The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
Paper ID #42854

# WIP: Rewriting Capstone: The Unexpected Solution to Our Assessment Problem

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## Abstract

Industrial engineering capstone courses provide students the opportunity to apply the technical tools they learn in their major classes to a real-world project. To effectively demonstrate understanding of learning objectives, students must communicate clearly to a wide range of audiences, including instructors, other team members, and the project client. Full assessment of learning objectives may require engineering professors teaching capstone courses to spend considerable time evaluating student writing. Varied teaching tools and methods to convey the importance of communication in professional environments may also be incorporated to enhance student learning. Clear communication within an engineering capstone course is important for students and engineering instructors.

The work in progress describes an effort to improve communication and assessment of student learning in an industrial engineering capstone course. To better assess learning objectives, several changes were made to the curriculum over a four-year period. The changes include the development of a course guide, updated rubrics, project charter discussions, teamwork assessments, midterm check-ins, and the experimentation with different final presentation formats. Despite these changes, assessment of student learning outcomes remained elusive as most of their analysis and understanding was conveyed through written deliverables. For teams that struggled with written communication, we could never quite understand their work, let alone whether they were doing it well. In 2023, a writing instructor was integrated into the class to help students better communicate their understanding of the problem, methods, and solutions. The contribution of the writing instructor has addressed several of the communication challenges that other innovations were attempting to solve. Moreover, and to our surprise, our assessment issues began to improve. Preliminary results indicate that the addition of formative assessments have helped students better communicate the problem and solution to a wider audience in their project deliverables. A revised instructional model is presented, along with future evaluation plans.


## Introduction

As engineering students move into the workplace, their success depends on their technical skills and ability to communicate. Studies have shown that based on their position within an organization, engineers may spend up to fifty percent of their time writing [1]. While writing has been presumed to be part of an engineer's job, it has not always been considered a central component of the engineering profession [2], [3]. The role of writing in engineering has inspired several studies utilizing a variety of methods to prepare future engineering graduates to communicate technical work [4], [5]. Research has found that the most important writing tasks in the workplace include emails [6] and business proposals [7]. In response to research findings and input from faculty and industry partners, the Accreditation Board of Engineering and

Technology (ABET) criteria for student outcomes include "an ability to communicate effectively with a wide range of audiences" [8].

When and how to teach writing in the engineering undergraduate curriculum has also been the focus of education research. Scholars have documented how communication has been integrated in individual engineering courses and across the curriculum [9], [10]. Studies have also described how engineering and writing faculty have developed and co-taught required engineering design and communication classes for first-year engineering students [11], [12]. While discipline specific courses have incorporated writing assignments to evaluate learning, often in the forms of brief memos or summaries, it is often not until capstone courses that students are required to complete a writing-intensive assignment in the form of a technical report [4]. Capstone course research has focused on problem-based learning [13], student collaboration [14], and communicating solutions [15] and more so from an oral than a written communication practice [16]. Evidence also suggests that using active theory and learning principles in the way instructors and students interact in engineering capstone courses can help students develop transferable communication skills [17].

As we made changes to our capstone course, we agreed that writing is a key element in the learning, teaching, and assessment process of core professional engineering skills. While updating assignments for corresponding learning objectives, we sought to incorporate both summative and formative assessments that are most frequently discussed in the scholarship of teaching and learning [18], [19]. Summative assessments measure students' knowledge at the end of the course through exams, papers, or projects [20]. Formative assessments are more frequent and low-stake opportunities for students to receive feedback on their performance, identify gaps in their knowledge [21]. While engineering studies have focused on engineering and writing, it is an exciting moment to continue the conversation and ask how IE capstone courses integrate formative assessments as part of communication and writing?

**Background**

The client-facing Industrial Engineering/Operations Research (IE/OR) capstone course is a longstanding tradition in our undergraduate program. The class is designed so that student teams work on a real client-driven unstructured problem. We value the real-world experience it provides, so the class emphasizes meaningful projects, student leadership, and a consulting project structure. To improve the quality of the projects available to students, strengthen learning outcomes, and enhance the capstone experience, in 2019 the department undertook a comprehensive review of the course. Discussions with the faculty, the alumni advisory board, and corporate partners affirmed these fundamental course goals:

- Apply IE skills to an open-ended problem with support from faculty.
- Learn project management and client management skills.
- Interact with clients sufficiently early to impact networking and job recruitment.
- Present strong incentives for students, clients, and faculty to deliver high-quality projects and results.

