Being and Becoming an Engineer: How Generative AI Shapes Undergraduate Engineering Education

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Abstract

This paper presents preliminary findings from the first year of a longitudinal study on how undergraduates in engineering programs at a large Midwestern R1 institution use Generative AI (GenAI) and view its role in their education. Based on surveys and interviews with first-year and upper level undergraduates enrolled in engineering degree earning programs, we explore how GenAI technologies influence the iterative process of developing engineering expertise and identity. While faculty discussions around GenAI often focus on controlling its use, student perspectives – how and why they use GenAI – remain under examined. Early findings suggest students see GenAI as a helpful but limited tool. However, its broader social, cultural, and technical impacts on engineering education are still unfolding. Identity and expertise are evolving practices shaped within a network of human and technological actors. Understanding how GenAI reshapes these processes is essential for developing student-centered pedagogies, policies, and practices related to GenAI.

Introduction

This paper presents preliminary research from the first year of a longitudinal empirical study of how undergraduates (first year students and students in senior design courses) enrolled in engineering programs at a large midwestern R1 institution use generative AI (GenAI) and their attitudes towards this technology[1]. While all of our participants reported using GenAI to develop expertise in engineering curricula, none reported any direct instruction on GenAI literacies beyond course policies related to authorship and plagiarism. This suggests an undercurrent wherein students are actively developing AI literacies that impact how they develop *as engineers* but with loose coordination with the faculty charged with curating the learning experiences that structure engineering expertise. Our project seeks to understand student being and becoming during the early moments of the GenAI era.

The emergence of GenAI has shifted higher education and the role of language, writing, and literacy in students' learning. Students will need to develop GenAI literacies that can help them complete learning tasks without compromising the intellectual labor they need to exert in order to acquire professional expertise [1] and to develop ideas [2]. Findings from early studies after the public release of ChatGPT have found that students see GenAI as a useful but limited tool [3-6]. GenAI tools saturate digital writing ecologies and continue to gain power with each iteration, yet student use of GenAI remains an understudied aspect of generative AI uptake in higher education literacy [7]. Engineering education has unique features (e.g., coding, calculations, design processes, technical communication) and deserves its own empirical research on student writing practices in relation to GenAI, not yet done to our knowledge.

Additionally, it is still unclear how generative AI technologies will shape the engineering education landscape as students grapple with the social, cultural, material, political, and technical

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implications of GenAI in their personal and professional lives. Work in writing studies has long shown that literacy practices mediate the formation of disciplinary expertise [8-11]. As students enter into the discourse communities [12-13] or communities of practice [14] they must develop specific kinds of knowledge and language practices (ways of saying-being-doing-thinking-feeling) that can allow them to be recognized as engineers [15]. However, the formation of disciplinary identity is affected by literacy experiences outside of STEM and engineering curricula [16-17]. GenAI promises to disrupt education and learning primarily by intervening in and altering the literacy practices that students use to acquire expert knowledge.

The formation of expertise is an established concern in engineering education. Litzinger, Lattuca, Hadgraft, and Newstetter argued for increased attention on the development of expertise in engineering education through learning experiences that foster deep conceptual knowledge and skill development related to engineering practice [18]. The disciplinary knowledge that structures engineering curricula both modulates and is shaped by the engineering identities acquired by individuals who make up the community of practice [19-21], thus understanding how students use GenAI in engineering curricula carries implications both for students' identities as engineers as well as the structure of knowledge and learning in the broader community. Thus, enacting engineering identities is not a monolithic or static activity, for as Rodriguez, Lu, and Bartlett further argue, students navigate their roles and negotiate the experiences that arise in engineering education [22]. Students currently enrolled in engineering degree programs are already negotiating the impacts and opportunities of an emerging technology.

However, in order to investigate how novices in engineering communities acquire expertise, we need more nuanced criteria to structure qualitative research on engineering identity [22]. Beaufort's longitudinal study resulted in a model to theorize the various interlocking knowledge domains required to achieve expertise [8], later updated by [9]. This model centers three core areas of knowledge, including subject-matter knowledge or the disciplinary content in engineering education, genre knowledge, and writing process knowledge. These are set against a background of rhetorical and discourse community knowledge domains, as well as metacognitive knowledge and critical discourse knowledge, which describes the boundaries between one community and another, such as electrical engineering and electrician (see Fig. 1).

