as well as the priorities they have for forms of technical communication.

Student perceptions for technical communication practices or concepts that students were hopeful to achieve were captured in the analysis of the second question. Students were found to show an interest in items such as improving conciseness in their writing as well as being provided numerous opportunities to engage with technical writing and being given feedback consistently as well. Other themes included aspects such as active voice in writing, clarity, formatting, memo writing, style, structure, organization etc. The interesting aspect to these findings is that the lecture created to improve technical communication provide a high amount of overlap with the student perception of their needs around technical communication. Question three of the survey also showed high synergy between the student perceived needs in technical writing and the intentional instruction embedded in the new course design. Table III below shows the thematic results, the number of occurrences, and example quotes for the items students perceived improvement on for their technical communication.

Table II: Qualitative Coding Results for Student Perceived Improvement in Technical Communication Practices

| **Topic** | **n** | **Example Quote** |
|---|---|---|
| Clarity | 4 | *I have improved at making complex things easy to understand and to the point* |
| Collaboration | 5 | *Working as a part of a team is getting easier and it's getting easier to write a lot of content for classes* |
| Conciseness | 10 | *More concise and focused responses* |
| Documenting testing | 3 | *I think my technical writing skills have improved a decent bit in a few categories. I think I have gotten better documenting testing and organizing a constantly changing document. I have gotten a better at planning out my writing and communicating information in a concise manner.* |
| Formatting | 5 | *My ability to correctly word and format documents has improved significantly.* |
| Organization | 4 | *I became better at using different section headings and subheadings to break up and organize long text and make my writing more easily readable.* |
| Tone | 3 | *I have gotten more experience with group technical writing. While I am quite good at writing on my own, it definitely was a challenge to keep a similar flow and tone between writers. That is something I have more experience with now.* |

From the survey, 40% of the 5C's (Concision, Clarity, Coherence, Correctness, Confidence) of Technical Communication were perceived by several students in improving throughout the course of the semester both for clarity and conciseness. Similarly, students also discussed on best practices for formatting, organization, and tone all of which are aspects of technical communication that demonstrates alignment with lectures and activities centered around writing for audience and purpose, another lecture in the course design. Students also were found to improve on the ways in which to integrate design data and results into professional communication documentation aligning with the goal of included best practices for document design. Though the findings in this analysis are preliminary and require further validation, it is suggesting that the (re)envisioned model of Multidisciplinary Capstone Design should be further investigated to understand better the impact to student technical communication and to continue to redefine multidisciplinary teaching approaches. Redefining multidisciplinary goes beyond simply enhancing the technical aspects of pedagogical courses; it involves harnessing knowledge and disciplines to elevate both teaching methods and collaborative efforts among peers and it shows preliminary positive impacts to students' technical communication abilities.

## 6. Conclusion and Future Plans

*Conclusion*

The goal of this co-teaching model is to enhance student technical communication skills in a multidisciplinary engineering design capstone course sequence. This model is an example of sociotechnical integration of technical and nontechnical instruction within an engineering course [6]. Particularly, this co-instruction includes the social (technical communications) and the technical (engineering design) learning from instructors who are trained in these fields. Course lectures, in-class activities and grading rubrics have been continually revised to improve the delivery and learning outcomes associated with technical communication. The purpose of this assessment of this teaching model is to evaluate the impacts on student learning and to use student feedback to improve the student experience. Based on student survey feedback, the revisions to curricular and structural content are responding to student interests in improving their skills. These interests include concision and clarity in writing and receiving feedback to improve their communication skills across a variety of written and oral genres. The respondents indicated they wanted to improve these skills and recognized the need to practice through writing and oral presentations both formally and informally. This multidisciplinary teaching model is observed to respond to the need for improved workplace communication skills.

*Future Work and Continued (Re)Vision*

As mentioned at the beginning of this paper, this is a multi-year study of the impacts of a multidisciplinary teaching model. The authors will be continuing to review the survey results from the student perceptions and self-reflections and make improvements to the capstone course curriculum. Demographics will also be reviewed to see if there are any differences between gender, race or ethnicity that impact the student's experience. The authors also will be evaluating the impacts of engineering vs. non-engineering majors on students’ perceptions of technical communication. In addition to student responses, the authors will be conducting a direct assessment of student work related to their final written project reports to evaluate the impacts of before and after adding the engineering technical communications instructor to the instructional team.

**References**


[1] L. Reave, "Technical Communication Instruction in Engineering Schools: A Survey of Top-Ranked U.S. and Canadian Programs," Journal of Business and Technical Communication, vol. 18, no. 4, pp. 452-490, 2004.

[2] Wilson-Fetrow, M., Svihla, V., Chi, E., Hubka, C., & Chen, Y. (2023). Engineering Students' Writing Perceptions Impacts Their Conceptual Learning. IEEE Transactions on Professional Communication.

