Perceptions of Engineering College Instructors and Their Students Towards Generative Artificial Intelligence (GenAI) Tools: A Preliminary Qualitative Analysis

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Abstract

GenAI tools, such as ChatGPT, have gained significant traction in engineering colleges and are revolutionizing how students approach each assignment and project. However, integrating them into the education system introduces challenges to the core assessment criteria and the traditional grading system that has been used in these institutions for decades. To achieve a better understanding of the significant influence and disturbance caused by GenAI, this study employed semi-structured interviews to collect qualitative data from a group of six students and two instructors, chosen via stratified sampling, from a research-intensive engineering college in Southeast Asia to explore their perspectives regarding GenAI. Initially, we discussed the positive and negative effects of GenAI on engineering education. Subsequently, we explored the correlation between ChatGPT and the current assessment pattern. It turned out that the widespread adoption of GenAI tools has made it necessary to reevaluate current assessment methods at educational institutions. The conventional grading scheme also found itself increasingly incompetent against the capabilities of ChatGPT, posing a potential threat to the equilibrium of academic integrity. The adaptive strategies employed by institutions in response to GenAI are also discussed in this paper, and we have explored whether instructors restrict students' access using sophisticated detection systems or simply advocate ethical and responsible use of GenAI. The potential consequences of these policies on students' learning were also explored with an emphasis on whether students feel unfairly disadvantaged when detection systems fail or if they perceive the need to rely on GenAI tools to maintain academic competitiveness.

Keywords: Engineering education, generative AI (GenAI), adaptive strategies, undergraduate

Background

Engineering education is an ever-changing field that is continually evolving to accommodate the rapid advancement in a technology-driven world and constantly updating the requirements of the engineering industry (Fong et al., 2024; Qadir, 2023). For instance, industrial and academic leaders have expressed their worries regarding the lack of ability of our engineering graduates and posed urgent demands for a more practical-oriented engineering education (Fong et al., 2023). This dynamic nature of engineering education requires instructors and students to continuously learn and update their knowledge and problem-solving skills to adapt and perform effectively in their respective roles (Crawley et al., 2007; Zhao et al., 2023).

Among all the technical advancements in recent years, the emergence of Generative Artificial Intelligence (GenAI) tools, notably large language models (LLM) such as ChatGPT, may have reshaped the current educational landscape in the most significant way (Grassini, 2023; Mollick, 2024) due to their capacity to enhance academic performances, revolutionizing how students approach assignments and projects. Technical and AI literacies are crucial for everyone in today's advanced digital landscape, enabling individuals to understand, engage with, and critically assess the AI technologies that increasingly influence many aspects of daily life, as emphasized by Qadir et al. (2020) and Yang et al. (2024), who focus on essential competencies

and AI literacy, respectively. However, alongside the development of GenAI, a change in the assessment criteria and grading systems is also required to evaluate such work. Several challenges arise while trying to update these age-old systems and strike a balance between using GenAI for its learning benefits. For instance, Chan and Colloton (2024) suggest that GenAI might reduce student engagement, quality of education, and social engagement, and relying completely on the GenAI-generated output without having a fact check might lead to inaccurate information, which then might have a domino effect in making further mistakes.

The Significance of the Study

This study aims to explore the perceptions of the integration of GenAI within an academic context through semi-structured interviews with six students and two instructors chosen via stratified sampling from a research-intensive university in the Southeast Asia region. The objective is to gather insights into their perceptions of using ChatGPT in their education. Additionally, the study ventures into how two students approach the same set of assignments before and after the introduction of ChatGPT. Ultimately, this study explores whether students and instructors perceive GenAI tools as a boon or a bane to the education system and how they have adapted accordingly.

Research Questions

This study seeks to elucidate crucial inquiries pertaining to the utilization of GenAI in the following manner:

- What are the beneficial effects of GenAI on the engineering education landscape?
- What are the adverse effects of GenAI on the engineering education landscape?
- Given the impressive capabilities of GenAI, how should we interpret the relationship between GenAI and the current academic assessment framework?
- Regarding the impact of GenAI on engineering education, how can we, as students and instructors, effectively address and adjust to this technology?

