Paper ID #50445

Work in Progress: Embedding Technical Communication into Project-Based Environmental Engineering Education—A Mixed-Methods Case Study of Co-Teaching

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Abstract

Technical communication expertise is important for our current and future engineering graduates, yet its integration into undergraduate curricula remains inconsistent or ineffective. Traditional approaches to teaching technical writing skills often lack connection or alignment with distinct engineering design work, or technical communication is taught in isolation as its own course. This study presents an alternative model to these approaches by examining the integration of technical communication into a second-year introductory environmental engineering course through project-based learning and co-teaching. The work described herein builds on prior research demonstrating the value of embedded communication instruction in engineering courses and the potential of co-teaching in engineering disciplines. It addresses gaps in engineering education literature by describing a co-teaching model that influences students' perceptions, confidence, and performance on technical communication tasks, thereby better supporting foundational engineering design instruction.

The proposed instructional design aligned and integrated communication lectures within the phases of the engineering design process for a semester-long design project. Within the project, students were required to submit interim products, both written and verbal, prior to a final technical briefing and design report, during which they were to effectively present and argue for their design. Environmental engineering and technical communication professors co-taught the course, providing targeted instruction and feedback specific to their disciplines and areas of expertise. Initial results from the study showed that both self-reported confidence in technical speaking and writing increased for 100% of participants, and that 80% of participants found that the communication instruction also furthered their engineering knowledge.

The study contributes an innovative and scalable instructional framework by aligning engineering-specific technical communication instruction with functional design tasks, thereby enhancing students' experience and performance in both. Application of this framework at the earlier stages of an engineer's education is intended to improve longitudinal communication performance by providing dedicated communication instruction in an engineering context. The study offers actionable insights for engineering programs seeking to strengthen communication outcomes without compromising technical rigor.

Introduction

In this paper, we present a work-in-progress account of an attempt to redesign and record the outcomes of embedding technical communication instruction directly into an introductory course within an environmental engineering program. Following a recent academic program restructuring at the United States Military Academy that merged civil and environmental engineering programs within a new department [1], professors in this study made a concerted effort to leverage this restructuring to revisit the role of technical communication within the environmental engineering course of study. Though technical communication was previously emphasized, students did not receive a dedicated course on the topic, leaving the instruction of technical writing and presentation to the discretion of the course professors. After a successful, but abbreviated, integrated lecture attempt in Spring Term, 2025, a more comprehensive integration of technical communication into the engineering classroom was implemented.

In Fall Term, 2025, after gaining IRB approval, the researchers designed a new course style centered on a paired instruction approach to teaching technical communication embedded within an engineering course. This course added a second-year, project-based, introductory environmental engineering course (EV201) with a series of ten dedicated lectures on technical communication, tailored to students' needs as they completed various communication assignments and checkpoints for an engineering design project throughout the course. Both a technical communication professor and an engineering professor were present in the course at this time, allowing students to receive complex, interdisciplinary feedback and guidance that was directly applicable to their project-based experience.

The initial project-based course was created from a previous non-integrated course design that asked students to design a point-of-use water filtration system using locally accessible materials in a remote setting, enabling quick, reliable filtration during periods of limited potable water access. In the previous course, students documented progress through their design with a series of technical briefs and design reports that aligned with the widely recognized engineering design process. Students would then present their completed designs during a final review, followed by a technical report. The reduced quality of these design reports was the catalyst that encouraged the researchers to address a perceived gap in educational practice.

Problem Defined

While the program, in its current form, excels at training students in the practice and problem-solving skills needed for modern engineering, technical communication within the program is handled indirectly. From a writing perspective, students are given a general overview of writing in their introductory composition course (EN101) at the university, but there are no other courses that directly cover technical communication topics, especially those related to engineering. An initial concern, then, is that students might lack significant practice and instruction in technical communication strategies, which they are expected to apply in the EV201 project. Technical communication experience is often needed to make a project-based design approach fully achievable. While students could be counted on to acquire such knowledge and experience throughout their time in the program, the early positioning of the course in the overall curriculum meant that students entering the course in their second year would need significant assistance to reach even a reduced version of the completed design documents and presentations that would be needed. This significant assistance was lacking, so it was determined that a new, integrated co-teaching approach could help students quickly make up for this deficit in communication instruction—including both written, verbal, and multimodal technical communication.

