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Work in Progress (WiP): Scaffolding the Transition from Student to Engineer: A Situativist Model for AI Integration in Capstone Design

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Work in Progress (WiP): Scaffolding the Transition from Student to Engineer: A Situativist Model for AI Integration in Capstone Design

Abstract

The rapid integration of Generative Artificial Intelligence (GenAI) into the engineering profession demands a parallel evolution in engineering education that moves beyond tool proficiency toward professional identity formation. This "Work in Progress" (WiP) paper details a situative pedagogical initiative designed to help students practice in the classroom the professional judgment they will exercise throughout their careers. Grounded in cognitive apprenticeship theory, we position GenAI not merely as a productivity tool but as an epistemic tool that mediates how students come to know and verify engineering knowledge. Our intervention in an interdisciplinary capstone course includes a formal AI Usage Disclosure and Certifications policy to simulate the professional liability and transparency required in industry, alongside ethics instruction and scaffolded GenAI integration in technical risk identification. Preliminary findings suggest that AI-generated errors—including hallucinated standards and implausible recommendations—serve as productive "teachable moments" that make visible the verification practices experts perform routinely. We conclude that this mentorship model is effective not because it teaches use of GenAI as a tool, but because it uses the tool's limitations to teach the essential human element of engineering judgment.

Keywords: generative AI, capstone design, situativism, cognitive apprenticeship, engineering ethics, professional liability.

Introduction

The engineering design workplace is undergoing a seismic shift as Large Language Models (LLMs) and Generative Pre-trained Transformers (GPTs) become ubiquitous [1]. In response, the senior engineering design capstone course at Dartmouth College has moved away from restrictive policies toward a model of responsible, professional integration. This paper describes a "Work in Progress" intervention that views the instructor as a mentor "coming alongside" students to guide their induction into the engineering community of practice, where they will serve as a "Human in the Loop" proficiently using GenAI tools. This approach is grounded in situativism, which frames engineering learning as occurring through participation in authentic practices, where students develop professional identity while gradually moving from peripheral to fuller participation in engineering communities [2]. The engineering design capstone, taking place in the final year of a student's undergraduate engineering education, is an appropriate application for cognitive mentorship on student practices with tools such as GenAI [3]. Capstone engineering students are prompted to apply the knowledge and skills built throughout their engineering education to an industry project and in so doing, to act at the highest levels of Bloom's Taxonomy in creating, formulating, investigating and refining design solutions [4].

This transition to higher levels of cognition, and the consequent identity shift from student to practitioner, that takes place in the capstone is visualized in Figure 1. Stevens et al. characterize "becoming an engineer" as a process that unfolds across academic, professional, and personal dimensions. Students must not only acquire technical knowledge but also learn to see themselves as engineers and be recognized as such by others [5]. The capstone, as a liminal space between academia and industry, is a critical site for this multi-dimensional identity formation.