Literature Review

The field of engineering education has undergone considerable advancements with the widespread adoption of GenAI tools. In their study on the transformative impact of ChatGPT on modern education, Gill et al. (2024) suggested that students' utilization of GenAI technologies enhances learning results. The study emphasizes the students' capacity to utilize ChatGPT as a tool to enhance their comprehension of intricate subjects and literary works, thereby honing their critical and analytical abilities. Moreover, the tool assists students in language acquisition and application, which is crucial in the context of academic writing (e.g., Alkaissi & McFarlane, 2023).

Gill et al. (2024) and Qadir (2023) agree that integrating ChatGPT into academia presents several challenges. One of these challenges is the potential lack of accuracy and reliability in the responses provided by ChatGPT and other GenAI tools. This is because these generative models can sometimes produce output that appears realistic but does not align with real-world input, a phenomenon known as “AI Hallucination“ (Alkaissi & McFarlane, 2023) (Grassini, 2023). Weidinger et al. (2021) highlight broadly the ethical and social risks of harm that can arise from language models. This presents a substantial hazard since students can see AI-generated content

as absolute fact, perhaps obtaining incorrect information without participating in additional verification.

Another issue arises from the blatant plagiarism facilitated by these tools, as students depend on ChatGPT and similar GenAI applications to fully generate essays and code files, hindering their active participation and inhibiting their learning experiences. Adding to this issue is the lack of a completely reliable technique for identifying AI-generated information, which raises worries about the academic integrity of students' work. The convergence of these difficulties indicates a requirement for comprehensive techniques and ethical guidelines to alleviate the negative consequences of incorporating ChatGPT into educational settings at institutions.

Nikolic et al. (2023) proposed a change in evaluation methods in engineering education, influenced by the evolving availability of resources, while including ChatGPT. The authors reached the conclusion that online evaluations should be gradually replaced with face-to-face oral assessments and on-site tests, which are considered more dependable alternatives. Nevertheless, the authors recognized the worth of ChatGPT as a means of promoting critical thinking. Therefore, they supported the intentional incorporation of GenAI tools rather than completely excluding them from students. This approach considers both the benefits and drawbacks of these tools.

Methodology

Data Collection

This study utilized qualitative research methodology to investigate the perspectives of both students and instructors regarding the use of GenAI in engineering education. The major approach for collecting data was conducting semi-structured interviews, which allowed participants to express their experiences, thoughts, and concerns surrounding the use of GenAI tools in academic environments. The information obtained from the partially conducted interviews with instructors and students was subsequently transcribed, categorized, and examined through theme analysis.

Semi-structured Interview Protocol

The interview questionnaire was designed to address common problems in gathering data through interviews, especially for topics such as GenAI, focusing on preventing bias. To reduce bias during the interviews, the interviewer strictly followed the interview guide without sharing his own thoughts. The questions were also designed to be open-ended so that the interviewees could form their own opinions rather than being persuaded towards a side due to the structure of the question. The interviewees were anonymous and allowed to articulate and share their experiences without constraints on time or content. To address ethical considerations, all participants in this study participated voluntarily with informed consent after understanding the scope and purpose of the study; they were also duly informed of their right to withdraw at any point in time without penalty and that all their details are anonymized to ensure their privacy and anonymity. The interview is also recorded with the consent of the participants for subsequent transcription.