Literature Review

While integrated approaches to technical communication instruction in engineering are not novel, they are rare. Currently, only a handful of programs across the United States utilize an integrated approach to engineering communications, with most favoring a separation of engineering and communication practices into disciplinary silos [2], [3].

Much of the literature on engineering communication identifies this separation as a structural, rather than pedagogical, problem. Traditional models typically position technical writing as a service course or as an external requirement, often delivered by English or communications departments, with limited coordination with engineering faculty [4]. While these models may improve surface-level correctness or genre familiarity, they frequently fail to connect communication practices to the epistemic work of engineering itself—namely, problem formulation, modeling, decision-making under constraints, and justification of trade-offs. For engineering students, communication in these contexts can become ancillary rather than instrumental, reinforcing the misconception that communication is an “add-on” skill rather than a core engineering competency.

In contrast, integrated models treat communication as inseparable from engineering thinking. Programs adopting this approach embed instruction in writing, speaking, and visual communication directly within engineering coursework, aligning communication tasks with authentic disciplinary practices [5]. These models are often informed by Writing Across the Curriculum (WAC) and Writing in the Disciplines (WID) traditions, but integrated engineering technical communication models are distinguished by their emphasis on engineering-specific genres, audiences, and constraints, rather than WAC and WID models that may focus on biology, math, psychology, etc., as well as engineering. From an engineering perspective, this integration allows communication to function as a design activity—iterative, constraint-driven, and evaluative—rather than as a post hoc reporting exercise.

One of the most frequently cited examples of large-scale integration is the Massachusetts Institute of Technology’s Communication Requirement, which distributes discipline-specific communication instruction across multiple undergraduate engineering courses [6]. Rather than relying on a single technical writing course, the requirement ensures repeated, contextualized practice tied to students’ evolving technical expertise. Similar principles underpin other large-school engineering communication programs, which embed communication specialists within engineering departments and courses [7]. Paretti’s work [7], for example, famously emphasizes collaboration between engineering and communication professors, with the explicit goal of supporting engineers’ ability to reason, design, and persuade through discipline-appropriate communication. Importantly, this model positions communication instruction not as remediation, but as a parallel form of expertise that develops alongside technical competence.

Across these integrated programs, several common outcomes are reported. First, students demonstrate improved ability to articulate technical reasoning to varied audiences, including non-specialists and decision-makers [8]. Second, professors note greater coherence between students' technical work and their written and oral explanations, suggesting deeper conceptual understanding. Finally, these approaches align closely with accreditation expectations, such as ABET student outcomes related to effective communication, teamwork, and ethical responsibility, without displacing technical content [9].

When integrated programs are adopted, past studies show that the model works best when integrated at earlier levels of the design process [10]. Often, as students progress later into their education, they risk absorption in the technical details of their projects to the detriment of communicating their work effectively. Although students who have been studying longer are fully capable of outperforming their early-year counterparts, previous studies demonstrate that early-program students are eager to engage in real-world engineering challenges and are more receptive to communicative practice instruction.

Despite these documented benefits, adoption of integrated models remains limited. Barriers include curricular inertia, resource constraints, and persistent assumptions about the role of communication in engineering education [11], [8]. What is more, to truly integrate curricula, faculty must be given institutional credit for their work in another department, which can be challenging to formalize within larger institutions. For institutions with tightly sequenced curricula—such as service academies—there is additional pressure to justify any instructional innovation on both efficiency and mission alignment grounds. As a result, many programs continue to rely on stand-alone technical writing instruction or even implied, osmotic communication instruction, even as evidence accumulates that integrated models better reflect the communicative realities of engineering practice.

However, after recognizing the success and importance of integrating technical communication and writing directly into engineering courses, the researchers implemented an integrated communication model for EV201 at West Point. This model was initially implemented through faculty initiative to provide proof of concept for institutional support.

Integrated Course Approach

The new approach to EV201 represented a shift from traditional "siloed" instruction with discrete courses on both communication and introductory engineering topics to a co-teaching model that embedded technical communication lectures directly into the environmental engineering instruction. In the typical 40-lecture semester at our university, the EV201 course curriculum was modified to integrate ten dedicated technical communication lectures tailored to students' semester-long design project experience, which was further structured around the engineering design process. The course progression was treated as an initial pilot without permanent modification to the curriculum.