[3] National Academy of Engineering. (2004). The Engineer of 2020: Visions of Engineering in the New Century. Washington, DC: The National Academies Press. https://doi.org/10.17226/10999

[4] American Society for Engineering Education (ASEE). (2012) "Innovation with Impact: Creating a Culture for Scholarly and Systematic Innovation in Engineering Education." [Online]. Available: https://www.asee.org/member-resources/reports/Innovation-with-Impact

[5] J. M. Smith, J. Lucena, A. Rivera, T. Phelan, K. Smits, and R. Bullock, "Developing global sociotechnical competency through humanitarian engineering: A comparison of in-person and virtual international project experiences." Jour. of Int. Engineering Education, vol. 3, no. 1, article 5, 2021.

[6] Reddy, E. A., Kleine, M. S., Parsons, M., Nieusma, D. (2023, June) Sociotechnical Integration: What is it? Why do we need it? How do we do it? In 2023 ASEE Conference & Exposition.

[7] M. D. Patton, "Beyond WI: Building an Integrated Communication Curriculum in One Department of Civil Engineering," IEEE Transactions on Professional Communication, vol. 51, no. 3, pp. 313-327, 2008

[8] J. L. Craig, N. Lerner, and M. Poe, "Innovation Across the Curriculum: Three Case Studies in Teaching Science and Engineering Communication," Professional Communication, IEEE Transactions on, vol. 51, no. 3, pp. 280-301, 2008. [Online]. Available: 10.1109/TPC.2008.2001253.

[9] Paretti, M. C. (2008). Teaching communication in capstone design: The role of the instructor in situated learning. *Journal of Engineering Education*, *97*(4), 491-503.

[10] Howe, S., & Goldberg, J. (2019). Engineering capstone design education: Current practices, emerging trends, and successful strategies. Design education today: Technical contexts, programs and best practices, 115-148.

[11] Johri, A., & Olds, B. M. (Eds.). (2014). Cambridge handbook of engineering education research. Cambridge University Press.

[12] Ford, J. D., Paretti, M. C., Kotys-Schwartz, D. A., Howe, S., Gewirtz, C., Deters, J., ... & Giardine, F. (2019). Transitioning from capstone design courses to workplaces: A study of new engineers' first three months. International Journal of Engineering Education, 35(6), 1993-2013.

[13] Gewirtz, C., Kotys-Schwartz, D. A., Knight, D., Paretti, M. C., Arunkumar, S., Ford, J. D., ... & Hernandez, C. (2018). New engineers' first three months: A study of the transition from capstone design courses to workplaces.

[14] Meah, K., Hake, D., & Wilkerson, S. D. (2020). A multidisciplinary capstone design project to satisfy ABET student outcomes. Education Research International, 2020, 1-17.

[15] Neeley, K. A., & Alley, M. (2021, July). Engineering Communication and Engineering Criteria 2000: Assessing the Impact Through Papers Presented at the ASEE Annual Conference. In 2021 ASEE Virtual Annual Conference Content Access.
[16] Fornaro, R. J., Heil, M. R., & Peretti, S. W. (2001, October). Enhancing technical communication skills of engineering students: An experiment in multidisciplinary design. In *31st Annual Frontiers in Education Conference. Impact on Engineering and Science Education. Conference Proceedings (Cat. No. 01CH37193)* (Vol. 3, pp. S2G-1). IEEE.
[17] Behdinan, K., Pop-Iliev, R., & Foster, J. (2014). WHAT CONSTITUTES A MULTIDISCIPLINARY CAPSTONE DESIGN COURSE? BEST PRACTICES, SUCCESSES AND CHALLENGES. Proceedings of the Canadian Engineering Education Association (CEEA).
[18] Pembridge, J., & Paretti, M. (2010, June). The current state of capstone design pedagogy. In 2010 Annual Conference & Exposition (pp. 15-1217).
[19] Duncan, S., Budnik, M. M., Will, J., Johnson, P. E., & Nudehi, S. S. (2011, June). Overcoming the challenges of implementing technical communication in a capstone senior design course. In *2011 ASEE Annual Conference & Exposition* (pp. 22-1135).
[20] Goldberg, J. R., Cariapa, V., Corliss, G., & Kaiser, K. (2014). Benefits of industry involvement in multidisciplinary capstone design courses. International Journal of Engineering Education.
[21] Zheng, L., Hu, D., & Jesiek, B. K. (2021, July). A Systematic Review of Multidisciplinary Engineering Education: Accredited Programs, Educational Approaches, and Capstone Design. In *2021 ASEE Virtual Annual Conference Content Access*.
[22] Winkelmes, M.A. (2014). *Transparency in learning and teaching in higher education.* Retrieved from https://tilthighered.com/transparency.
[23] Miles, M., Huberman, A., and Saldaña, J. (2020). Qualitative Data Analysis a methods sourcebook.