Participants

A stratified sampling method was employed to choose a group of six students from a prestigious engineering university in Southeast Asia. Simultaneously, two instructors from the same engineering institution were chosen to take part in comparable semi-structured interviews. This dual-perspective approach enables a comprehensive understanding of the impact of GenAI in engineering education. This also ensures that the result of this study is not heavily in favor of either side. All the individuals that were interviewed were assigned pseudonyms, and certain information about them was included in the table below:

Table 1. *Participants' demographic details*

Name	**Gender**	**Identity**	**Major/Research fields**
George	Male	Instructor	Computer Science
Clint	Male	Instructor	Computer Science and Engineering
Hillary	Female	Year 3 student	Mechanical Engineering
Olivia	Female	Year 3 student	Computer Science, Business
Serena	Female	Year 3 student	Computer Science, Business
Ben	Male	Year 3 student	Mechanical Engineering
Anne	Female	Year 3 student	Chemical and Biomolecular Engineering, Business
Todd	Male	Year 3 student	Computer Science, Economics

Data Analysis

All the information was captured by mobile phone and saved as MP3 files throughout the interview. After completing all eight interviews, the recordings were transcribed and promptly erased. Subsequently, all the transcriptions underwent multiple reviews and comparisons to guarantee the comprehensive identification of all the emerging themes from the interviews before commencing the analysis. The data analysis process is based on Braun and Clarke's (2021) thematic analysis method, which entails creating initial codes after becoming familiar with the data in order to look for themes. The themes were then reviewed, defined, and named to facilitate an in-depth exploration of the diverse implications of GenAI on the education of students and the perceived impact on the curriculum from the perspective of instructors. A sample of the results of the thematic analysis protocol can be found in Appendix A.

Limitations

While all of the eight participants have provided rich insights during semi-structured interviews, we still need to be aware of the limitations of our methodology. Compared to other research methods, such as a questionnaire, the semi-structured interview itself is time-consuming and limited by the size of the sample (Bell & Waters, 2018). In this study, the sample of our participants is relatively small, so it may not be representative enough for the analysis of the

general insights of individuals involved in engineering education, especially regarding the perspective of instructors since only two of them were interviewed in our research. Meanwhile, there will always be bias inherited in the qualitative research that comes from the interviewers. As Jager et al. (2020) and Bell and Waters (2018) emphasized, the responses of participants could be influenced by interviewers, especially by the researcher who holds firm opinions regarding the topic they investigate.

Preliminary Findings and Discussion

Guided by the methodology described above, all eight interviewees contributed substantially to the four research questions. In this section, we will present a comprehensive analysis of each of the questions.

Positive Impact of GenAI on Education

From the analyzed dataset, one of the most significant benefits of using GenAI in engineering education is improving academic performance, especially when explaining complex topics. The majority of participants have expressed the impressive capacity of GenAI to explain difficult tasks thoroughly:

> *'And I think the second feature that really, really helps in learning my course material is, for example, if it's a really difficult and complicated topic that exists, what I do is ask ChatGPT to explain it to a child, like a five-year-old kid… it also makes it, like, really easier to understand and visualize those concepts. So in that way, definitely, definitely it helps me understand my concepts better.'* (Serena)

Not surprisingly, our discovery is consistent with the majority of research regarding the advantages of GenAI (Yang et al., 2023; Baidoo-Anu & Ansah, 2023; Khanzode & Sarode, 2020), which suggested that AI is defined by its ability to solve difficult questions. Existing studies (e.g., Javaid et al., 2023) also confirm that GenAI could help students by being a better alternative to Google search as it provides a step-by-step explanation, which includes visual examples and common pitfalls, and is far superior to Google's response. However, the existing research has shown a certain degree of dogmatism as they neglect the fact that GenAI will be used in a lot of different special conditions, for example, to solve the different questions specific to STEM education. Additionally, a number of participants expressed their concerns regarding the misinformation of GenAI when confronted with certain specific issues:

> *'GPT still can't solve my numerical because there's too much stuff to input in a weird way. So inputting them, it's still hard. So it can't really solve a bulk of my physics problems. So I don't really get to use it in that way.'* (Hillary)

This contradiction of perspectives has obviously led us to further discussion regarding the reasons why the performance of GenAI is unsatisfying in some cases. Therefore, it is important for future research to investigate the vital role of transparency and explainability of GenAI, as emphasized by Radwan and Mcginty (2024), and become much more careful in the daily use of GenAI tools. However, the results align with the claim that despite its inherent limitations, it is a nearly undeniable fact that ChatGPT and other generative AI have come to stay and will continue revolutionizing the current educational system (Baidoo & Ansah, 2023)