The project structure required a series of interim products, both written and verbal, that expanded upon the previous tasks, each increasing in detail, complexity, and components. These changes also brought shifts in delivery mode. The scaffolded tasks culminated in a final design briefing presented to peers and stakeholders, as well as a comprehensive technical design report. Following a review of course objectives and assessment of major course components, the researchers collectively determined technical communication topics that targeted the foundational skills students needed to successfully connect and meet the interim and final project requirements. These topics included design thinking, design reports, argumentation, functional hierarchy, survey writing, brainstorming, technical speaking, lab reports, data visualization, and briefing techniques. Subsequently, the researchers redesigned the learning progression within the course, ensuring that technical communication lectures were delivered at appropriate checkpoints that aligned with the corresponding technical engineering instruction and project evolution. This learning progression and schedule are seen in Figure 1:

LSN	Lesson Description	LSN	Lesson Description
1	Introduction to Engineering	21	Technical Speaking
2	Introduction to Environmental Engineering	22	Interim Design Report Briefs
3	Introduction to the Engineering Design Process	23	Lab Report Writing
4	Design Thinking	24	Experimentation - Lab Intro, Walk-Through, Techniques
5	Problem Identification and Definition	25	Environmental Data Collection - Sample Collection in Training Area
6	Intro to Design Project	26	Environmental Data Collection - Lab Day 1 (Disinfection)
7	Design Reports / Executive Summary	27	Environmental Data Collection - Lab Day 2 (Filtration)
8	Argumentation	28	Data Visualization, Interpretation, Representation
9	Stakeholder Management, Values-based Decision-making	29	Fundamentals of Solving Complex Engineering Problems / Excel 1
10	Functional Hierarchy / Survey Writing	30	Fundamentals of Solving Complex Engineering Problems / Excel 2
11	Creative Solutions Driving Design / Brainstorming	31	Excel Workday
12	Expeditionary Water Treatment Design	32	Green Engineering and Sustainable Engineering Design
13	Filtration Techniques and Design	33	Engineering Ethics
14	Filtration Lab	34	Design Studio 1
15	Disinfection Techniques and Design	35	Technical Design Briefing
16	Disinfection Lab	36	Design Studio 2
17	Creative and Expeditionary Design Day	37	Design Studio 3
18	Design Development and Visualization Tools 1	38	Group Design Project Presentations
19	Design Development and Visualization Tools 2	39	Group Design Project Presentations and Course Closeout
20	SolidWorks Workday	40	Course Closeout

Figure 1. Course syllabus outlining integrated instruction in technical communication alongside introductory engineering topics. Communication-specific lectures are indicated with blue highlight.

The learning progression above depicts the series of lessons and titles as they appeared within the course, with each title representing one lesson. The integrated technical communication lectures are highlighted in blue. As you can see, rather than being offered in a unified block or sub-course, the lessons were separated and integrated into the rest of the course, typically placed before students would need that particular skill. This integration allowed students to acquire the communication experience and understanding that they needed near the point of application, rather than in a manner that might disconnect communication from environmental engineering.

The skills that the students would need were determined by the engineering assessments present throughout the semester as shown in Figure 2. These tasks were then assessed through a series of rubrics to provide students with feedback and evaluate the learning metrics for the program. To ensure that the metrics and assessment standards did not have an impact on the results of the study, the standards were kept and maintained to the previous standards for the course, set by the engineering professor.