While it may well be that GenAI offers a number of possible benefits for developing students' engineering expertise through personalized learning, language support, and other features [24], the homogenization of language and ideas in the prevalent corpora and LLM/GPT algorithms used may limit the diversity of thought in engineering practice [25] and students will need to continue developing a capacity to use writing to think and learn [26]. However, as [27] outlines, technology is never neutral or apolitical; new technologies build on old technologies, technology must be taught, and policing the use of technology in the classroom is not the same as developing a responsible technology pedagogy. If we are going to move past the conversations around policing student use of GenAI, we will need an understanding of how/when students use generative AI in their academic work, how/whether those engagements with GenAI are valued by students, and how those engagements affect the process of engineering enculturation.

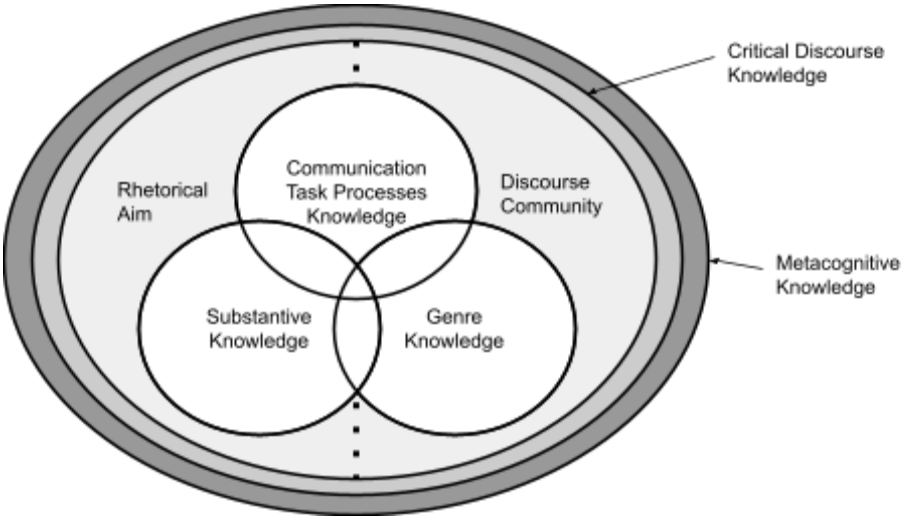

Fig. 1. Model of expertise based on [8] and updated by [9] shows the interlocking knowledge domains that structure the formation of identity with a given community of practice.

As a research team led by humanities-trained technical communication instructors working in a college of engineering, we understand identity and expertise not as static states, but rather as a set of iterative, recursive practices that one develops (and often never stops developing) over time [28-30] and that these practices exist in a networked ecology of human and nonhuman actors, all affecting this process of being and becoming. As engineering students move through their undergraduate education and beyond, new technologies like GenAI will ultimately affect the networked, ecological process of being and becoming an engineer. We believe it is worthwhile to examine the process of being and becoming in the age of AI. If engineering educators are to prepare students to be socially responsible, culturally aware, and technologically savvy, we must attune to students' social, cultural, material, and technological contexts.

Thus, a major goal of this project is to identify strategies for engineering and technical communication instructors and administrators to address GenAI in ways that are student-centered. We have to empower students to act as experts in their collaborations with GenAI, but without losing the intellectual labor that students need to exert in order to develop as writers, engineers, and technical communicators in their field (c.f., [26]). Further, as [31] argue in their qualitative study of students' use of AI, students will be experimenting with AI tools in their writing labor for academic curricula, and "whether we explicitly address the use of these tools in our classrooms or not, we are actively participating in the creation of a local ethic governing the use of AI" (p. 2). A responsible approach to supporting students' use of AI must incorporate what Vetter et al. describe as "students' ecological understanding of AI authorship, agency, reliability, and accessibility" through longitudinal studies of student uses of and attitudes towards GenAI (p. 9). In recognizing that non-human objects, including technologies like GenAI, can have distributed and diverse impacts on people (and people on them) through sustained interaction, we use *network* [32] and *ecology* as frameworks for exploring the impacts GenAI technologies have on the formation of expertise, writing knowledge, and professional identity [28-29] [33].

Our project asks two questions: (RQ1) How are engineering students using GenAI to develop academic expertise in engineering curricula, if at all?; and (RQ2) How do students value the benefits/limitations of using GenAI to support coursework in engineering curricula? This paper considers being and becoming an engineer during the GenAI era through analysis of initial findings that focus on how students use GenAI to develop subject matter knowledge and writing process knowledge in engineering. In what follows, we first describe preliminary survey results from our first semester of data collection, followed by a brief discussion of emerging trends from first-round interviews. The results from the survey include both quantitative data from likert-scale responses and qualitative data from open-ended questions with written responses. For this paper, first-round interview transcripts were analyzed holistically. In the concluding section, we attempt to identify common themes across all data sources and describe how these themes will shape our continuing research.

