# WIP Productive Uses of Generative AI: Preliminary Findings from an Electrical and Computer Engineering Capstone Course

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***Abstract*— This work-in-progress, research-to-practice paper examines how students have used generative AI (GAI) productively and with permission to complete their senior capstone course in an undergraduate electrical and computer engineering program. Data were extracted from two sources: faculty lists of permissible use and student feedback. Data show that GAI was used to clarify concepts; generate bibliographies; summarize literature; write code; classify phenomena; edit written work; and produce models. Similar student use has been reported in other engineering education contexts. One striking finding is that some students elected not to use GAI. They reasoned that the capstone project was too high stakes a task to risk submitting incorrect work as they were uncertain about their command of the subject matter to confidently vet the AI's outputs. This study is part of a larger discussion on how to productively deploy GAI in classrooms. It proposes a preliminary cache of uses specific to electrical and computer engineering and it may prove useful to engineering instructors who wish to create assessment tasks that leverage GAI.**

***Keywords*— assessment, capstone course, electrical engineering education, generative AI**

## I. INTRODUCTION

There have been many calls to incorporate generative artificial intelligence (GAI) in teaching and learning [1-7]. These calls are informed by an attitude that can be described as pragmatic and future driven. Educators recognize that all-out bans are impossible to police [8]. They accept that the technology must be accommodated as have other technologies in the past [4, 9, 10]. Afterall, GAI is ubiquitous—it is part of the lived realities of students [5, 11, 12]; and it will eventually figure in their working lives [6, 7]. While there are many convincing arguments to deploy GAI in our classrooms, it is not immediately clear how instructors may accomplish this. The challenge is multidimensional.

The first challenge is that students and staff simply do not know enough. There have been repeated calls for ongoing training of both students [4, 6, 13-15] and staff [4, 6, 16, 17], so they may know its limitations and its affordances, allowing GAI to be leveraged productively.

The second challenge of deploying GAI in classrooms is attending to issues of responsible use. Besides defining and supporting responsible use, instructors must specify what use is permissible [6]. And the question of what use is permissible is informed by what is possible, returning us to challenge one.

The third challenge is that there is very little research on actual use of GAI in engineering classrooms [18]. Too few empirical studies on actual use compounds both the first and second challenges—it is an additional dimension of not knowing and being unable to best use the technology appropriate to our teaching goals and contexts.

This gap in the scholarship is understandable given the nascence of GAI, and the research-to-publication cycle [13, 19]. The massification of free-to-use GAI is recent, making GAI, as a class of technology, far from mature [7]. And as scholars explore various GAI products, new versions emerge, as do entirely new GAI. There is arguably a slipperiness to any evolving technology that defies neat boundaries of investigation and commentary. Added to this is the protracted period, in quality scholarly processes, between research to final publication.

This work-in-progress research-to-practice paper is informed by all three challenges; it provides empirical data on actual use of GAI and attitudes to the technology. Two sets of data are presented. The first set of data shows how students used GAI with permission to complete their senior capstone projects. The second data set—preliminary feedback from students—exposes attitudes to using GAI in the engineering classroom. There is a need to explore attitudes to the technology [1, 15], as this will largely dictate how GAI will be received by students. Data gathered for this study answers two questions with respect to a single offering of a senior capstone project in an undergraduate program in electrical and computer engineering:

RQ1 What tasks were completed using GAI?

RQ2 What are the attitudes of students towards GAI?

This study is part of a larger discussion on how to productively deploy GAI in classrooms, paying attention to discipline specific teaching and learning contexts [1]. Moreover, it proposes a preliminary typology of student GAI use specific to electrical and computer engineering. This study is particularly useful to engineering instructors who wish to create assessment tasks that leverage GAI.

## II. LITERATURE REVIEW

This review begins with an important distinction between Artificial Intelligence in Education (AIEd) and GAI use in higher education classrooms. The former is conceived as a set of scholarship dating to the late 1990s [20, 21]. Following Baker, et al. [22], AIEd can be divided into three categories:

- learner-facing systems which support student learning;
- teacher-facing systems which reduce instructor workload; and
- system-facing AI which helps in institutional processes.

Whereas GAI is understood to be a subset of technologies belonging to the universal which is artificial intelligence. And while AIEd concerns itself with AI deployment in all facets of education, this paper focuses on the use of GAI in the engineering classroom, specifically to realize the learning and teaching outcomes of the senior capstone course.

As it relates to scholarship on GAI in classrooms, we discerned four perspectives. The first perspective is written with the instructor in mind. The goal of this scholarship is to suggest how the technology may be deployed to lighten the teaching load. Some instructors have used GAI to correct papers and provide feedback [23-25]. While others have used the technology to craft assessment items [4, 26].