These goals, together with available resources, curriculum structure, and recruitment culture led to the creation of Client Project Challenge (CPC). Faculty, students, and clients satisfy different roles to accomplish these goals:

- Client projects are recruited and accepted only when tightly scoped and accompanied by appropriate data. Client representatives are expected to attend a kickoff meeting with all necessary data in hand on the first day of the course and are asked to meet weekly with the student team. Clients are asked to make a modest donation at the end of the project. These requirements result in higher quality project submissions and more engaged clients.
- IE faculty instructors assign students to projects and project teams, accounting for technical needs of the projects, student skills, and interpersonal dynamics. Instructors support students, assess progress, and determine final grades. Additional technical support is provided by other IE department faculty based on research expertise.
- Students are encouraged to enroll in the course in the last term of junior year, after completing the IE methods core (probability, statistics, and statistical learning; optimization; stochastic processes and simulation). Students are responsible for all client communications, and for identifying the project scope and solution approach. At this stage, students are preparing for final summer internships and full-time job recruitment, thus are highly invested in developing strong relationships with client representatives, and strongly motivated to develop professional skills they can leverage in upcoming opportunities.

One challenge became immediately apparent as we began to offer the revamped course in 2020: students struggled to explain their work. Some project clients require that students sign Non-Disclosure Agreements (NDAs) before sharing data. Instructors do not sign NDAs, and do not attend team client meetings. Therefore, student teams must communicate the problem, analysis, and solution to not only the client but also to instructors who do not have access to data but evaluate the course learning outcomes. The challenge had been observed in the predecessor course but was easily dismissed as a byproduct of the presentation format. As it happens, the problem persisted. Course instructors were frustrated by the student writing quality and their inability to assess the project's technical work. Because projects are run by students, course instructors are reliant on *student descriptions of the work* to assess the *quality of the work*. As such, the two became horribly confounded. Was the work technically unsound, or did the students simply explain it poorly? How can an instructor assess a project without understanding what a student team has done? These problems were exacerbated by distracting issues of disorganized and ungrammatical writing. It was difficult to focus on technical solutions.

From Spring 2020 to Spring 2022 we experimented with interventions to address student writing and communication issues. We created instructional rubrics and format outlines to help structure student work and clarify course expectations, ultimately formalizing our expectations in a comprehensive course guide. We also invested in improving team function and provided more instructor guidance from the outset. At core, these interventions addressed issues of content, format, and grammar. Yet they did not get to the core issue hampering our ability to assess students' technical work: students simply were not able to explain their project problems and/or solutions clearly. In short, our core issue with faculty assessment was really an issue with student writing. The goal of this Work in Progress (WIP) paper is to share how a writing instructor was initially integrated into the course for more frequent formative assessments involving writing, provide qualitative writing examples of student learning, and illustrate how this process assisted IE faculty better understand student work and technical solutions.

**Revised instructional model**

In Spring 2023, a writing instructor was hired to co-teach the class with two IE faculty members. A team-teaching model was utilized to merge content and pedagogy from engineering and writing to the capstone course. Team-teaching has been shown to provide a multifaced pedagogical approach and provide necessary skills for engineering students, as well as enhance the instructors' professional development [22], [23]. The co-teaching approach was helpful for our capstone class as well. While the curriculum did not change when the new instructor was added, we clarified the teaching roles and responsibilities. IE instructors are responsible for goal setting, curriculum, project selection, team assignments, and evaluating methodology and analysis. They provide rigorous questioning, interrogating assumptions, and detailed feedback to help students understand the problem and proposed solution. The writing instructor has a communication facilitator role and is involved before and after assignments are submitted to the IE instructors and provides feedback in sequence. During this term, the two IE instructors were full time faculty members in the department and received half a course teaching credit, respectively, and the writing instructor was hired as a supplemental adjunct. The university is supportive of cross-disciplinary team teaching, and has been for more than 25 years, as our first-year engineering design program offers a similar teaching model [11]. Ultimately, students receive one grade for their team project and for the class.

**Writing check-ins and general course structure**

Structurally, the course requires students to write through the process of solving their client's problem. That is, even before students have a complete understanding of the problem, they are required to document their work in interim reports. Four major written deliverables punctuate the term: a project proposal, a background research write-up, a midterm report, and a final report. *Writing check-ins* take place between written deliverable deadlines. Table I outlines the course timeline and how the IE and writing instructors grade and provide feedback on these deliverables.