Methods

We surveyed students enrolled in first-year and upper level design courses in an R1 institution located in the midwest during Fall 2024 and Winter 2025. All courses included in the study had both engineering and technical communication faculty assigned as co-lead instructors. In total, we received responses from 182 students. In this survey, we asked students to rate their experiences and attitudes towards generative AI across a few key domains using likert-scale questions, including students' language backgrounds, the types of AI tools they have used, as well as specific question groups that focused on how students use GenAI technologies to develop expertise. Our survey focused on how students use GenAI to support the acquisition of subject knowledge in engineering courses, how they develop writing process knowledge both in engineering and technical communication courses as well as non-engineering courses, and finally how students use GenAI in their broader non-academic lives. The survey also included qualitative short-answer questions in each question group.

We invited all survey respondents who expressed an interest to participate in a semi-structured interview. In order to reduce the power differential between interviewer and respondent, the interviews were conducted by graduate student members of the research team rather than by the faculty members on the team. Survey respondents who participated in interviews (n = 24) were asked to talk about how they use GenAI in engineering and other course work, including in writing-focused coursework. All interview participants were invited to share examples of their writing with GenAI and to participate in follow-up interviews with the interviewer. Interviews were analyzed holistically and short-answer qualitative survey responses were analyzed using *in-vivo* coding methods for first-cycle analyses [34].

GenAI and the development of content knowledge in engineering

In terms of students' experiences using GenAI to develop engineering content knowledge, our early findings suggest mixed, and perhaps contradictory, experiences with GenAI. When asked to rate the statement *I use generative AI to help me develop content knowledge in my engineering courses* on a scale of 1-4 (1=Always, 4=Never), 65% of students indicated a negative response,

with 54 responses rated 3 and 36 responses rated 4 (never)[2]. The distribution of student responses can be seen in Fig. 2. The responses to this question suggest that a significant number of students *do not* use GenAI to develop content knowledge in their engineering courses on a regular basis.

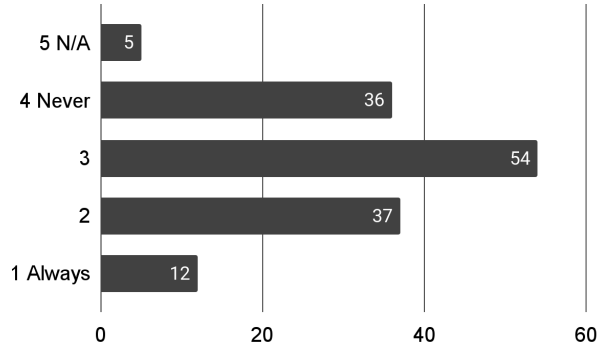

Fig. 2. Survey responses (n=144) for the statement **"**I use generative AI to help me develop content knowledge in my engineering courses." The majority of respondents (65%) indicate a negative response, indicating they never or rarely use GenAI to develop content knowledge.

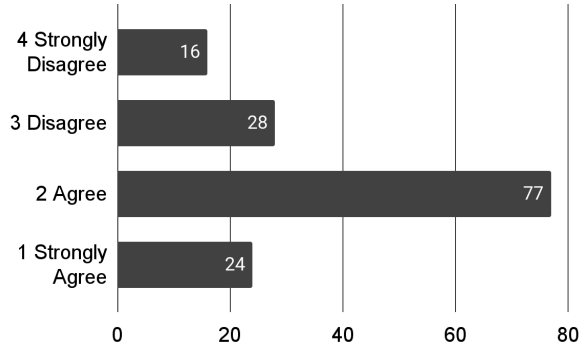

Fig. 3. Survey responses (n=145) for the statement **"**My use of generative AI tools has enhanced my understanding of complex engineering concepts." The majority of respondents (70%) indicate GenAI has improved their understanding of engineering concepts.