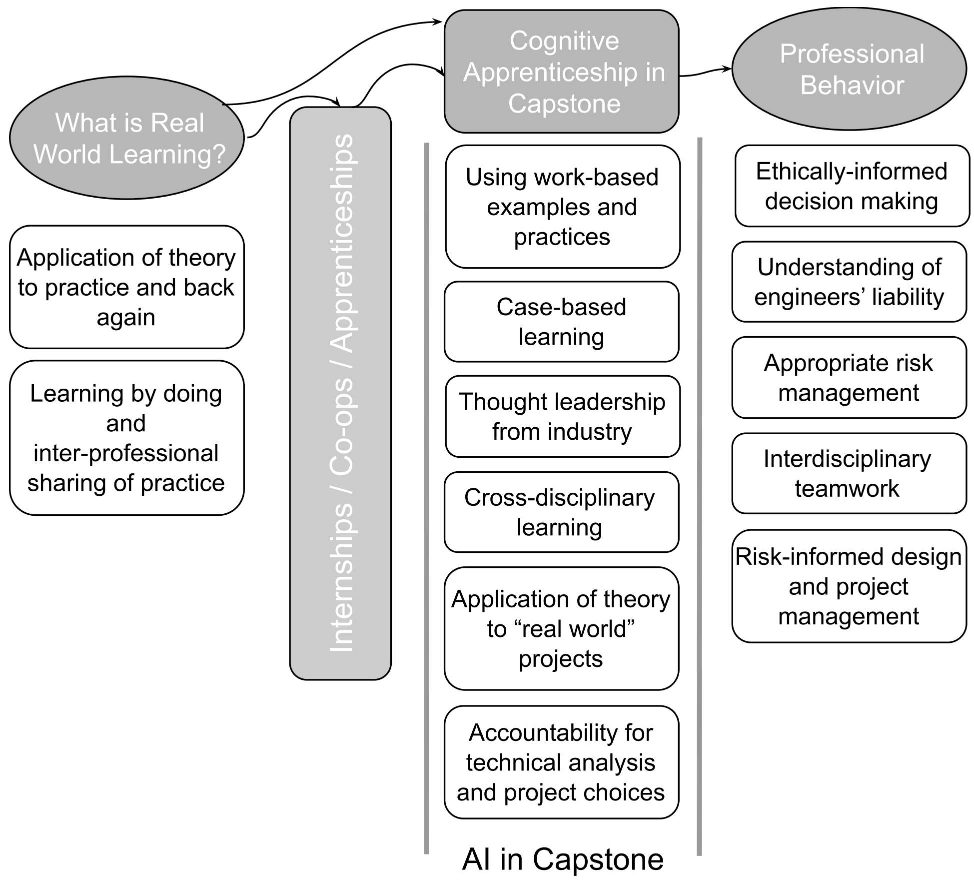

Figure 1: How cognitive apprenticeship functions in the capstone and situates design learning within a student's journey to professional practice in the engineering community. Adapted from [6].

The primary goal of this particular intervention in the engineering design capstone is to address the gap between novice and expert "problem framing" [6], [7]. This goal aligns directly with ABET Student Outcomes 4 and 5: the ability to "recognize ethical and professional responsibilities in engineering situations and make informed judgments" and the ability to "function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" [8]. By framing GenAI usage as an exercise in professional judgment rather than mere tool proficiency, we situate ethics and collaboration at the center of technical skill development. Furthermore, by integrating AI ethics into the professional development sequence and implementing a GenAI Use Disclosure and Certification form, we frame AI usage as an exercise in embodying professional engineering identity. Students are taught that, much like a signed and stamped engineering technical drawing, an AI-informed report represents a non-transferable responsibility to public safety and welfare that should be handled with care.

2. Theoretical Framework: Situativism and Cognitive Apprenticeship

This study is grounded in the situative perspective of learning. We view the capstone course as a "community of practice" where students engage in legitimate peripheral participation [2]. Specifically, we utilize the model of cognitive apprenticeship in higher learning, which emphasizes making the "invisible" thought processes of an expert visible to the novice through modeling, coaching, and scaffolding [6], [9]. Following design-based research principles [10], we use cognitive apprenticeship theory both as a design framework for the intervention and as an interpretive lens for analyzing student responses. This WiP reports on the first iteration of this design cycle in Dartmouth's engineering capstone course.

Our pedagogical backbone also draws on Bransford et al.'s *How People Learn*, specifically the distinction between how novices and experts approach problem framing [7]. While novices often look for "right answers" or "system defaults," expert design engineers utilize systematic processes to produce "good" outcomes amidst ambiguity. In this context, GenAI is not merely an instrumental tool; it is a site of professional identity negotiation where students must reconcile the efficiency of AI-generated content with their emerging responsibility as engineers to verify, validate, and take ownership of technical work. We interrogate whether AI use helps students move toward "expert-like" framing—considering broader contexts and risks—or if it reinforces "novice-like" behaviors, such as over-reliance on unverified data.

Critically, we position GenAI as a productivity tool that accelerates task completion, but further as an epistemic tool that mediates how students come to know and verify engineering knowledge. When students prompt an AI for risk identification or design guidance, they engage in a fundamentally different epistemic practice than consulting a textbook or performing hand calculations—one that requires them to evaluate the credibility of outputs they cannot trace and validate claims against their own developing engineering judgment [11]. Unlike traditional information sources, where provenance and reasoning can be examined, AI outputs present what Bearman and Ajjawi term a "black box" challenge: students must develop new forms of epistemic agency to work critically with tools whose reasoning processes remain opaque. This framing aligns with recent calls in engineering education to examine not just *whether* AI helps students complete tasks, but *how* its use shapes their reasoning processes and professional epistemology [3].

3. Methods and Research Question

This study seeks to answer: *In a capstone design course structured around cognitive apprenticeship, how do students' epistemic practices with GenAI-generated outputs shift across a term-long intervention, and what role do scaffolded encounters with AI limitations play in that shift?*

This mentored GenAI pedagogical intervention was implemented in the fall term of a two-term interdisciplinary capstone course and is still in progress. We utilize a multi-faceted approach across technical projects and professional development (PD) modules. This data is still incoming at the time of submission, but our intended method is to study student work under IRB exemption with anonymization by removing cover pages from final reports and redacting any names included in the report, then review the AI Disclosure and Certifications for each student project team. We plan to analyze data from 24 interdisciplinary project teams with approximately 120 students through:

1. Grounded Theory Coding: Analyzing students' PD reflections to identify shifts in student perception of AI and student application of the National Society of Professional Engineers (NSPE) Code of Ethics to a case study based on an AI-centered case that came before the NSPE Board of Ethical Review [12], [13], [14].
2. Expert vs. Novice Comparison: Reviewing project documents (like risk registers, project plans, and final reports) to compare the "breadth" of AI-assisted risk identification against historical, non-AI project data.
3. Epistemic Reflection: Evaluating how students' internal thinking about the tool evolves over the course of the capstone experience, we will analyze qualitative evidence from four primary sources: (1) a prompted "Four Principles" reflection at the end of each term, (2) the in-class risk identification exercise, (3) written responses in the PD4 ethics module concerning the NSPE Code of Ethics and professional liability and (4) the AI Disclosure and Certifications submitted with final reports at the end of each term.