The second set of scholarship is written from the perspective of the technology. This type of scholarship predominates the discussion on GAI deployment in classrooms [27]. Here scholars consider the affordances of GAI with a view to speculating how it may be used. For example, Sabzalieva and Valentini [28] suggest seven roles that GAI can play in learning: as a possibility engine; Socratic opponent; personal tutor; collaboration coach; study buddy; motivator; and dynamic assessor. Laato, et al. [29] recommend seven ways in which students can leverage GAI based on its functionalities: to brainstorm; translate; generate content; code; analyze; summarize; and edit. In terms of language learning, GAI promises to be a veritable on-demand conversational partner and tutor [30] providing authentic interactions; formative feedback and correction; and translations, among other forms of language learning support.

A third type of study reports how scholars have tested the capabilities of GAI. For example, one study [31] written by nine faculty members, with varying engineering backgrounds, from seven Australian universities, tested ChatGPT's ability to respond to nine different assessment types including project work. They found that the GAI struggled with project-based and research related writing assessments. However, with careful training, the GAI eventually produced passing efforts. Another study in this tradition examined ChatGPT's ability to complete a capstone course in chemical engineering. In this pre-print, the authors [32] report that the GAI—ChatGPT—was able to write an introduction, suggest experimental procedures and mathematical models, analyze experimental data, and propose improvements.

The fourth category of research is written from the student perspective. It examines student use of GAI and their experiences. Indicative studies of this type include a study of a semester-long capstone course [33]. GAI was used to help students with their weekly progress reports. The study indicates that ChatGPT-3.5 and ChatGPT-4 helped students improve the overall quality of their reporting, with students expressing satisfaction with both tools and a willingness to use GAI again. In another study, the authors [34] crafted authentic tasks for which students were allowed to use GAI to build databases and user interfaces which interact with an API. Students reported mixed experiences with using GAI. Students lauded the AI's ability to reduce 'drudge work' like poring through documentation. Others found that the AI's outputs were faulty, such as generating faulty code.

It is in the vein of the fourth type of research that we write: we examined actual student use of GAI.

## III. Teaching Context

Our BSc in Electrical and Computer Engineering is accredited by the Institution of Engineering and Technology (IET). As in most engineering programs, our students must complete a senior capstone engineering project. This project is an individual project with significant design elements. It is a student-driven task, but students enjoy a range of support, including close supervision from at least one faculty member. With the proliferation of free-to-use GAI, we instituted a responsible use policy, effective academic year 2023−2024. The policy permits use as specified by project supervisors. This permitted use is itemized by supervisors and becomes part of the project's documentation.

## IV. Method

Data were drawn from the 2023−2024 course offering with a cohort of 38 students. Two sets of data are presented.

The first comes from the lists of approved uses of GAI; these approved uses are specific to each capstone project, given that each student has a unique individual project. Data on permitted use were analyzed to answer one question: what were the specific tasks for which students used GAI?

The second data set is student feedback. This feedback, gathered through interviews, was used to comment on students' attitudes and experiences of using GAI.

## V. Findings

### A. Student Use

Of 38 individual projects, 17 did not use GAI. Of those that did, GAI was used for eight distinct tasks (see Table I). The most common use was as an information source and the least common tasks were to classify data, make predictions, and create project plans.

To propose a cache of GAI uses specific to engineering and computing, we examined student use reported elsewhere and tabled these uses alongside the ones we found among our students (see Table II). Where we have entered *no studies found*, this reflects our ongoing search for studies that specifically report student use in engineering and computing. We expect that more studies will be forthcoming as GAI matures.

### B. Student Attitudes

Student feedback reflects three distinct attitudes: a positive attitude with students using GAI confidently; a measured approach where students were more tentative in their use; and outright refusal to use GAI though given the opportunity.

Of those five who used GAI with facility, they welcomed the opportunity as it allowed them to focus on more demanding tasks. They off-loaded low-level tasks like sifting through research. This experience is shared by other students elsewhere [34, 35].

Of those four students who expressed some reservations about using GAI, they all used the tool nonetheless. They trusted the tool only to complete, what in their view, were low-level tasks, like exploring concepts. They did not trust significant tasks like programming to the GAI as they felt this would impact the integrity of their work. Students elsewhere expressed similar concerns [35].

Five students did not use GAI for three main reasons. Some felt that the tool was unhelpful. They explained that their projects were hardware based, and they found no value in using GAI. Others said that they could not be bothered to learn to use GAI. In fact, learning to use GAI was seen as another task and they preferred to expend their time and effort on their projects. Some expressed concern about using the AI's outputs. They did not feel equal to vetting the AI's outputs and feared submitting incorrect work. Some also feared submitting work for which they could be accused of lifting from the GAI.

TABLE I. TASKS FOR WHICH GAI WAS USED AND NUMBER OF INSTANCES

| *Task* | *Number of Occurrences* |
|---|---|
| analyze results, such as:<br>– calculating statistics<br>– identifying trends<br>– visualizing data | 2 |
| classify data, such as grouping malicious prompts | 1 |
| edit reports | 4 |
| research, such as:<br>– brainstorming<br>– reviewing literature<br>– retrieving information on algorithms<br>– generating bibliographies | 11 |
| generate code, such as:<br>– writing software<br>– creating database schema | 7 |
| generate data, such as:<br>– generating synthetic noise<br>– generating images | 9 |
| create project plans | 1 |
| make predictions, using large data sets | 1 |

There was a commendable recognition among students that GAI is not a trustworthy source. Where there was need for support in their design decisions and argumentation, for example, they turned to scholarly sources.