However, survey results from a different question show that the *impact* of GenAI on students' understanding of complex engineering concepts is out of alignment with their use of GenAI to develop content knowledge in engineering courses. For example, when asked to rate their level of agreement with the statement *My use of generative AI tools has enhanced my understanding of complex engineering concepts* from 1-4 (1=Strongly Agree, 4=Strongly Disagree), 70% of student responses indicate that GenAI tools have enhanced their understanding (see Fig. 3 above), with 53% rating the statement as a 2 (n=77) and 17% rating their agreement as a 1 (n=24). Even though 65% of students (n=90) indicated that they *do not use* GenAI to develop content knowledge in their engineering courses, 70% of students (n=101) report that the *use of generative AI tools has enhanced* their understanding of complex engineering concepts. While these results may seem antithetical to one another, it may be the case that students are using GenAI for purposes that include but are not limited to developing content knowledge, and are thus also acquiring content knowledge while achieving other goals for using GenAI. The vast majority of respondents have used GenAI (96%; n=175) with 5 respondents reporting they had not used GenAI and 2 reporting that they were unsure if they had used GenAI, with more students reporting using it late in the writing process rather than early in the writing process.

Nonetheless, these results are correlated with a significant, moderately strong relationship (chi-square: 95.724; Cramer's V: 0.471; df: 12; $p < 0.0001$), which suggests that students who use GenAI are very likely to agree that their use of GenAI tools has enhanced their understanding of complex engineering concepts. Further exploration of why a significant number of students indicate that they generally *don't use generative AI to develop content knowledge* in

[2] Since five students responded "N/A" to this survey question, they were left out of the calculations used to analyze responses to this survey question.

engineering courses while also generally *agreeing that their use of generative AI tools has enhanced their understanding of complex engineering concepts* will be a key investigation in future iterations of our study.

Students were also asked to provide qualitative responses related to their use of GenAI to develop engineering expertise. Qualitative responses (n=104) to the question *When you think about using generative AI to learn engineering content, what is important to you?* were initially analyzed using *in-vivo* coding to identify emerging trends, which we will describe here. Through first round *in-vivo* coding, two dominant trends emerged related to students' use of GenAI to learn engineering content. Students care about accuracy, factual correctness, and integrity in their use of GenAI (n=37); and students care about using GenAI as a learning tool to check, practice, and understand engineering content (n=48). That students care about accuracy, factual correctness, and integrity is unsurprising, since discussions about hallucinations and academic honesty abound in higher education spaces. However, students' characterization of GenAI as a learning tool indicates that they are thinking about how GenAI plays a role in their individual learning goals. Because students are using GenAI technologies as learning tools to develop their engineering content knowledge, these findings imply that GenAI may continue to play a role as a professional engineering practice as these students matriculate and enter the workforce: *being* an engineer in the age of GenAI might include the use of GenAI as an engineering tool.

Some responses to *When you think about using generative AI to learn engineering content, what is important to you?* that describe how students use GenAI as a learning tool include:

- "how [sic] they [generative AI technologies] can give an overview on topics or find information for me that i [sic] can then go and reference" (Kelly)
- "Using it [generative AI] to better understand content, as opposed to using it to avoid learning content" (Harper)
- "Using it [generative AI] to learn concepts, but then using it to create problems to practice those concepts" (Nimitz)
- "It [generative AI] is useful to help break down problems and understand what is being asked of me" (August)
- "Explaining things well, give help that works" (Adrian).
- "That it [generative AI] helps me to understand the concepts or create conceptual ideas, meaning it doesn't just give me an answer but is able to explain why something works. (If I can't find a video or other source of information first.)" (Brian)
- "It is important to make sure that the AI is helping me learn rather than just giving me answers that I can copy down" (Charlie)

Notably, responses from Adrian, Brian, and Charlie emphasize the importance of using GenAI to *learn* and *understand*, rather than just using GenAI to "give me an answer." In other words, they view GenAI as a tool for learning engineering content–learning how to *be* an engineer, to develop an understanding of engineering content.

Taken together, the dual trends of valuing accuracy, factual correctness, and integrity while also valuing GenAI's ability to serve as a learning tool to check, practice, and understand engineering content reveals a relatively balanced tension between students' beliefs about the limitations and opportunities for GenAI to enhance their learning and growth as engineers. On the one hand, students are concerned about the accuracy of information developed through GenAI

technologies, and they emphasize the need to use GenAI in a way that doesn't disrupt authentic, deep learning in their discipline. On the other hand, students value the potential for GenAI technologies to enhance their learning practices as they become engineers and report that it is important that GenAI be used in a way that complements other learning strategies (such as talking to a teacher or looking things up online). Students are thinking about how GenAI, as a learning tool, can be used to enhance their development of engineering expertise. Some of these trends will be discussed further in our analysis of interview data below.