These three analytical approaches are designed to surface evidence across three theoretically-derived markers of productive epistemic shifts:

1. Behavioral Marker: Students modify or reject AI-generated outputs based on engineering reasoning rather than accepting them uncritically. This is observable in risk registers and final reports.
2. Epistemic marker: Students articulate that AI outputs require independent verification and that this verification is the engineer's responsibility. This is observable in PD4 responses and end-of-term reflections.
3. Identity marker: Students frame verification not as an academic compliance requirement but as inherent to what it means to be a professional engineer. This is observable in the language and completeness of their AI Disclosure and Certification forms.

We do not expect uniform demonstration of all three markers across all students. Rather, we will use them as analytical anchors to characterize the range of student responses and to identify which intervention components appear most associated with productive shifts.

4. Application: Scaffolding Professional Identity

4.1 Professional Development: Engineering Identity and GenAI in the Ethics of Liability

Alongside the technical project work, we integrated AI ethics training into our existing professional development (PD) curriculum, which is intended as an asynchronous mentored exercise in honing key engineering skills while articulating a professional identity as an engineer [15]. This intervention was sequenced so that each component built on the previous component. This sequence began with “PD1: Define Your Values” (Appendix 2), where students identified their core professional values (e.g., integrity, accuracy, inclusivity) to establish a personal framework for decision-making. As part of the assignment, a course instructor shared their answers to each of the prompts, showing students what an expert’s approach to solving this “problem” might look like. Students were prompted to use GenAI to create a LinkedIn “About Me” paragraph that integrated their values and key moments in informal learning.

In “PD4: Ethics” (Appendix 3), students were asked to apply the values stated in PD1 to a case study designed to address the ethical responsibilities associated with emerging AI technologies. We leveraged GenAI to synthesize professional experience from one of the capstone instructors and a case review from NSPE Board of Ethical Review (Case 24-2) to generate a hypothetical case study titled “Use of AI in HVAC Design” [14]. In this simulated case scenario, an engineer relied on AI-generated analysis to meet a deadline, but the uninterrogated use of AI analysis resulted in system failures to the detriment of human health. Students analyzed this case through the lens of the NSPE Code of Ethics [12]. This case-based, real-world approach facilitated nuanced discussions around issues such as algorithmic bias, the potential for unintended consequences, and the engineer’s non-transferable liability for public safety. The professional identity foundation established in PD1 and ethical framework developed in PD4 were designed to scaffold students' critical evaluation of AI outputs in the technical risk identification exercise.

4.2 Risk Identification: Divergent vs. Convergent Thinking

One of the most challenging aspects of capstone design for novice engineers is identifying “don’t know you don’t know” (DKDKs in Josephs and Rubenstein’s *Risk Up Front*) [16]. In the “Project Safety and Risk Management” module of the capstone, teams were shown how to use generative AI to brainstorm potential project failure modes specific to the technical focus area of their capstone projects and situated in the capabilities of their particular student team (i.e., which courses have been taken and what technical work the team is prepared to complete). Students prompted the AI with their design specifications and asked for a list of potential safety hazards, regulatory concerns, and prototyping roadblocks. They were then required to cross-reference these AI-generated lists with their own Failure Modes and Effects Analysis (FMEA) to build out their FMEA and risk register for their project.

This module involved both divergent (brainstorming) thinking and convergent (verification) thinking tasks, as visualized in Figure 2. Instructors acted as coaches, pointing students toward “what good looks like” by challenging AI-generated content that lacked physical grounding or hallucinated ASTM standards.