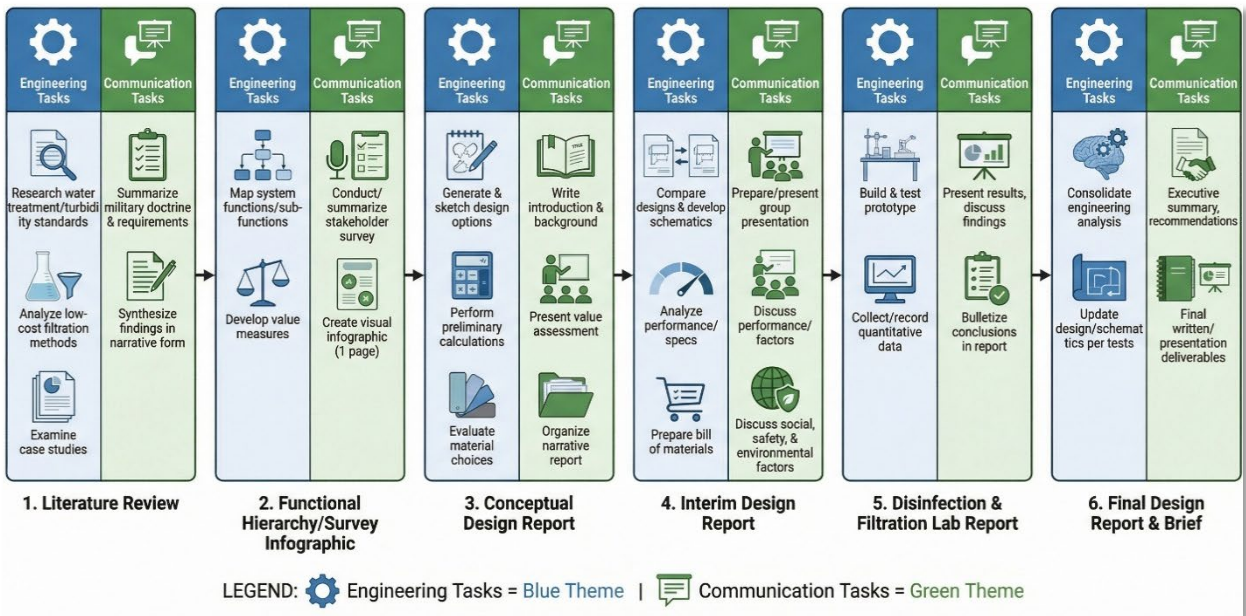

Figure 2. Engineering assessments and project deliverables within the semester-long engineering design project progressed from a literature review to a final technical design report and brief. Each deliverable is distinctly divided highlighting both the engineering and communication tasks required therein. Source: Figurelabs, 2026, prompt: "Display the progression of project deliverables with respective engineering tasks and communication tasks required for each deliverable."

Both environmental engineering and technical communication professors were present in the classroom, with the technical communication professor being present primarily for the technical communication lessons and presentations. Both professors provided students with collective feedback that was immediately applicable to their technical work. This framework sought to deliver technical communication instruction early in our engineers' education as a means to establish a foundation that would then allow future instructors and courses to enhance their longitudinal learning and overall experience. By aligning writing and communication tasks with engineering design tasks, the integrated course approach aimed to demonstrate that writing and communicating are valuable tools for solving engineering challenges rather than requirements that needed to be fulfilled only after the solution is developed. The alignment of tasks enabled a strong connection between the two aspects of instruction, helping students learn to think like engineers while becoming more effective writers and communicators.

After establishing this process and during preparation to teach the course, the interdisciplinary instructor team established baseline methods to monitor and record the successes and shortcomings of such an approach.

Case Study Methods

This study remains a work-in-progress. The study received ethical approval from the university's Institutional Research Committee (approval #CA-2026-15) on November 7, 2025, with students briefed on their ability to consent to participate on December 9, 2025.

Data collection occurred via surveys (Likert-scale quantitative and open-ended qualitative), end-of-semester interviews, student writing samples, and faculty teaching reflection. All students enrolled in EV201 (n=10) participated in the study via survey responses and writing samples, while five students provided qualitative responses during end-of-semester interviews. Specifically, the student cohort included seven male and three female students, all within the age range of 18-20. While this sample size is small, it represents a significant portion of the environmental engineering cohort, making the data valuable for future data collection. Though it would be impossible to draw any causal links with such a small sample, especially because the study participants were convenience sampled from an instructor's course, this utilization of a mixed-methods approach provided a more robust dataset for evaluating changes in writing confidence, perceived relevance of writing to engineering, and writing performance within the program's engineering context. The goal of the approach was to get a sense of both the educational possibilities that such a course might provide, as well as the student and instructor appetite for future similar collaborations between disciplinary areas of study.

Data collection occurred over the course of one semester, with the primary survey occurring at the end of the course. Interviews were conducted the following semester, after students had returned from break. This gap between interviews and surveys allowed for reflective questions that responded to the survey data. The study was set up in such a way as to make longitudinal and continuing data possible, but not required. Within the scope of this work in progress, the initial data set was rendered complete, allowing for results analysis.