GenAI and developing writing skills in engineering communication

Both quantitative and qualitative survey responses indicate that students are perhaps more skeptical about the value of using GenAI technologies in their writing practices than in their engineering practices. When asked to rate their level of agreement from 1-4 (1 = Strongly Agree, 4 = Strongly Disagree) with the statement *I am confident that I can write well without using generative AI*, 90% of students either strongly agree (n=70) or agree (n=48). The distribution of student responses for this statement can be seen in Fig. 4.

In addition to being confident in their ability to write well without using GenAI, students indicate that they generally prefer to write *without* using GenAI. When asked to rate their level of agreement from 1-4 (1 = Strongly Agree, 4 = Strongly Disagree) with the statement *I prefer to write without using generative AI*, 66% indicated that they strongly agreed (n=48) or agreed (n=38). The distribution of student responses for this statement can be seen in Fig. 5.

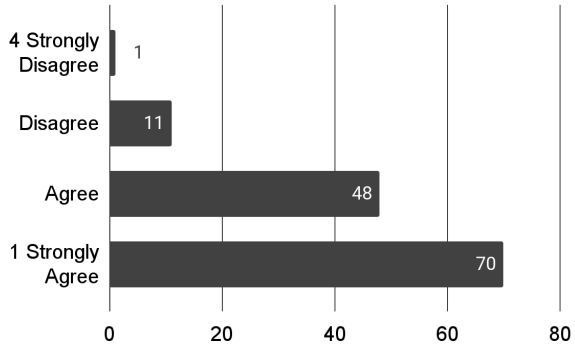

Fig. 4. Survey responses (n=130) for the statement "I am confident that I can write well without using generative AI." The vast majority of respondents (90%) agree with the statement.

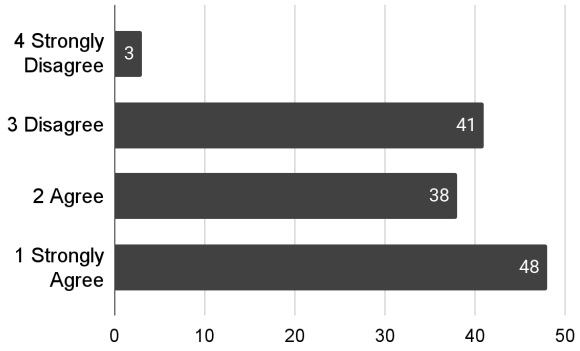

Fig. 5. Survey responses (n=130) to the statement "I prefer to write without using generative AI." The majority of respondents (66%) agree with the statement.

There is a significant, moderately strong correlation between students' *confidence in writing well* without the use of generative AI and their *preference for writing without generative AI* (chi-square: 71.274; Cramer's V: 0.427; df: 12; $p < 0.0001$). Several reasons might explain why currently enrolled students would prefer to write without using GenAI (such as prior experience,

ethical concerns about plagiarism and academic honesty, or concerns about authorship, ownership, and intellectual property in one's writing). Nevertheless, it is yet to be seen if this correlation between students' confidence in their writing ability and a preference for writing without GenAI continues as GenAI technologies become more ubiquitous in other technologies and tools used to do the work of academic writing (such as in word processing software or in email clients).

Qualitative responses about the use of GenAI in writing practices (n=74) correlate to the quantitative survey findings. In response to the question *When you think about using generative AI to write, what is important to you?,* the most significant themes in responses were surface-level editing (26%, n=19), writer's voice (24%, n=18), and, like the qualitative responses discussed above in reference to developing engineering content knowledge, correctness (18%, n=13).

For the sake of concision, here we will discuss select student responses about writers' voice, since these responses offer the richest opportunity to examine student attitudes towards GenAI as it relates to writing.

Many of the responses about writer's voice emphasize the importance of writing "sounding" like a human and having a human element.

- "When thinking about using AI to write, it is important to me that the voice and tone of the writing sounds like a human talking to the specific audience. AI can sometimes make writing sound just like it came from an AI source instead of having an authentic human feel to it." (Arya)
- "I think generative AI lacks what, in my mind, is the crucial portion of writing; its human aspect. Originality is all but removed from any text generated by AI in my mind, and as a result reads clunky. Plus, I don't think it can consider the aspect of readability; that is, generative AI has no concept of how its output may be understood." (Dara)
- "What's important to me is how to revise writing I already made without losing the central voice or choice conventions." (Bartholomew)
- "Generative AI may be useful as a way to plan out the writing of certain documents; however, it is important that AI does not replace the actual writing of the document. Doing so dramatically reduces the authenticity or "human-ness" of the document, regardless of whether or not it is actually distinguishable from human writing, because it is not the result of human thinking." (Beto)

All of the qualitative responses on style expressed similar concerns about sounding too much like a robot and losing the choice or ability to express their own voice. As Beto explains it, there is a danger of losing the human-ness of the writing that students are concerned about.