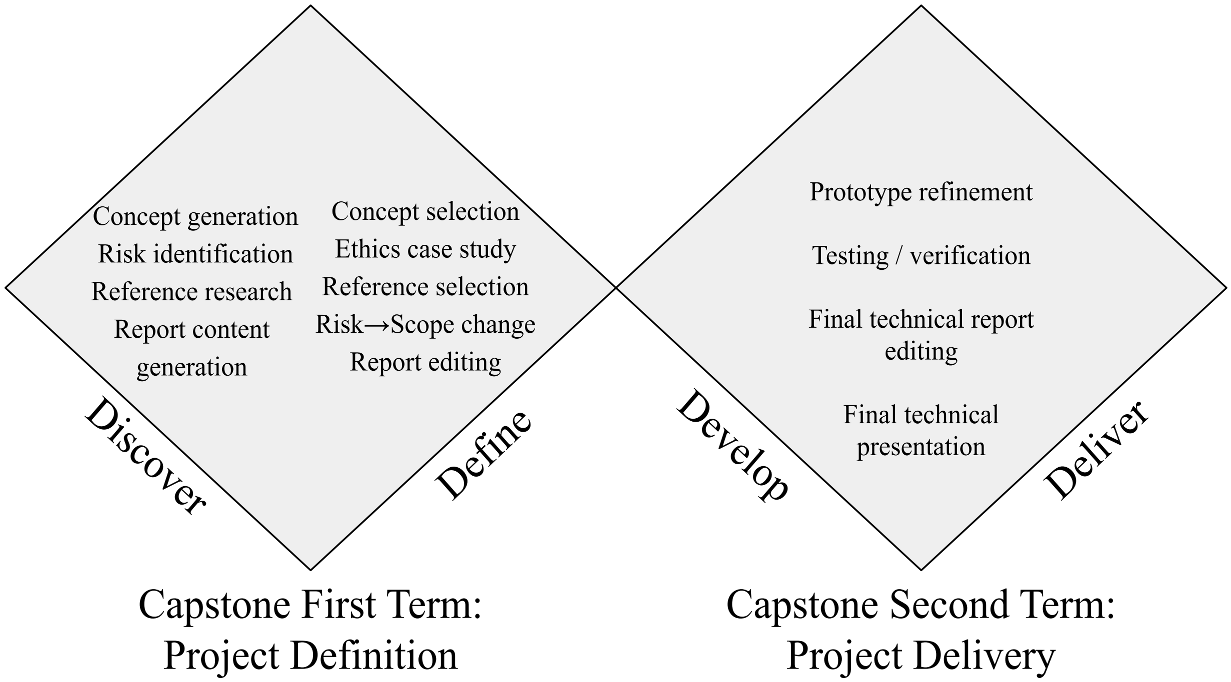

Figure 2: The double diamond converge - diverge model as applied within Dartmouth's two term capstone course, showing in-class activities and asynchronously-produced work products.

This exercise highlights a key distinction in how GenAI functions as an epistemic tool compared to traditional engineering resources. When students consult a textbook for failure modes, they encounter knowledge with visible provenance: the reasoning is derivable, the source is authoritative, and the scope of applicability is stated. When they consult a mentor, the knowledge comes with contextual judgment and the mentor can explain *why* certain risks matter more than others for a given project. In contrast, when students prompt GenAI for the same information, they receive outputs that appear authoritative but lack traceable reasoning. The AI cannot explain why it prioritized one risk over another, and it cannot distinguish between a genuine standard and a plausible-sounding fabrication. Even with coaching from the course directors, students who used GenAI for risk identification followed a fundamentally different epistemic path—one that required them to develop verification skills that traditional information sources do not demand. This distinction positions this risk identification exercise not merely as a productivity tool demonstration but as a site for developing the epistemic agency that professional engineers exercise routinely.

This sequence instantiates the cognitive apprenticeship progression from modeling (the instructor's PD1 exemplar), through coaching (the guided PD4 case analysis), to scaffolded independent practice (the risk identification exercise with instructor feedback).

5. Preliminary Results and Observations

5.1 Impact on Risk Analysis and Problem Framing

Implementation of this intervention will yield quantitative data on AI usage patterns and qualitative observations regarding work quality and ethical awareness. Observed student usage of AI is visualized in Figure 3.

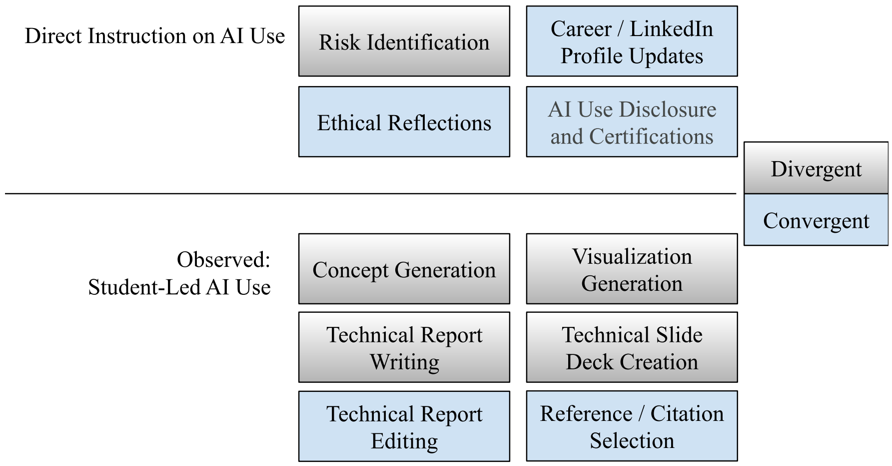

Figure 3: This visualization shows where we instructed students to use and disclose their use of GenAI, compared to where we observed students using AI tools (with and without disclosure).