Students are required to apply their core IE/OR methods and skills to solve their client's problem. Typically, three types of scenarios play out with student work product in this course where teams: 1) create a basic solution (like a spreadsheet) to address the client's problem that does not apply core methods, 2) apply core methods to create a basic solution that does not fully address the client's problem, and 3) apply core methods to create a comprehensive and thoughtful solution that addresses all aspects of the client's problem. The first two scenarios occur because students have an imperfect understanding of the entire scope of their problem.

TABLE I
TEAM-TEACHING MODEL RESPONSIBILITIES AND TIMELINE

| Week | IE instructors | Writing instructor |
|---|---|---|
| 1 | Lead student and client kick-off presentations | Lead an introductory writing workshop |
| 2 | Grade **team charters** and meet with teams to discuss | Grade preliminary **background research** assignment |
| 3 | Grade team **project proposals** | Grade **background research** |
| 4 | | Meet with teams for ***writing check-in #1*** and discuss background research |
| 5 | **Meet with teams or individual students as needed** to discuss feedback and prepare for midterm assignments | |
| 6 | Grade **progress assessment** and meet with teams for project review meeting | Read and provide feedback on **midterm reports** |
| 7 | Read and grade **midterm reports** after writing instructor | |
| 8 | | Meet with teams for ***writing check-in #2*** and discuss midterm report feedback |
| 9 | **Meet with teams or individual students as needed** to discuss final deliverables | |
| 10 | **Meet with teams or individual students as needed** to discuss final deliverables | |
| 11 | Lead **final presentation** grading | Read and provide feedback on **final reports** |
| Final grading | Read and grade **final reports** and assign **final grades** | |

**Key**:
- **Blue:** IE instructors led feedback and grading
- **Red:** Writing instructor led feedback and grading
- **Purple:** All instructor collaboration on feedback

Writing check-ins are designed to help all student teams not only communicate their work, but also grasp the whole of the problem so they can understand what work they need to do. Student writing is guaranteed to be unclear if student thinking is unclear. Understanding and communicating the complexities of client projects is crucial to success in this course. Thus, before even talking about the solution approach, the data, and analysis, the writing instructor works with the team to refine and clarify the contours of their project. Writing check-ins include two primary components: discussion of feedback on deliverables and development of improved communications for the next deliverable. Regarding the former, the writing instructor operates as a mediator or communication facilitator:

- **IE Instructors → Students:** the writing instructor helps students understand IE instructor feedback on non-technical aspects of the report. For example, when IE instructors say something is "unclear," the writing instructor works with students to understand where the lack of clarity comes from and helps them fix it.

- **Students → IE Instructors:** the writing instructor works closely with IE instructors throughout the term to identify team problems (from teamwork function to deliverable execution) and provide the right intervention to help the teams move forward.
- **Clients → Students:** While the writing instructor never meets with or communicates with clients, the writing instructor can help students unpack the client's written project description, formulate questions for client meetings, and identify problem areas as the students begin to draft their reports.

The writing check-ins also help students communicate their work. To do this, the writing instructor begins by asking students to explain their understanding of the project problem, objective, and stakes without relying on notes or reading anything they had previously prepared. As the students talk about their project—and this is key—the instructor takes detailed notes, attempting to capture specific language, including repeated phrases or emphatic moments. Once the team has at least minimally addressed the project problem, objectives, and stakes, the instructor reads back the notes and paraphrases the main takeaways. This process—students hearing their own words repeated and listening to a paraphrase of the main problem statement—tends to identify problem areas very quickly. A conversation with clarifying questions follows, at the end of which the writing instructor can help students: 1) better understand their problem, 2) better communicate their problem, and 3) more clearly explain their solution.

The next phase of work is a process of draft revision. The writing instructor emails student teams the notes from the conversation, clearly identifies areas for improvement, and requests a revised draft. The writing instructor reviews the revision, offering comprehensive feedback and asking questions to help the students with organization, focus, and clarity. In the next section, three case studies illustrate how the writing instructor helped students better communicate their work in the spring of 2023.