Related to the idea of writer's voice is the idea of ownership over one's ideas in writing. Campbell touches on this by saying "It is important for me to check only quick errors which any peers could have given if they were around. In other words, it is important for me that the AI touches my writing only so much as a peer review will touch, not too much that my ideas will change." The idea of using GenAI only in ways that could be reasonably replicated by a human is something that also comes up in interviews, which we discuss below. What appears to be key

to students' commentary on the use of GenAI as it relates to writer's voice is that their creativity, individuality, and humanity is preserved.

In summary, survey responses reveal that students are generally confident in their ability to write well without GenAI and express a preference for doing so, with 90% and 66% of participants agreeing or strongly agreeing with these respective statements. Qualitative responses further emphasize the importance of maintaining a human voice and individual agency in writing. Moreover, while many students recognize GenAI's potential for assisting with surface-level editing, concerns about its lack of human tone, originality, and contextual understanding are prominent.

While future survey results may lead us to other conclusions, early trends in quantitative and qualitative survey data indicate that students view generative AI technologies as tools that are only as useful as their ability to provide accurate, trustworthy information, augment their ability to retain individuality and authorly voice in writing, and enable deep, authentic learning and understanding of engineering content. In short, these early results demonstrate that students' attitudes towards generative AI are complex, nuanced, and thoughtful.

GenAI and its relationship to the contexts of student learning

In these semi-structured interviews, one theme that emerged was how students think about using GenAI within a rich matrix of coursework, assignment criteria, and personal learning goals. Overall, we found that students reported using GenAI technologies primarily to support their learning in math and physics courses, and only reported limited use when writing reports on engineering content in courses that had a technical communication orientation (or for writing other essays in writing-focused non-engineering courses). However, it is likely that this trend may be affected by the fact that many of our interview respondents were first-year students, and that the official policy at our institution for using GenAI in the first-year writing engineering course limits its use for generating text that will eventually be turned in as part of a writing assignment. Nonetheless, the interviews do reveal that students' individual contexts, experiences, and learning goals shape their relationships to and interactions with GenAI technologies, and that these interactions provide insight into how GenAI shapes students' beliefs about what it means to be an engineer.

Students delineated the efficiencies and affordances of working with GenAI to develop writing and math competencies by drawing from their own personal learning journeys. For example, one participant, Gosha, sees GenAI as being "extremely good at editing" but not "good at, say, writing an essay for you" in part because "it's pretty obvious when when an AI writes something." Several participants raised similar comments about how GenAI outputs were easily distinguished from human writing. A few, for example, noted concerns about sounding "like a robot." However, for Gosha the "main reason" that it's obvious when AI generates content "is because when you just ask [GenAI Chatbots] for like a response to a general essay prompt, they don't really understand. The AI doesn't really understand that topic in the context of your learning or your curriculum or your personal experience." Gosha emphasizes here the relationships between context and writing as important factors when considering the impact of

GenAI. Gosha's comment suggests the efficacy of writing depends, in part, on contextualized and personal aspects, such as the context of one's learning and one's own personal experiences.

In contrast, Gosha continues by discussing some affordances of using GenAI for certain writing tasks: "But when you do have a content already formulated, I think it does wonders at fixing the grammar or, um, pushing you closer to the word limit. And I think that's what I did for a lot of my college essays, where I would try to write what I would want to write in as much detail as possible. So I would go over the word limit. But then after that I would use GenAI to maybe to rearrange some of my sentences and word choice so that even though if the essay is written by me, it is more concise and also at the same time doesn't have the ambiguities that GenAI essays might have." Gosha appears to describe using GenAI chatbots as a kind of editor (rather than co-author or collaborator), which reiterates survey findings about student preferences for writing without GenAI. How different students define "writing with generative AI" will be explored further as we continue our research. Taken together, Gosha's comments emphasize the important role of context and personal experience in the development of writing-as-thinking or writing-as-learning. GenAI has limited impact for Gosha when he is writing within specific curricular contexts, but GenAI does provide important potentials when a piece of writing has been formulated and is ready for editing.