Preliminary analysis suggests a significant increase in the quantity of risks identified with guided use of GenAI for this purpose. We are measuring the delta between AI-generated risks and student-verified risks to quantify the "verification gap." A key limitation of this WiP is the absence of a controlled comparison group; we use historical data as an imperfect baseline. However, the *quality* of these risks varied.

- **Expert-like Framing:** One team used AI to discover specific ISO biocompatibility standards for a medical device that they had not considered, which they then verified through library databases (a behavioral marker).
- **Novice-like Framing:** Another team included AI-generated "safety tasks" in their project plan that were physically impossible given their budget, failing to exercise the convergent judgment required to prune the AI's divergent noise.

This module also exposed the limitations of GenAI as an engineering tool; several teams reported that the AI invented nonexistent ASTM standards. This provided a "teachable moment" reinforcing the engineer's responsibility to verify all data—a lesson directly reinforced by the PD4 ethics case study. Future iterations of this module will examine whether observed convergence failures reflect student development or assignment scaffolding gaps.

5.2 Hallucinations as "Teachable Moments"

We observed that the GenAI Use Disclosure and Certification Policy (Appendix 1) changed the narrative tone of student-instructor interactions. Because "cheating" was redefined from AI use as a shortcut to AI use without disclosure and verification, students were for the most part candid about when AI failed. This transparency created opportunities to examine how encountering AI errors impacted students' thinking about verification and professional responsibility.

We further observed from Weekly Accountability Meeting project planning documents that many students used AI to generate lists of project tasks, and some students presented those tasks in the official project plan without verifying the necessity of the work. This resulted in confusion and ultimately an excess of tasks the students committed to without review. Early in the term, students treated AI outputs with the same epistemic authority as a textbook or instructor guidance—a novice stance that assumes information sources are pre-verified. However, when confronted with fabricated ASTM standards or physically impossible safety tasks, several teams reported a notable shift in their approach. One student reflected, "I realized I can't just trust what it gives me—I have to actually know enough to check it." This epistemic marker designates a shift from GenAI as authority to GenAI as a tool that must be verified, and it is the beginning of what we interpret as a transition toward professional judgment: the recognition that the engineer, not the tool, bears ultimate responsibility for verification.

Additionally, the course instructors had to return several midterm draft reports where students admitted to using AI but failed to verify the output, resulting in generic technical writing and hallucinated references. It is noted that the instructors did not detect any further unverified AI use on the final reports at the end of the term. While these cases represent incomplete development of a professional identity with regard to GenAI use (and accompanying responsibility for the generated results), they also served as high-stakes "teachable moments." The act of having work returned, with the explicit message from instructors ("experts") that professional engineers cannot submit unverified analysis, reinforced the non-transferable nature of engineering liability in ways that a lecture alone could not. Within our cognitive apprenticeship framework, these productive failures serve a critical pedagogical function: they make visible the verification practices that experts perform automatically but rarely articulate, transforming tacit professional knowledge into explicit learning opportunities.

At the end of the second term of the capstone course, a formal voluntary course assessment included five questions related to AI practice. Of 121 students in the course, 79 students responded to the survey questions. The results of the survey are shown in Figure 4.