**Case Study #1: Understand the Problem Better**
Sometimes it takes student teams many weeks to understand their client's problem completely. Writing instruction can help tease out some of the areas where misunderstanding occurs. An example of how understanding the problem evolves through the writing process can be seen in the transformation of problem statements produced by a team. This team understood that their client ("Client A") had a problem with back-of-house storage allocation in their fast-casual restaurants. From the midterm to the final report (below), this team's understanding of the problem changed dramatically. The midterm report reproduces in large part what the client told the team: they thought storage space was a problem. The problem statement in the midterm report uses three sentences to state that their client needed to optimize their back-of-house storage. This repetitive statement lacks detail and only explains the client's problem in the most general terms:

> [**Midterm submission**] *Multinational quick service restaurant and coffee shop [Client A] aims to* ***improve their outdated back of the house storage mode****l for restaurants around the country to reflect current offerings. This* ***model needs improvement*** *because [Client*

> *A] does not believe they are building enough storage in new restaurants to accommodate the restaurant's size and sales. They also want to* ***ensure the back of house takes up necessary space -*** *they want to avoid over allocating storage in a restaurant that does not need it, and conversely want to* ***ensure they do not under allocate storage*** *in restaurants that may need to restaurant a lot of product.*

The final report includes much more detail, describes the current model, and clearly explains that the real problem was "non-optimal ordering":

> **[Final submission]** *[Client A], a multinational fast-food restaurant, is facing a problem with its current predictive algorithm for forecasting storage needs in its restaurants. The back-of-the-house in their restaurants has not been updated in over 10 years and does not accommodate their evolving product mix, which requires different space allocations for dry, cold, and frozen products.* ***The existing model relies on a static matrix with inputs such as weekly sales and the number of deliveries, completely ignoring important factors such as optimal ordering and product mix.*** *To address this problem, our analysis will focus on 24 Chicagoland restaurants to determine the validity of the current back-of-house storage model,* ***analyze potential misordering in restaurants, and quantify how many resources [Client A] is misallocating due to non-optimal ordering to provide value-creating recommendations.***

**Case Study #2: Communicate the Problem Better**

Even if a student team has an elegant solution, they still need to explain the problem clearly to the IE instructors assessing their work. The efficacy, value, and impact of a solution is likely to be questioned or inadequately assessed by the instructors if the problem is not explained clearly. We saw an instance of inadequate problem communication with a team tasked with a technical project to predict energy loss due to icing events for a client ("Client B") in the renewable energy industry. The team developed a sophisticated solution, but in the midterm report IE instructors struggled to assess its applicability and rationale because it was unclear why the team's model seemed to only take wind speed into account, and not temperature or dew point.

> [**Midterm submission**] *Our client, [Client B], analyzes weather-related risks for investors at new or existing solar or wind farms (terrains with many solar panels/turbines). The company is currently unable to quantify the isolated effect of icing events on energy loss. A tool to do so would greatly improve [Client B's] forecasts of profitability and reliability for potential farms.* ***Our project goal is to deliver a regression model that will predict the derate that turbines face during icing events by benchmarking energy production in icing situations against production in non-icing situations.*** *We will do so by segmenting our data into icing and non-icing events and comparing the expected energy production at certain wind speeds when no icing occurred versus the actual observed output during the icing events. A distribution will be fit on the gap that is observed between these two groups.* ***The final deliverable will model energy derate across a variety of potential wind speeds.***

The major impediment to assessing this team's work stemmed from confusion about wind speed, both in the role it played in the problem, and the rationale for its exclusive use in the energy prediction model in the solution. The team worked with the writing instructor during a talk back session where she read back their verbal problem statement. The conversation was illuminating for the students. She assisted in helping them revise their problem statement, revise the graphic visualizing their problem, and add a clarifying statement about the weather condition variables. The revised graphic and clarification are included below:

> [**Final submission**] ***While all three weather conditions [temperature, dew point, and wind speed] are needed to calculate derate, wind speed serves a different role in modeling than temperature and dew point.*** *The formation of ice is controlled by dew point and temperature (see Appendix 1). Thus, these two features were used to identify icing events internally and segment the data into icing and non-icing subsets. Wind speed, in contrast, was the only factor used externally in our machine learning model to predict energy production. Wind speed is the only condition with a strong effect on energy production once icing/non-icing events are separated (see Appendix 3: Step 2).* ***All three features are essential in modeling derate; temperature and dew point play an implicit role through data segmentation; whereas wind speed explicitly predicts energy production (Fig. 1: Step #6).***