Case Study Results and Discussion

The integration of technical communication into the engineering course of study was intended to help students advance beyond their engineering work by summarizing and presenting their complex, technical information at key checkpoints in the engineering design process. For ease of understanding, a gauge chart is included in Figure 3.

The multi-layer gauge chart depicts a series of gauges representing positive responses to survey questions. The blue fill on each of the four gauges corresponds with the percentage of agreement each qualitative indicator received. As the diagram demonstrates, there is a clear trend of agreement in all categories, which indicates a general holistic perceived improvement to the changes in the course. This is borne out in the specifics from the survey.

Survey results indicated success in all areas above, with 100% of students reporting an improved understanding of how to shape engineering information for concise but meaningful delivery to interested audiences. Students felt better equipped to formally present their engineering calculations, designs, and recommendations. Indeed, several students identified specific lessons learned, such as "how to present data in graphs and tables" and the importance of "being concise" as key characteristics for professional communication. One student further reflected that the co-teaching instruction helped him realize he needed to know how to "write/talk in order to get ideas across" effectively, rather than solely focusing on the technical aspects of his project design.

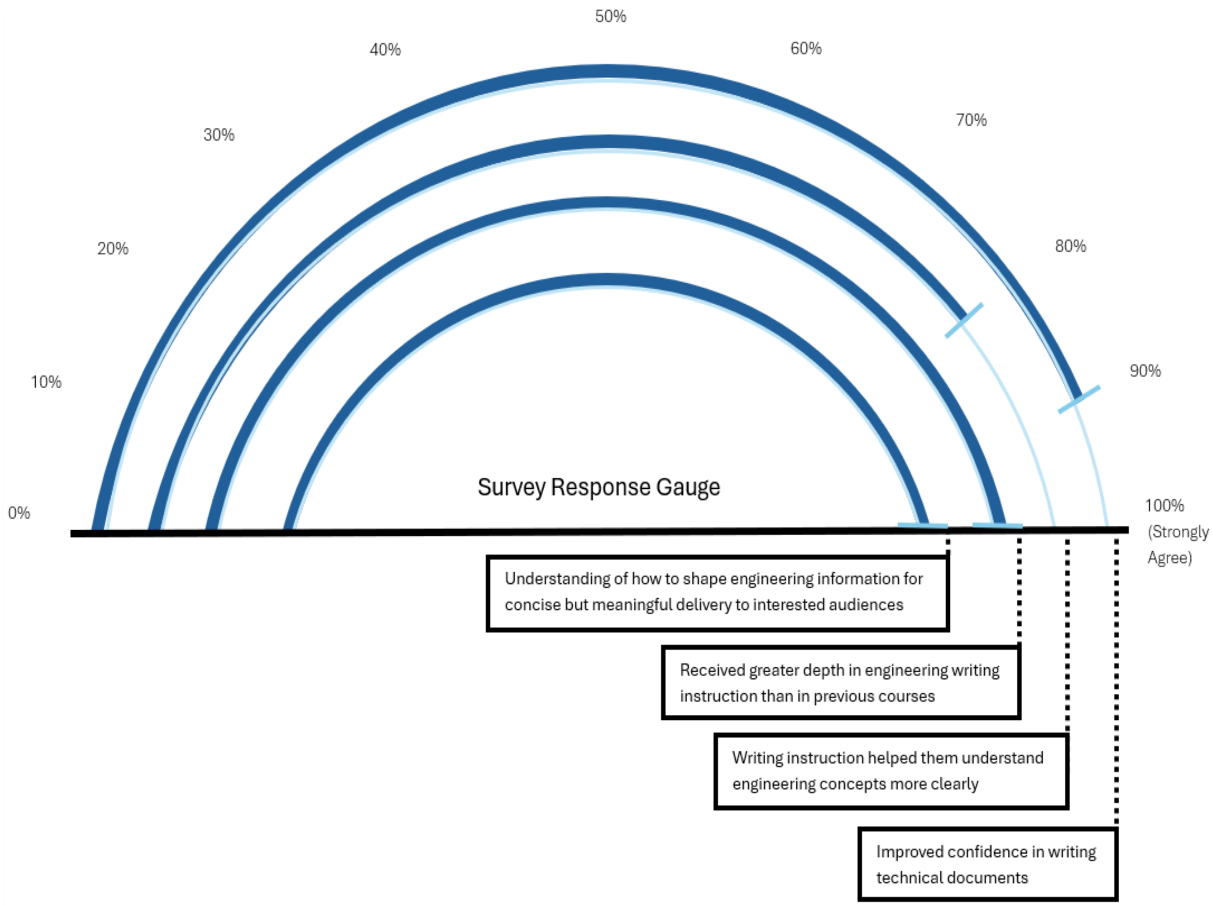

Figure 3. Multi-layer Survey Response Gauge Diagram displaying agreement metrics for various survey questions. Agreement with particular survey components is indicated in dark blue. The components themselves are connected to their corresponding gauge with a dotted line.