The second benefit raised by participants regarding the use of GenAI is its ability to summarize and merge new ideas at a higher level (Johri et al., 2023):

> *'When it comes to engineering education, you still teach the fundamentals to students, but then you can tell them, okay, now you know the fundamentals, how it looks like, then you can use generative AI to merge some ideas and go to the next level'* (Clint)

While all the interviewees acknowledged GenAI's capacity to summarize information, there was a debate concerning the generation of novel insights. For instance, Hillary and Todd believe GenAI can facilitate self-learning by providing good ideas and serving as a starting point for academic writing, while Serena and Ben argue that it only comes from in-depth individual research and brainstorming.

Among all the outcomes, there is also an illustration of GenAI as a time saver, especially when it comes to information research:

> *'Along with this, academically, I think it just helps shorten down the time it takes to do a Google search and then go to five different websites and then figure something out.'* (Ben)

George also supported this statement by considering GenAI as an online search engine, just like Google, but with more efficiency. Henceforth, we can make a claim similar to the finding of Chan and Lee (2023) about another important role of GenAI in engineering education: improving the productivity of students, especially in small issues that may not be directly relevant to their learning process, such as writing an email to supervisors.

Negative Impact of GenAI on Education

When it comes to the negative impact of GenAI, all eight interviewees have emphasized the ethical concerns related to the use of such technology. Lindsay et al. (2023) have highlighted these ethical concerns related to the use of GenAI in engineering education. Plagiarism, for example, has become a significant concern for engineering instructors and universities (Rudolph, et al., 2023):

> *'Students still, they are grade oriented. So, they only care about, oh, I need to pass, I need to score this, I need to score that. Not the, oh, I need to understand this… students will not have faced any difficulty or face any kind of stress from using this kind of tool that, in their mind, it doesn't make sense to avoid it.'* (Clint)

This statement by Clint has sadly revealed the fact that some students inside our engineering faculties are studying engineering simply for a degree instead of getting a deeper understanding of what is happening in the relevant field or how they could make the world a better place with the knowledge they obtained. Engineering faculties must tackle the serious problem of how to refine this mindset, and deliberate if this mindset at all needs to be refined.

Another important ethical concern that emerged from our interviews is the unfairness caused by the availability of GenAI:

> *'I tried not to use these tools. But at the end of the day, I realized that I was at a disadvantage in comparison to all the other peers that I'm competing with in my*

> *academics, right? So, yes, not using them, in my opinion, to a certain level does put you at a disadvantage.'* (Serena)

In related work, such negative consequences have been highlighted. Researchers have highlighted how educational technologies like GenAI can exacerbate inequalities, highlighting the "EdTech Matthew Effect" (Reich, 2021) and the "rich gets richer" (Warschauer et al., 2023) phenomenon. These dynamics suggest that those with prior advantages gain more, as early access and proficiency with such technologies deepen existing divides. Additionally, Warschauer et al. point out the "with or without" contradiction, where reliance on AI tools may hinder fundamental skill development, potentially deskilling disadvantaged students further. Hamilton et al. (2023) discuss strategies to mitigate these issues, emphasizing the need for balanced integration of technology in education.

The experience of Serena is not exceptional; some of the other interviewees have also expressed similar concerns regarding the matter of fairness. However, this situation may lead to a dilemma when some students, such as Serena, view the utilization of GenAI as a violation of academic integrity and refuse to use it, while others consider it simply as a useful tool and employ it during their assignments (Chan & Hu, 2023).

Unfortunately, this dilemma has become even more difficult to tackle since the introduction of advanced GenAI modules that necessitate a subscription for access:

> *'There is an unfair advantage to GPT-4 or any paid versions that are available, obviously, because of difference in economic background or just priorities of where you want to spend your money.'* (Hillary)

Hence, instead of determining whether it is right or wrong to use GenAI, it is crucial for instructors and engineering faculties to clearly clarify their viewpoints regarding the use of this technology and ensure their opinion can be widely adopted by students at the beginning of their learning.