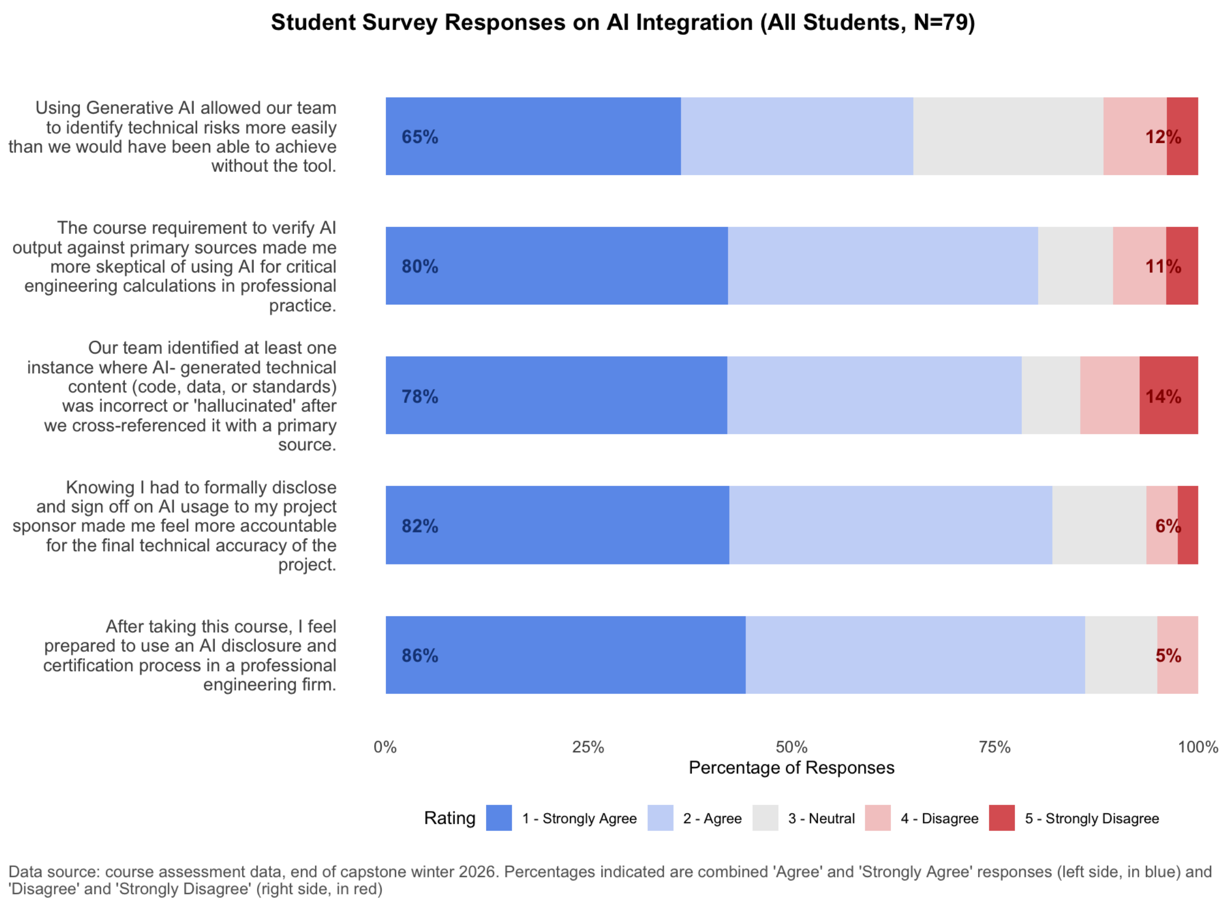

Figure 4: The results of the course assessment by students indicated the majority of students agreed or strongly agreed with five key statements about their AI use related to their professional identity and the practice of engineering.

6. Discussion and Next Steps

This capstone GenAI cognitive mentorship model is still under evaluation. Implementation challenges included inconsistent student compliance with disclosure requirements and instructor time required to verify AI-generated content in student submissions. We believe the capstone design course offers an opportunity for instructors to mentor students into good engineering practice, and for students to develop a sense of what it means to belong to the engineering community of practice. From a situative perspective, the guidance instructors provide on GenAI usage represents more than procedural instruction—it embodies the accumulated professional judgment of the engineering community. When students adopt these practices for their capstone projects, they are not simply learning to use a tool; they are participating in a tradition of practice that connects them to the broader professional community [2].

Importantly, instructors are not the only practitioners students interact with in this community. Project sponsors from industry also model current professional norms around GenAI usage in practice, while faculty advisors demonstrate disciplinary approaches to technical verification. When an industry sponsor questions an AI-generated risk assessment or a faculty advisor challenges a hallucinated or out-of-context specification, they reinforce the same message from different positions within the professional community. This multi-voiced mentorship—where students receive consistent guidance from instructors, advisors, and sponsors—strengthens the authenticity of students' peripheral participation and accelerates their movement toward full membership in engineering practice.

These findings indicate that the model succeeds by reframing GenAI's limitations as pedagogical tools. This approach shifts the focus from 'how to use AI' to the human-centric core of engineering, situating student work within a broader professional context.

Future Work

As this is a Work in Progress, data collection is ongoing. We plan to quantify the impact of GenAI on technical writing quality and instructor bias by hallmarks of GenAI, though methodology is still in development. We will also survey external industry sponsors to gauge their perception of the "GenAI Disclosure and Certification" statements and comparative quality of student reports with varying levels of declared GenAI use.

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Appendix 1: Generative AI disclosure policy used by students in this capstone course

Generative AI Use Disclosure and Certifications
Duplicate this form, check the appropriate boxes, and include it immediately following the cover page in your written reports.
Generative AI can boost productivity, ideation, and efficiency. This disclosure is intended to help ensure responsible use, protect IP and confidentiality, maintain academic integrity, and support safety, compliance, and reproducibility.