Beyond allowing students to advance their engineering work, the data suggests that the integrated course model also assisted student confidence in relating that work to others. The integrated course approach enhanced student confidence and provided a depth of instruction previously missing from the curriculum. All (100%) participants (n=10) agreed that they received greater depth in engineering writing instruction than in previous courses, with 80% "strongly agreeing." This depth translated into a measurable increase in self-confidence, with 80% of students reporting improved confidence in writing technical documents.

Qualitative responses from the post-course interviews suggest the origin of this confidence was in clarifying the "how and what" of technical communication, with one student noting that the course design and co-teaching approach helped him understand the "standards and guidelines" required for professional communication. Another participant explained that while she initially felt "very unprepared" for writing engineering design reports, the instruction helped her gain confidence by developing a better understanding of the required "format and type of writing." Further, these responses suggest that the understanding facilitated by the course was deepened in both the communication and engineering components.

The data suggest that embedded technical communication instruction facilitated a deeper understanding of technical engineering content, rather than existing as a separate disciplinary "silo" of instruction. Nearly all (90%) students agreed that writing instruction helped them understand engineering concepts more clearly. Students noted that the assignments helped them "understand the why behind what [they] were doing" and "understand the importance of connections." One student explicitly stated that the integrated approach "helped me to think like an engineer but to also become an effective writer." This shift in cognitive recognition highlights the benefits of the co-teaching approach, in which technical communication instructors offer the means to professionally convey and explain the technical underpinnings established by engineering instructors.

Linking writing assignments to deliverables within the engineering design project ensured that all students remained involved in both aspects of instruction. All (100%) students found the writing tasks highly applicable to their engineering projects, with 90% strongly agreeing. Similarly, the students reported that each writing task felt connected to the engineering course of study, demonstrating that the goal of discipline-specific relevance was achieved. Despite these strengths, 20% of students "somewhat disagreed" that they felt prepared for future professional roles. While confidence may have improved, this suggests that some students still personally perceived a gap between their classroom skills and the potential expectations of an unknown professional setting. However, others noted the high "applicability" of the lessons—such as briefing techniques—to their future roles and responsibilities.

Reflection and Lessons Learned

While this study remains a work-in-progress, we believe the results previously discussed are promising indicators of the success of an integrated technical communication model in environmental engineering. We attribute the bulk of the results to two factors: the direct integration and alignment of technical communication lectures within the engineering course structure, and co-teaching by both environmental engineering and technical communication professors. While these factors may be the driving force of the integrated course approach, the actual implementation framework is quite malleable and can respond to programs that may have difficulty implementing a fully integrated course model, due to budgetary or personnel constraints. Reflection on the new course's development, implementation, and results thus far yielded three overarching adaptation considerations that may be helpful to other engineering programs seeking to strengthen communication outcomes without compromising technical engineering rigor in their courses of study:

- **Consider your desired scale when designing the course.** While one lecture group, similar to the population in this study, presents an easily supported opportunity, the framework could easily be scaled up to courses with much larger enrollments. In larger enrollment courses, course design could be optimized to address technical communication lectures in large group settings, with smaller design teams splitting out for the technical engineering portions of the course, perhaps by engineering discipline if in a multi-discipline course. This would enable a single technical communication professor to provide instruction for multiple courses, albeit with the potential loss of direct feedback. At minimum, two direct sources of expertise and an intentional placement of lessons within the curriculum are needed for an integrated model to work, making scalability possible for future iterations.

- **Modularity and flexibility enable transition across disciplinary boundaries.** Topics for technical communication lectures could be modified to address identified student shortcomings or better align with faculty areas of expertise. The timing, frequency, and duration of technical communication lectures could also be adjusted to align with differing engineering content, project type, and scope. This framework is not limited to environmental engineering students; it can be applied to other engineering disciplines or a cohort with mixed academic backgrounds.