Furthermore, as previously discussed, our interview extensively addressed the reliability issue of GenAI, including concerns about misinformation, AI hallucination, and its limited capacity to solve complex problems:

> *'The generative AI is not pretty good in math or comprehending complex probability questions. And also, a lot of the times you need help with creating diagrams, it always misinterprets the question and the required output.'* (Todd)

> *'It comes with a lot of confidence whenever it says something which is wrong and you could fall in that trap basically because you don't know when it's saying something that's incorrect because a lot of the time when I've looked up something and it's actually given the completely incorrect answer with a lot of confidence.'* (Anne)

In addition, some participants highlighted the impediment that GenAI poses to students' personal development:

> *'I think oftentimes I wouldn't want to sit down and write code from basics. Because I know ChatGPT can just use its knowledge and just build it very easily. So I feel like in those terms, I can get very lazy.'* (Olivia)

Therefore, it is important for students to be cautious enough when using GenAI and not completely rely on the results it produces, for instance, avoid over-reliance (Chan, 2023). From the standpoint of instructors and faculties, engaging in discussions on appropriate strategies to guide the proper utilization of such technologies is also important.

Correlation between GenAI and Existing Assessment Systems

Out of the eight interviews, both instructors have raised the most concerns about the correlation between GenAI and the existing assessment system. Undoubtedly, GenAI has posed significant challenges to our traditional way of assessment:

> '*I don't think it's easy to detect that unless you have... So if you're in small classroom settings, where you have a good understanding of students, and their abilities, and you know, their background, then maybe if you give me a written assessment, you know, which is a summary of a ChatGPT versus the student, I think I can probably figure it out*.' (George)

> '*I think that the fact that you have this underlying framework that can help you retrieve a lot of information in a short amount of time. So the assessment of just whether you know this piece of information becomes irrelevant*.' (Clint)

Revisiting the previous statement about plagiarism and the unfair assessment of the GenAI, alongside the great challenges it has posed on assessment patterns, there is a pressing need for making a shift in existing assessment methods to make it correspond to the fast development of technology. Educators and educational institutions must reconsider how to assess students and implement new measures to prevent academic misconduct (Shoufan, 2023) and agree with the stance on the need for change. Wegerif and Major (2024) have highlighted the importance of developing a dialogic foundation for educational technology so that interactions between students and AI tools can enhance learning, fostering critical thinking and creativity to ensure technological advancements enrich education rather than serving as shortcuts.

One possible shift towards a more advanced assessment system, as indicated by both instructors, is the shift of evaluation objectives:

> *'So then the natural question is the objective of the assessment changes, I think, because anybody can use the tool to give me a summary. I guess my view on that would be that maybe assessments can start looking at students' ability to critically analyze these summaries that GenAI tools provide, to reason about what is accurate, what is not accurate.'* (George)

Our findings also aligned with Nikolic et al.'s (2023) suggestion for a shift in assessment from online to oral or in-person exams. A similar conclusion was reached by Qadir (2023), who believed a shift in assessment methods towards oral exams or individual projects could reduce the risks posed by GenAI, while the traditional way of assessment can be used as daily exercise with less focus on the students' final grades.

Hillary proposed that future examinations should be highly application-based and not just information-based. For example, there could be more quantitative assessments like tests and quizzes. Meanwhile, Serena has found a significant increase in the level of complexity of her assignments, particularly when compared to the past years' assignments that were given before

the introduction of GenAI. However, the increase in difficulty may again aggravate the unfairness towards students who choose not to use GenAI in their projects, ultimately resulting in a decline in overall academic achievement among students:

> *'... and that actually had a negative impact on the overall distribution of results. So to give you the variation of, or the mean of the quiz and midterm grades in the courses that I'm teaching actually dropped significantly this semester, where ChatGPT has been used heavily, and we have detected a number of ChatGPT usage inside the midterm exams.'* (Clint)

How can we adapt to the application of GenAI?