Gen AI Use Disclosure

- ☐ Tasks used (check all that apply):
    - ☐ writing/editing;
    - ☐ idea synthesis;
    - ☐ figure generation;
    - ☐ image modification;
    - ☐ code drafting/refactoring;
    - ☐ data/statistical analysis;
    - ☐ prior art/literature search.
- ☐ GenAI Tools used (check all that apply)
    - ☐ Dartmouth institutional locally-hosted
    - ☐ Dartmouth institutional cloud-hosted
    - ☐ Personal accounts (not permitted for sponsor materials)

Certifications (check <u>all</u> boxes to certify compliance with course expectations)

- ☐ We remain fully responsible for the accuracy, compliance, and authenticity of all content, including the responsible protection of intellectual property, copyrights, and trademarks.
- ☐ All AI-assisted text, figures, code, facts, references, and claims were read, understood, edited for accuracy, and verified by the primary team member author and corroborated by a second team member.
- ☐ No confidential or regulated data (PII/PHI/personal data, FERPA/HIPAA/GDPR/student data, ITAR/EAR/restricted data) was uploaded without explicit prior authorization.
- ☐ Prompts, key settings, model/version, dates, and outputs are retained; complete logs are available for audit in the team's course drive workspace.
- ☐ Licensing of AI outputs assessed; compatibility with open-source/commercial licenses confirmed; copyleft implications for code considered.
- ☐ AI-influenced designs/code were tested/verified and aligned with applicable standards (e.g., ISO/IEC/IEEE); safety reviews/sign-offs documented.
- ☐ Outputs screened for bias/harm.
- ☐ AI-generated or modified media is clearly labeled.
- ☐ All team members have discussed and approved of the team's AI use strategy
- ☐ The project sponsor reviewed and approved of the team's strategy for managing AI usage risks prior to using sponsor materials in any AI tools.
- ☐ The team has consulted with the course directors on ambiguous or high-risk cases.

Appendix 2: The PD1 assignment used by students in this capstone course

Professional Development Assignment 1: Define Your Values

Engineering professionalism arises from living our values with integrity. [1] Our values help to guide us in determining right versus wrong in our thoughts, speech, and actions. Learning to practice engineering with integrity begins by becoming aware of how we think, speak and act in relation to our values, and how our learning experiences, both formal and informal, have shaped us. [2], [3] This awareness arises from self-reflection and gives us the opportunity to identify our strengths and where we have room for improvement. [4], [5]

Instructions

Submit a pdf listing a list of values that you personally hold and plan to express during your capstone design course, along with a table of experiences that shaped those values. Then build or edit your "About" section that could be used on LinkedIn or a cover letter: a max of 2,600 characters informed by your values and experiences. Samples of each of these three components for this assignment are shown in the Example Assignment Submission section.

Additional Context

When preparing your submission, a bulleted list of values is fine, and somewhere between 3 and 10 values will be sufficient. A reflection is not necessary (and is not expected - no points will be given for a reflection) but may be something you wish to do for your own personal growth.

These values will help you identify professional goals and project tasks that are in alignment with the way you want to live and work. Please refer back to them.

Formal and Informal Learning Experiences

Before writing down your values to submit this assignment, please think about where you have had substantive learning experiences in your engineering journey. These could look like hilltop moments where you realize just how far you've come in your learning, or moments of struggle where you realized you needed to take a different approach, or experiences where you saw great work modeled by someone. [6] Take note of where you were (classroom, internship, extracurricular, etc.) and summarize your experience. What values did this help you catalyze? Add as many rows as you need - each value you list in your final submission should be linked to a line in your table, but each line in the table can define multiple values.

Template to Use

Add as many lines as you need.

Experience Description (1-2 sentences)	**Experience Setting** (ex. Classroom, internship, etc.)	**Value(s) Developed**

Example Assignment Submission

Please include all three key items in your submission: your list of values, your table of experiences, and your About paragraph for cover letters or LinkedIn. This example submission is genuinely true for Professor Emily Monroe (https://www.linkedin.com/in/emily-h-monroe/).

Values

- Take initiative!
- Systematic, quantitative decision-making should be used more than intuition / "this is how we've always done it"
- Inclusivity - consider all perspectives
- Integrity - do what you say you will do
- Humility
- Accuracy
- Reliability

Table

Experience / Learning Description (1-2 sentences)	**Experience Setting** (ex. Classroom, internship, etc.)	**Value(s) Developed**
Engineers don't always know everything they need to know when they start a project. I learned this by watching senior engineers tackle complex projects.	Internship at a manufacturing plant	Initiative, independent learning
Sometimes the best designs are not the best technically, but are an optimized mix of technical functionality, maintenance / repairability, initial cost, and usability. I learned this by designing (in mechanical design class and in an internship) and having to redesign a fixture because it achieved force requirements but was difficult to use and expensive to maintain (internship).	Design classroom and internship at manufacturing plant	Consider all perspectives - be inclusive
Accuracy is important, but it also is important to approach accuracy with humility. I learned this throughout my athletic career as an archer.	Archery - athletics	Accuracy is important. Humility is critical.