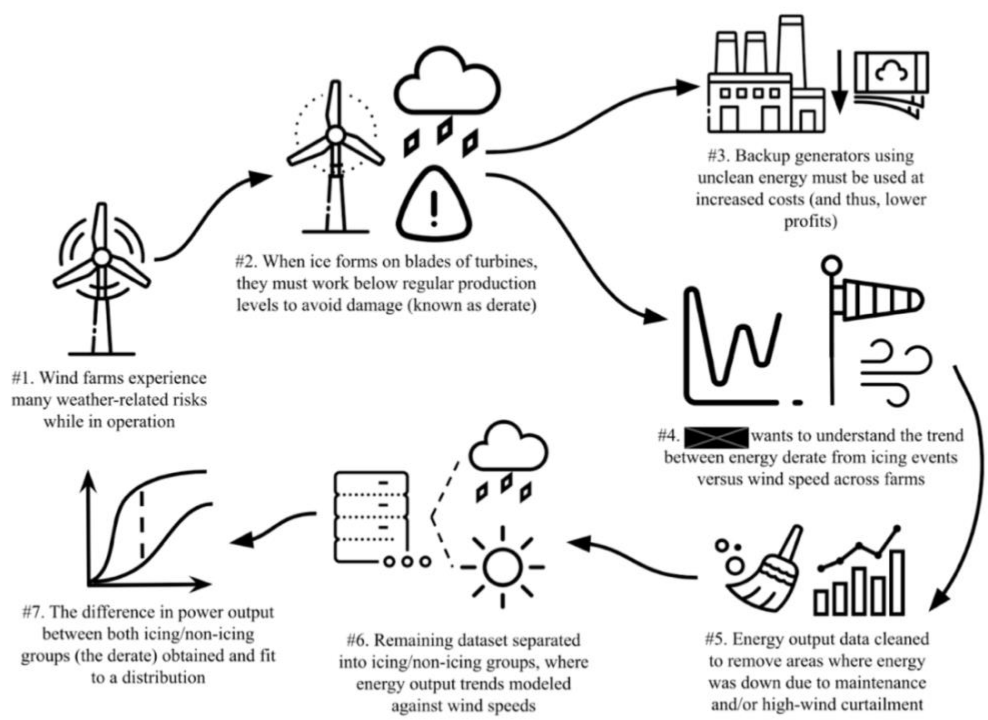


Fig. 1. Final team figure to explain the problem and area of interest for their solution.

**Case Study #3: Explain the Solution More Clearly**

In many instances students create a superb model, but it is difficult to assess the value and success of the solution because the team struggles to communicate clearly what they are doing. Another team struggled to explain their solution, which ultimately was to improve a police-accountability toolkit by adding statistical analysis functionality. At the beginning of the term this team's project proposal offered too much context in its presentation of the solution in language that was too integrated with the client's ("Client C") mission:

> [**Proposal submission**] ***There is a need for tools*** *that can be used by community-based organizations and individuals with basic data literacy to process, analyze, and understand law enforcement data.* ***This understanding and analysis is desperately needed*** *to support calls for police reform and understanding existing biases. [Client C] is trying to develop [a] Toolkit so that it can be independently used by small-town communities to understand local law enforcement data, implement the Toolkit on existing data [Client C] has, and implement the toolkit in an Illinois-based community.*

Apart from general wordiness and awkward grammar, this team only alludes to their solution approach vaguely later in their proposal, that is to create **"fully developed analysis methods and easy-to-understand outputs."** By midterm, the team was able to clearly state that their **"team's job is to build upon the toolkit's technical capabilities by implementing various high-level statistical analysis techniques."** The problem statement in the midterm report (omitted here for space) was an improvement from the proposal, but was still wordy, too granular, and awkward. The team worked through multiple drafts of their final report with the writing instructor, and in the end was able to clearly and succinctly describe and visualize their solution approach:

> [**Final submission**] ***Therefore, our team's job is to build upon the toolkit's technical capabilities by implementing three high-level statistical analysis techniques – a linear regression model, data visualizations, and a logistic regression prediction model.*** *By incorporating these additional analytical techniques, the toolkit can provide easily interpretable visualizations and predictive models. Our solution to this problem is visually illustrated in [Fig 2], which provides a representation of the inputs and outputs resulting from the use of additional data analysis techniques. In all, the expansion allows users to gain insights into both current and anticipated local policing patterns, significantly enhancing [Client C's] original toolkit capabilities.*