TABLE II. COMPARISON OF TASKS ACROSS STUDIES

| *Task as Reported in the Study* | *Task as Reported in the Scholarship* |
|---|---|
| analyze results | No studies found |
| classify data | No studies found |
| edit reports | No studies found |
| research | [33-35] |
| generate code | [34, 35] |
| generate data | [34] |
| create project plans | No studies found |
| make predictions | No studies found |

## VI. DISCUSSION

In poring through the data, it became clear that there is need to carefully distinguish between using GAI as a tool and working in the field of AI. Deploying GAI—the tool, involves cognitive offloading. Cognitive offloading is having the tool complete a task that normally would have been completed by the person. Whereas working in the field of AI involves drawing on the theory and practice of AI. This distinction is necessary for electrical and computer engineering classrooms where the lines between using the tool and using the body of knowledge (BoK) can be easily blurred. Of 38 projects, eight straddled this boundary. For example, students were asked to use machine learning and deep learning algorithms for image upscaling and sentiment analysis. Such projects foreground the need for very careful delineations of permissible use of GAI. Students can easily be confused.

Some tasks, like using GAI to program, beg the question of how much cognitive offloading is permissible. Cognitive offloading can be as innocuous as using a calculator for simple addition or as extremely dishonest as using GAI to complete entire tasks where the student's own effort was expected. If, for example, the student was allowed to use GAI to program and the intent is to test the student's programming competence, then instructors need to deliberately probe the student on their programming knowledge. Students, for instance, must explain how the code works, how it was tested, how it was debugged. Moreover, instructors need to be careful in assessing such work [25], considering what should be rewarded—the AI's outputs or the student's considered use of the outputs?

Allowing student use of GAI for mundane tasks, elsewhere termed *drudgery* [34] and *busy work* [35] is less problematic. Where for example the student was allowed to use GAI to classify large data sets, the intent was to allow the student to off-load tedious tasks which do not test a core engineering competence.

In the lists of permitted GAI use specified by the supervisor, we found that some were less prescriptive than others. Very general descriptions of use can be interpreted as a preference for giving students latitude in their project work. While very detailed instructions, such as giving actual prompts, provide well-defined boundaries of use and can be supportive of students who are less confident in their use of GAI. Arguably, highly prescriptive descriptions allow project supervisors to more easily check that GAI is being used as permitted. If there are claims of student misuse, it is more likely that tighter prescriptions can better support these claims.

## VII. Conclusion

This single study of GAI use in an engineering classroom is in response to calls for exploring how GAI may be incorporated productively in teaching and learning [1, 17].

As it relates to the engineering classroom, the study suggests eight distinct tasks for which students can leverage GAI (See Table 1). Some studies report similar uses (See Table 2). This is of particular value as it reflects consensus in practices across diverse teaching contexts. But there is need for more empirical research, especially as GAI matures. As it relates to Table 2, one gap is a failure to consider GAI uses elsewhere that were not reflected among our eight uses. For example, in one study [33], students were allowed to use GAI to generate documents, whereas we did not allow this use. There is a clear need to collate data across studies on actual student use if we are to forge a shared understanding of how GAI can be best leveraged for teaching and learning in engineering.

The study belied two expectations held by the first author: that her students would have been glad of the opportunity to use GAI, if only to shed some of their workload; and secondly, that being students of technology and somewhat tech-savvy her students would not have encountered a steep learning-curve with GAI. However, the data show a continuum of attitudes ranging from some students being all-embracing of the technology to some being highly skeptical; and a range of competence from some students being confident in their use to others being less so.

And as we probe the data and move towards completing this research project, a few questions arise. Why did some faculty not allow their students to use GAI? Was GAI deemed unhelpful given the nature of the project? Or, is there among staff, like students, some ambivalence towards the technology? And if this is the case, how does course policy cater for faculty who are averse to using GAI? Will their students feel disadvantaged? Should all capstone projects use GAI, not use GAI, or use GAI in equal measure? It is established practice that there is parity in the demands that projects make of students. Is there need to cater for parity in the use of GAI? Also, how much prescription is needed in defining permissible use? Too much prescription may dampen student experimentation. But careful prescriptions are in themselves scaffolds for students who are not GAI savvy. How do we, in describing permissible use, cater for cognitive offloading? Surely, responsible use includes definitively describing the boundaries of offloading to the GAI.

And while we end with what appears to be more questions than answers, our community of practice—instructors and researchers in the field of electrical and computer engineering—must remind ourselves that GAI and GAI scholarship are yet to mature. We play a role in both those enterprises, especially understanding and shaping how users—our students—leverage GAI. This study was a small step in that direction, suggesting how we can productively leverage GAI in our classrooms.

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