Follow through - with shots taken (archery) and with how you treat people. I have learned this through athletics and multiple extracurricular clubs where communication is paramount to achieving the organization's mission.	Athletics and clubs	Do what you say you will - integrity
Deriving things from first principles, like F=ma, can help keep knowledge organized and make inferences in new subjects easier to discover and understand. I learned this through multiple experiences across solid and fluid mechanics, dynamics, differential equations, and E&M courses.	Multiple classroom settings	Knowledge is systematic

About

My work is guided by integrity, humility, accuracy, and inclusivity, ensuring that I not only deliver reliable results but also bring many perspectives to the table. Across my experiences in mechanical design, product development, and engineering management, I've seen the value of deriving insights from first principles to navigate complexity and connect knowledge across domains. These lessons have shaped me into an engineer who is not only technically strong but also reliable, thoughtful, and dedicated to inclusive, effective problem-solving. I bring this experience with me to the classroom at Dartmouth, where I equip students with the skills and know-how they need to succeed in their engineering careers in industry and academia.

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Appendix 3: The PD4 assignment used by students in this capstone course

Professional Development Assignment 4 (PD4 - Ethics)
ENGS 89-190 | Fall 2025

This series of professional development assignments fulfills the following ABET Outcomes:

- [ ] PD3 - Safety: ABET Outcome 2
  An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, **safety**, and welfare, as well as global, cultural, social, environmental, and economic factors
- [ ] PD4 - Ethics: ABET Outcome 4
  An ability to recognize **ethical** and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- [ ] PD5 - Economics: ABET Outcomes 2 and 4
  An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and **economic** factors

  An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, **economic**, environmental, and societal contexts

Introduction

Professional engineering practice involves design decisions that cannot be separated from ethical decisions. As philosopher Wade Robison writes in *Ethics Within Engineering*:

> "Whatever choice we make, we are choosing one configuration of values and effects. Design solutions *always* have ethical values… An engineer may not consciously decide to solve a design problem with ethical considerations in mind, but whether intentional or not, all design solutions will have ethical values because they embody some configuration of values." [1]

Licensure as an engineer requires adherence to the National Society of Professional Engineers (NSPE) Code of Ethics. [2] Ethical discussions in engineering ought to happen at every level of design and operation of engineered solutions, and it can be helpful to use the NSPE Code of Ethics as a framework for evaluating ethical choices. This assignment intends to introduce you to the NSPE Code of Ethics through a case study in ethical engineering behavior where there are multiple right ways to proceed (as well as some wrong ways).

Instructions

Review this case study. Concisely respond (approx. 500 words or less) to the case, making use of the NSPE Code of Ethics where relevant. Your response should address the following questions:

1. Did Engineer A fulfill the professional obligation to ensure public health, safety, and welfare when relying on AI tools with defaults not verified?

2. Should Engineer A have disclosed the potential for error from defaults to the client, especially given that design assumptions (insulation, duct losses) are critical?

3. Upon discovery of the problems, what duty does Engineer A have to correct the errors? Should Engineer A proactively notify the client, issue corrected designs, or remediate?

4. What role does the firm's management have to ensure proper verification and checks are built into work processes, including pressure from deadlines?

Case Study: Use of AI in HVAC Design and the Problem of Undisclosed Errors

Engineer A is a licensed professional mechanical engineer working for ClimateTech Design LLC, a consulting firm specializing in commercial HVAC (heating, ventilation, and air-conditioning) systems. When designing a new HVAC system for a large office building, Engineer A uses an AI-based simulation tool that predicts load calculations, duct sizing, energy consumption, and airflow under various conditions. The tool automates many parts of the design workflow.

Engineer A is under tight deadlines for this project. To speed things up, Engineer A relies heavily on default settings in the AI tool, assuming these defaults are sufficiently accurate. Some spot-checks are performed, but not every calculation is reviewed in depth. The project proceeds, the design is approved internally, and the client installs the HVAC system based on Engineer A's design.

Several months after commissioning, the building occupants begin to complain about uneven temperatures, inadequate ventilation in certain zones, and higher energy bills than expected. An independent audit is commissioned. It finds that:

1. In one wing of the building, the AI tool's default setting underestimated duct pressure losses. This led to undersized ductwork, causing reduced airflow in that wing.
2. The AI tool's default assumed higher thermal insulation than what was actually used. This mismatch caused the load calculations to be off, resulting in the HVAC system being overburdened during peak conditions.
3. Because every zone was not carefully re-checked, Engineer A did not catch these mismatches prior to installation.

Engineer A learns of these discrepancies and realizes the errors could have been discovered during review, but due to time pressure they were not.

Notes: This case is based on two real life cases considered by the NSPE Board of Ethical Review. [3], [4] If you are looking for helpful examples of responses, I would recommend exploring their page.

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