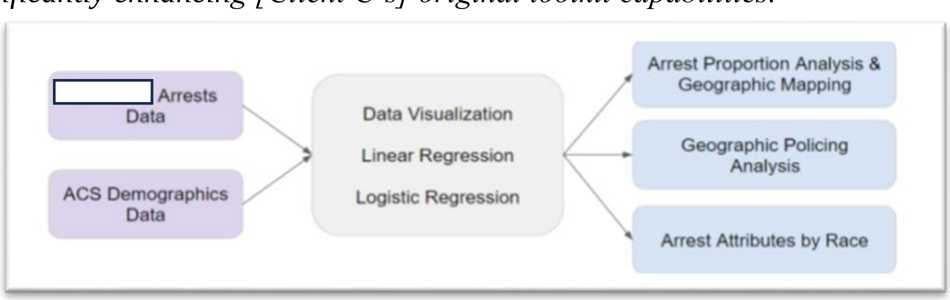


Fig. 2: A team using a visual to explain inputs and outputs in their solution.

## Discussion and future evaluation plans

Since the revised IE and writing team-teaching model was implemented in our capstone class in spring 2023, we have started to see a significant improvement in students' writing. Through a summative assessment process where students receive feedback and iterate on their writing and communication, the case studies illustrate how students: 1) better understand their problem, 2) better communicate their problem, and 3) more clearly explain their solution. A clear benefit conveyed in the co-teaching model responsibilities and timeline (see Table I), is that the writing instructor serves as an additional resource in the assessment process and is available to provide additional guidance on how to better communicate their understanding at each phase in the course. With the addition of the writing instructor, the IE instructors can better focus on and assess the technical descriptions of the problems and proposed solutions. Students also noted that the writing instructor was a helpful resource. For example, in the course evaluations one student noted that the writing instructor, "was really helpful and definitely impacted our written pieces positively." Another student noted the writing instruction "really encouraged me to apply the skills in other writing. I realize that I am more critical about my writing and more thorough when proofreading." A third student said the writing instructor "made writing easier."

Moving forward, we plan to continue to examine summative assessments, including final individual assignment and course grades, along with the formative assessments to enhance student learning and improve the team-teaching model. Research has indicated that students find co-teaching beneficial [22], [24]. At the same time, co-teaching may not always be a linear process for students and may create "an environment of uncertainty, dialogue, and discovery" [25, pg. 3]. As a team of instructors from different pedogeological backgrounds, our goal is to continue to discuss, understand and document students' comprehension of the IE/OR problem in the written deliverables. Next steps include embedding a peer review process into the first writing check-in, considering how to bring back the benefit of "talk back" (listening and repeating the problem description), and teaching students how to help each other clarify problem statements in the process, which may improve listening and communication skills. Rubrics will be updated to connect assignments more clearly to earlier submissions so students can see the iteration of their work to a final report. The rubrics will include competency levels of marginal, acceptable, and exemplary to clarify expectations of understanding throughout the project and how each section aligns with the IE program goals and learning objectives. Our goal is to continue to share lessons learned and best practices with the engineering education community in a future paper as we improve the capstone team-teaching model and assessment framework.

## References

[1] H. Silyn-Roberts, "Using engineers' characteristics to improve report writing instruction," *Journal of Professional Issues in Engineering Education and Practice*, vol. 124.1, pp. 12-16, January 1998.

[2] D. A. Winsor, "Engineering Writing/Writing Engineering," *College Composition and Communication*, vol. 41, no. 1, p. 58, Feb. 1990, doi: https://doi.org/10.2307/357883.

[3] D. A. Winsor, *Writing like an engineer*. New York, NY: Routledge, 1996.

[4] B. M. Aller, "*Writing practices in the engineering workplace: Findings and implications for teachers of engineering communication.*" Order No. 3035715, Michigan Technological University, United States -- Michigan, 2001.

[5] D. A. Winsor, *Writing power: Communication in an engineering center*. Albany, NY: State University Of New York Press, 2003.

[6] P. Spence and G. Liu, "Engineering English and the high-tech industry: A case study of an English needs analysis of process integration engineers at a semiconductor manufacturing company in Taiwan." *English for Specific Purposes*, vol. 32, pp. 97-109, 2013. https://doi.org/10.1016/j.esp.2012.11.003

[7] H. Kassim and F. Ali, (2010). "English communicative events and skills needed in the workplace: Feedback from the industry." *English for Specific Purposes*, vol. 29, pp. 168-182, 2010. https://doi.org/10.1016/j.esp.2009.10.002

[8] "Criteria for Accrediting Engineering Programs, 2022 – 2023," <https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023/#GC3>, accessed January 29, 2024.