Much to our surprise, when referring to the use of GenAI in the academic journey, all eight participants showed great confidence in recommending this technology to their colleagues and believe we should integrate GenAI into engineering education instead of the complete exclusion:

> '*I don't believe in restricting their usage… To me, I see GenAI fundamentally as a Google Search… the only unique thing about it is it gives you the summaries, you know, which you had to discern yourself in the past. So I'm very open to that.'* (George)

> '*I would recommend that. I mean, it is, it's something that's going to be here… so just make use of it, but don't rely on it entirely… I tell them (Students), hey, why don't you use AI to know what is this about, right? And sometimes I tell them, okay, ChatGPT wrote this, can you write it better?'* (Clint)

Nevertheless, this integration cannot be accomplished without a cost, and we must exercise great care in meeting the possible requirements. From the perspective of students, it is crucial for them to comprehend the prudent utilization of GenAI (Mhlanga, 2023). For instance, Hillary recommends that pupils acquire the skill of studying prior to utilizing GenAI:

> '*When it comes to studying from a student perspective, it could be really useful. But I feel like that's something that needs to be taught to students. Because study skills isn't a necessary subject in college. But it's a very important thing and you kind of spend year 1 and sometimes students spend longer figuring out how to study in college.'* (Hillary)

The majority of participants endorsed this statement, and they also recognized the importance of students cultivating critical thinking abilities and maintaining a skeptical mindset when utilizing GenAI:

> *'I am a little bit more egotistical. I think that the ChatGPT idea would be recycled and have less potential than if I just put my brain to it. I can use it to refine the idea, but I don't really ever use it to come up with the idea from scratch because I'll always have like a 10% doubt being like, oh, is this actually right?'* (Anne)

From the perspective of instructors and institutions, to achieve a great integration of GenAI into the engineering curriculum, the very first thing should be resolving the unfairness caused by different accessibility, for instance, to guarantee the equivalent access of all the students to GenAI tools:

> '*… restricting the kind of AI tool and the version, like, students are going to be using for their exam is really, really important to maintain that fairness level… Either you make a*

purchase of a really, really good model for, like, all the students in your cohort and give them access to that, or you simply just restrict. I wouldn't be okay, personally, with just using whatever you want.' (Serena)

While the equivalent of access is guaranteed, it is also important to provide a proper guide to the standard use of GenAI (Mhlanga, 2023). On the one hand, there should be an advanced supervision mechanism that corresponds with the fast development of GenAI technology. On the other hand, to ensure sustainable development, faculties should teach their students in the very beginning stage how to use GenAI in the right way, particularly for developing their problem-solving and ethical critical thinking skills, which have been identified by Venkatesh et al (2022) as indispensable abilities for engineering students:

'*We need to also start teaching students, how can we properly use this kind of tool, right? It is, it's a powerful one, but then you need to use it properly, right? So, to be able to maximize the benefits of that. So, I think this is something that maybe would be some sort of, like, a fundamental course on, like, use of, the use of Gen AI in, in education or in research.'* (Clint)

Furthermore, to attain successful integration, it is imperative to properly alter the current curriculum design. Clint has demonstrated a commendable approach by segmenting his talk into two distinct halves:

'*One is fundamentals course, and one is more of advanced project-based courses. So in the fundamentals course, you can use ChatGPT to know what's being taught in front of you. And if you've done something that's really not clear, and you want more examples, you can ask ChatGPT for that… On the advanced courses, when you come to project design, you can actually use ChatGPT in the development of the initial help you design and collecting materials'* (Clint)

Based on that, Clint further pointed out that in the future we have to develop new courses that can fit the growing ability of GenAI in academia:

'*I think we will have to start thinking of having what we call, like, content fusion courses, or like, I would say interdisciplinary courses. So, instead of having, for example, a computer architecture course and then, like, a mechanical engineering course, you would have what we call robotics design. And we would take both, like, both fundamentals would be covered in it and the advanced and all that. So, just, like, merging this together'* (Clint)