- **Course placement within the curriculum is not time-constrained.** In this study, the new course style was implemented in a second-year introductory environmental engineering course. However, while previous studies have shown that early curriculum work may lead to better results in these integrated frameworks, the presented framework could easily be conducted elsewhere in the undergraduate curriculum.

Expanding the Work-in-Progress (Conclusion)

We believe the integrated course approach driven by the co-teaching methodology of technical communication and environmental engineering faculty met its objectives. The framework enabled the provision of dedicated technical communication instruction, providing a more robust student learning experience during their application of the engineering design process. The study results demonstrate that embedding technical communication into a technical engineering course, as opposed to two separate and distinct courses, improved students' perceptions of communicating as a valuable tool for solving engineering problems, as opposed to an obligatory requirement once an engineering design is complete. Students appreciated hearing from technical communication faculty on how to formulate and write professional documents while maintaining the technical rigor required by the engineering instructor, and their confidence increased as a result.

The reorganization of engineering programs at our university provides an immediate opportunity to expand this work. The combination of disciplinary cohorts, including both civil and environmental engineering majors, allows the researchers to dissect strengths and weaknesses and shape the framework to best fit the new audience, both in terms of technical communication topics, as well as timing and alignment of lectures to meet revised engineering design process timelines. The researchers intend to longitudinally expand this work to determine if the positive effects remain as the student cohort described herein transitions to more advanced engineering courses that demand more refined technical communication skills. Student work may also be compared across multiple iterations of the course, allowing for more rigorous and standardized assessment of student outcomes. Future iterations of the study will undoubtedly move past self-reporting and look at student outcomes in their writing and communication to see growth that might be externally validated. While the results of this stage of the study were highly favorable, the researchers are excited to continue to investigate ways to strengthen their impact.

References

[1] P. Dacunto, M. Baideme and S. Katalenich, "Lessons Learned in Leading Academic Transformation – A Case Study in Merging Programs to form a New Department of Civil & Environmental Engineering," in *Proceedings of the 2026 American Society of Engineering Education (ASEE) Annual Conference & Exposition*, Charlotte, North Carolina, 2026.

[2] G. Tech, "School of Civil and Environmental Engineering | Georgia Institute of Technology - Atlanta, GA," 2026. [Online]. Available: https://www.ce.gatech.edu/academics/communication. [Accessed 15 1 2026].

[3] U. o. Michigan, "Mission statement and objectives | Tech Comm," 2026. [Online]. Available: https://techcom.engin.umich.edu/mission-statement-and-objectives/. [Accessed 16 1 2026].

[4] K. D. Dahm, S. Farrell and R. P. Ramachandran, "Communication in the Engineering Curriculum:Learning to Write and Writing to Learn," *Journal of Engineering Education Transformations,* vol. 29, no. 2, pp. 1-8, 2015.

[5] E. Yong and P. J. Ashman, "Integration of the structured development of communication skills within a chemical engineering curriculum at the University of Adelaide," *Education for Chemical Engineers,* vol. 27, pp. 20-27, 2019.

[6] Massachusetts Institute of Technology, "Communication Requirement," 2026. [Online]. Available: https://registrar.mit.edu/registration-academics/academic-requirements/communication-requirement.

[7] M. C. Paretti, "Teaching Communication in Capstone Design: The Role of the Instructor in Situated Learning," *Journal of Engineering Education,* vol. 97, no. 4, pp. 491-503, 2008.

[8] S. M. Lord, "Integrating Effective `Writing to Communicate' Experiences in Engineering Courses: Guidelines and Examples," *International Journal of Engineering Education,* vol. 25, no. 1, pp. 196-204, 2009.

[9] ABET, "2026-2027 Criteria for Accrediting Engineering Programs," ABET, Baltimore, 2026.

[10] M. J. Haslam, J. M. Adams and R. Gerrick, "Introducing First-year Students to the Engineering Design and Communication Skills Needed In Capstone," in *Proceedings of the 2023 American Society for Engineering Education (ASEE) Annual Conference & Exposition*, Baltimore, Maryland, 2023.

[11] K. Walker, "Integrating Writing Instruction into Engineering Courses: A Writing Center Model," *Journal of Engineering Education,* vol. 89, no. 3, pp. 369-375, 2013.