[9] J. D. Ford and L. A. Riley, "Integrating communication and engineering education: A look at curricula, courses, and support systems," *Journal of Engineering Education*, vol. 92, (4), pp. 325-328, 2003, https://doi.org/10.1002/j.2168-9830.2003.tb00776.x.

[10] S. Manuel-Dupont, "Writing-across-the-curriculum in an engineering program" *Journal of Engineering Education*, vol., no. 85, pp. 35–40. 1996, https://doi.org/10.1002/j.2168-9830.1996.tb00205.x.

[11] P. L. Hirsch, Shwom, B. L., Yarnoff, C., Anderson, J. C., Kelso, D. M., Olson, G. B., & Colgate, J. E. "Engineering design and communication: The case for interdisciplinary collaboration," *International Journal of Engineering Education*, vol. 17 (3 and 4), pp. 342–348, 2001.

[12] A. Chesley, Mentzer, N., & Laux, D., "*Design, communication, and writing: Interdisciplinary integration for first year technology students*," Proceedings of the 34th ACM International Conference on the Design of Communication. 2016.

[13] R. J. Bonk, P. T. Imhoff and A. H. Cheng, "Integrating written communication within engineering curricula," *Journal of Professional Issues in Engineering Education Practice,* vol. 128, (4), pp. 152-159, 2002.

[14] S. R. Jenkins et al., "Capstone course in an integrated engineering curriculum," *Journal of Professional Issues in Engineering Education Practice,* vol. 128, (2), pp. 75-82, 2002.

[15] B. Shwom and P. Hirsch, "Re-envisioning the writing requirement: An interdisciplinary approach," *Business Communication Quarterly*, vol. 62, (1), pp. 104-107, 1999.

[16] D. F. Julie and S. W. Teare, "The right answer is communication when capstone engineering courses drive the questions," *Journal of STEM Education: Innovations and Research*, vol. 7, (3), pp. 5-12, 2006.

[17] M.C. Paretti, "Teaching communication in capstone Design: The role of the instructor in situated learning," *Journal of Engineering Education*, vol. 97, pp 491-503. 2008, https://doi.org/10.1002/j.2168-9830.2008.tb00995.x

[18] B.S. Bloom, J.T. Hastings and G.F. Madaus, (eds). *Handbook on the Formative and Summative Evaluation of Student Learning*. New York: McGraw-Hill, 1971.

[19] P. Broadfoot and P. Black. (2004) *Redefining assessment? The first ten years of assessment in education,* Assessment in Education: Principles, Policy & Practice, vol 11 (1), pp. 7-26, doi: 10.1080/0969594042000208976

[20] G. Durovic, "Continuous summative assessment sessions as a motivational tool for STEM students: A case study," *2020 43rd International Convention on Information, Communication and Electronic Technology (MIPRO)*, Opatija, Croatia, 2020, pp. 587-591, doi: 10.23919/MIPRO48935.2020.9245384.

[21] H. A. Diefes-Dux, J. S. Zawojewski, M.A. Hjalmarson and M.E. Cardella. "A framework for analyzing feedback in a formative assessment system for mathematical modeling problems," *Journal of Engineering Education*, vol. 101 (2), pp. 375-406. 2013. https://doi.org/10.1002/j.2168-9830.2012.tb00054.x

[22] N. Ayish, "Student perceptions of an engineering course co-taught by an English instructor at an EMI university in the UAE," *Issues in Educational Research*, vol. 32 n1, pp. 16-35, 2022. https://search.informit.org/doi/10.3316/informit.475563657859356

[23] P. Vesikivi, M. Lakkala, J. Holvikivi and H. Muukkonen, "Team teaching implementation in engineering education: Teacher perceptions and experiences," *European Journal of Engineering Education*, vol. 44 (4), pp. 519-534, 2019. doi:10.1080/03043797.2018.1446910

[24] A. Harter and L. Jacobi, "Experimenting with our education" or enhancing it? Co-teaching from the perspective of students," *I.E.: Inquiry in Education*, vol. 10, (2), article 4, 2018, Retrieved from: https://digitalcommons.nl.edu/ie/vol10/iss2/4

[25] K. M. Plank. *Team teaching: Across the disciplines, across the academy*. Herndon: Stylus Publishing. 2011.