Other interviewees commented on how GenAI's inability to understand context hinders its utility for solving problems for students, as Bartholomew explains:

> "nowadays, like, [GenAI] knows how to solve math problems well, but still does not know how to solve math problems. Because like it has to, you have to ask it like a very specific in a very, very specific way, okay, to rephrase the problem. [...] So that takes, like, sometimes more work than actually solving a problem yourself. It's why there's like an entire field now called prompt engineering where people would like figure out what exact prompts and what exact types of questions they could ask the AI to get the exact kinds of results they want, and how like one word, one word that they include, or one word that they omit from their prompts, like changes from how the from how the AI like gives you the output. And I asked this a simple math question that I had on my homework. And it comes up with this like wacky formula that, and it comes up with, like, this method, that it does a method that I'm not, like, allowed to do on the homework. I have to do it one way, but ChatGPT does it the other way. So I have to, like, ask it like a rabbit hole of questions to see exactly what I want to see. And that takes more work than doing the problem, that actually doing the problem itself. Okay. And sometimes it doesn't even give you the right answer."

The effort of creating effective prompts and negotiating with GenAI chatbots often takes as much or more cognitive effort as doing the work in the first place, as Bartholomew describes. Furthermore, because of GenAI's inability to fully understand the context of learning in educational environments, it will produce results that are prohibited for students, such as using a method that the student is not allowed to use. Even though Bartholomew and Gosha cite different experiences and goals for using GenAI, both conclude that it falls short with its failure to recognize context–whether they're using it to solve math problems or complete a writing assignment. In other words, GenAI technologies cannot meaningfully account for their identities and contexts related to being undergraduate engineering students.

Similarly, Tony echoes some of Bartholomew's concerns about prompt engineering, noting that the outputs have to be massaged to some extent, while also indicating a desire for authentic learning, echoing survey responses. As Tony explains,

> "So, for example, if the AI is helping you write an outline, I make sure that, you know, I write an outline first and I just I tweak the, I prompt around, like I tweak the AI's output around to make sure that it's something I can agree with or something I can reproduce. Uh, in terms of homework problem, *I make sure that I understand what the AI is doing, and I would do it myself just to make sure that, you know, I can actually do the work rather than just rely on AI*. I know AI is pretty a big input, plays a big impact in coding, but for, so for coding I just don't use AI. (..) Unless it's something like, really, like really tedious work that I just don't want to do, that I'll use AI because it doesn't show any, like, actual work. It doesn't show any intelligence. It will just, like, I don't know, like make an array for me or something. Plugging in data into an array that I don't want to do on my own. But yeah, there's not really a way that you can ensure it. *It's just that you can just try your best to make sure that all your work is something you can reproduce*." (emphasis added).

While GenAI can help provide efficiency for repetitive tasks or tasks students don't want to do, Tony's comments suggest some awareness that however GenAI is incorporated into learning processes, there remains a responsibility on the student to ensure they are capable of producing a given academic work product without the use of GenAI. Tony recognizes, to some extent, that GenAI technologies cannot be an engineer, and that he will still need to be able to do the tasks he offloads onto GenAI on his own.

Tony's emphasis on individual responsibility is generally shared by another participant, Tim. However, when making decisions on how/when to use GenAI, Tim notes that time management and high pressure, high demand courses affect student use of GenAI:

> "Sometimes it's based on time, like in my physics class a lot of the times. (..) Uh, we would use it to, like, solve for the answer. And then if we're based, if it has like a super bad time crunch, then we'll just send the answers in, submit it, and then kind of go back and try to learn the content afterwards. So I think that's definitely the most important part. As long as you're not, especially in college when you're trying to use it just to really understand the material, I think that's really no harm, no foul. As long as you're going with, like, course policies and everything, right?"

Whether Tim successfully 'goes back to learn the content' as he suggests he will in this comment remains unclear. However, couching such uses of GenAI with statements about the value of authentic learning and understanding of course material is interesting when compared survey trends that reveal students more generally value GenAI as a learning tool to check, practice, and understand engineering content, as opposed to using GenAI as a learning replacement. Whatever Tim's learning practices are, Tim's interview response reveals an underlying vulnerability in tightly packed curricula, such as engineering degree programs. Students inevitably face time constraints that require students to be strategic with their use of GenAI (and other tools) to offload certain cognitive tasks. As students develop these practices within an undergraduate engineering context, it is worth asking how these practices might change or persist as students' expertise matures. Will these practices of offloading certain cognitive tasks become part of their engineering practices?