Above all, none of this can be achieved without the support of engineering faculties. Therefore, as identified by George, universities need to think about and come up with policies on how to deal with GenAI tools to clarify what is allowed and what is not allowed:

'*I think universities need to think about it and need to come up with policies on how to deal with Gen-AI tools. I mean, what is allowed, what is not allowed. We are doing this in research communities. For example, IEEE has a clear policy on Gen-AI, which is already public.'* (George)

Conclusion, Implications, and Future Research Directions

From paper notes to PowerPoint slides, from textbooks to Google research, the development of higher education has always corresponded to the evolution of technology (Dziuban & Picciano, 2015). Nowadays, within engineering education, the integration of GenAI has emerged as a revolutionary force that may change the way we see engineering education significantly (Broo, et al., 2022; Chiu, 2024). To achieve a more comprehensive understanding of this technology and maximize the benefits of integrating these tools into engineering education, it is always important for studies to investigate the perspectives of both students and instructors, who are directly involved in the education procedure.

Based on the qualitative data retrieved from semi-structured interviews, this research has provided insights into experiences, concerns, and expectations of students and instructors regarding using GenAI tools such as ChatGPT. It has highlighted the positive impact of GenAI in engineering education, such as enhancing students' academic performance by simplifying complex topics and facilitating research productivity. This research also identified the potential drawbacks of applying such technology, including misinformation, ethical concerns, and the great challenges AI poses to our traditional assessment pattern. Meanwhile, this paper adds to the ongoing discussion about the necessity of developing advanced strategies and assessment methods in response to technological advancements. Although the utilization of GenAI has several negative impacts, it is still necessary for instructors and students to embrace this technology in their daily lives and achieve a successful integration of GenAI into engineering education, with the support of appropriate strategies and a shift towards a more advanced assessment system.

In the future, it is expected that the GenAI technology will become even more powerful. Therefore, to meet the opportunities and challenges posed by this technology, future research could focus on the formulation of extensive ethical guidelines that encompass the utilization of GenAI tools in the field of education. Meanwhile, greater attention should be devoted to developing advanced assessment techniques to detect dishonesty and academic misconduct. From the perspective of curriculum design, it also suggests investigating how future courses can be designed to adapt to the development of such technology.

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Appendix A: A sample thematic analysis protocol and outcomes

Main Themes	Subthemes	Categories	Codes	Quotes
Positive Impact of GenAI in Education	Improve Academic Performance	Aid with complex topics	Available source	"I see the Gen AI tools as being equivalent to, let's say, an internet search engine from the past" (George)
			Useful explanations	"Most of the times it does come up with useful explanations and maybe provide some analogies for easily understanding" (Todd)
			In-depth analysis	"If there's a specific area or a specific word also that I need more information about, I can just ask it and dig deeper and deeper in one location" (Serena)
		Facilitating high-quality writing	High quality of writing	"When it comes to academic, uh, writing, right, this is leveling up the field of people who are native and non-native speakers. They can now write really high-quality outcome if they're using chat GPT" (Clint)
	Facilitate Productivity of Students	Assisting redundant and extracurricular tasks	Off-class activities	"It's helpful in coming up with like form responses or like writing an email or like the smaller aspects of being a student which sometimes take a lot of time which aren't actually related to your learning" (Anne)
			Redundant tasks	"So in terms of speed, Gen AI in redundant tasks, for sure, like, has the upper hand" (Serena)
		Time saver	Boost writing process	"If you get ChatGPT to write it for you, just for the time being, use it as a filler or a start, it really helps me finish my essays much faster" (Hillary)
			Boost research process	"I think it just helps shorten down the time it takes to do a Google search and then go to five different websites and then figure something out" (Ben)
	Assistance in Idea Generation	Producing new ideas	Merge of ideas	"Now you know the fundamentals, how it looks like, then you can use generative AI to merge some ideas and go to the next level" (Clint)
			Obtain new knowledge	"That would be a pretty useful way that students can use generative AI right now. In addition to self-learning and learning about anything around the world obviously" (Hillary)