Marty makes a similar point that GenAI can help collaboratively develop ideas. However, he notes that too often students try to use the tool to solve problems, and that only works if they have sufficient background knowledge. Marty observes that students misuse GenAI when they use it as "the way to do the problem" or "the way to learn the problem" instead of working from a position of "I know the problem, maybe this will give me an idea as to where to go." For Marty, " if you don't know the subject at all, you're gonna just, like, you'll take whatever they give you, you won't be able to get ideas from it. You will just copy it, which isn't good for learning. It isn't good for your success in the class either." The important aspects to the context of using GenAI in educational spaces identified by Marty include background knowledge and expertise. The efficacy of GenAI as a tool for learning depends on a minimal level of prior knowledge, a threshold that may very well be invisible for students as they acquire new content knowledge in their discipline.

Participants like Gosha, Bartholomew, Tony, Tim, and Marty draw attention to the relationship between GenAI and their individual contexts of learning. Their responses illustrate a shared recognition of GenAI's limitations, particularly its lack of contextual awareness and its challenges in adhering to specific academic requirements. These challenges often result in additional cognitive effort to craft precise prompts or verify outputs. Simultaneously, students see value in using GenAI as a supplementary tool rather than a primary one, leveraging it for editing, streamlining tasks, or strategically managing cognitive-offloading during time crunches. Ultimately, the interviews reveal that students are actively negotiating how and when to use GenAI, with an awareness of institutional policies, personal learning goals, and ethical considerations. While GenAI can enhance efficiency and assist in navigating dense academic schedules, students consistently acknowledge the importance of understanding and reproducing their work independently. This interplay between efficiency and responsibility underscores the evolving role of GennAI in higher education, where it is increasingly positioned as a tool to augment rather than replace traditional learning and problem-solving processes.

Limitations

The survey results are limited by the small number of respondents (Fall 2024 n=55; Winter 2025 n=127). However, a substantial portion of survey respondents (14%; n=24) scheduled at least one interview with the research team. This suggests an interest to talk about their experiences with GenAI. And often respondents ended interviews with positive feedback thanking us for allowing them to talk about this topic.

Another potential limit in the study relates to participants' willingness to fully disclose their use of GenAI, especially given the shroud of authenticity, plagiarism, and academic integrity associated with the technology in many public-facing communications and conversations. We mitigated the impacts of student reticence to fully talk about their experiences by having graduate students (who do not have teaching responsibilities) to lead the interviews. The graduate students were trained over the course of a month through a series of seminar-like meetings that focused on core scholarship that informed the study as well as training on interview methods.

Conclusion

GenAI literacies already are impacting how students develop subject matter knowledge, and while almost all of the students in our study are already using GenAI, a majority of students prefer to write without using GenAI, with many expressing concerns about its limits to understand their personal learning contexts. Emerging trends in our survey data and interviews both affirm that student attitudes towards GenAI are impacted by external pressures (such as institutional policies that restrict or prescribe particular uses of GenAI technologies) *and* that students' decisions to use GenAI as part of their individual learning practices are highly dependent on a shifting network of social, technical, material, temporal, and cultural contexts.

Individual decisions to use GenAI are inflected by students' broader contexts, including their personal goals and their motivation to be able to reproduce work generated with AI. Also, these decisions are shaped by other actors, including the parameters set by course policies and assignment descriptions, as well as the pressures generated across the grain of high-intensity engineering degree programs. On the other hand, students value the potential for GenAI technologies to enhance their learning practices as they become engineers and report that it is important that GenAI be used in a way that complements other learning strategies (such as talking to a teacher or looking things up online). Put another way, students report using GenAI as a tool to enhance their learning as *engineering students*. The practice of using GenAI is already part of being an engineering student, and they see it as part of becoming an engineer.

These early findings suggest that students approach generative AI as a tool to augment, rather than replace, their writing process, prioritizing the preservation of their creative and intellectual identity, such as by helping them to learn engineering content. Students want to use AI to help them do stuff - they want generative AI to help them learn, not just to copy answers down. Retaining a sense of their own individuality, voice, and control over their personal learning journeys are important to the students who participated in this study.

Future research should continue to explore how students use GenAI to learn engineering content. This may be somewhat of a moving target, as the capabilities of such tools remain in a state of rapid evolution. This research should also identify the scope of the affordances and limitations of using GenAI for students and to trace out how the rich context of being a student in a hyper digitized world intersects with being and becoming an engineer in the GenAI era.

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