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Educators' Perspectives on the use of Generative AI Tools in Teaching and Educational Research in Engineering

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Abstract

Since the release of ChatGPT by OpenAI in November 2022, the integration of generative AI (genAI) into teaching and education has gained significant attention and experienced rapid growth within university engineering programs. This paper investigates the application of genAI in engineering education and research, focusing on the potential benefits and challenges of its adoption. Specifically, the study: A) Analyzes how educators and students perceive and utilize genAI and ChatGPT in engineering education; B) Explores the advantages, challenges, and limitations associated with these technologies; and C) Examines educators' views on using and understanding tools like genAI, particularly ChatGPT. The research incorporates both qualitative and quantitative survey data from students and faculty, assessing educators' attitudes towards genAI, their methods of implementation, and specific use cases in teaching and research. It also considers the viewpoints of those who oppose the use of genAI or discourage its adoption among students. Additionally, the paper discusses students' insights regarding both the beneficial and detrimental uses of genAI. The findings from the surveys conducted with faculty and students are presented throughout the paper.

Introduction and Background

The research highlights the rapid growth and increasing attention generative AI (genAI) has received in university engineering programs since the release of ChatGPT by OpenAI in November 2022 [1]. The authors aim to explore the integration of genAI in teaching and educational research within engineering disciplines. This exploration includes analyzing how both educators and learners understand and utilize genAI tools like ChatGPT, examining the potential benefits and challenges associated with their use, and identifying the perceptions of educators regarding these technologies.

The objectives of the research are multifaceted and aim to provide a comprehensive understanding of the role of generative AI in engineering education. Firstly, the study seeks to analyze how educators and learners identify and utilize generative AI tools like ChatGPT, aiming to understand the patterns and contexts of their usage. Secondly, it explores the potential benefits, challenges, and limitations associated with integrating these technologies into teaching and educational research, providing a balanced view of their impact. Thirdly, the research aims to gather insights into educators' perceptions of generative AI tools, capturing both supportive and opposing viewpoints to present a nuanced perspective. Lastly, it discusses students' perspectives on the use and potential misuse of generative AI in their education, highlighting their experiences and concerns. The study endeavors to offer a detailed exploration of the implications of generative AI in the field of engineering education.

The study employs a comprehensive approach by incorporating both qualitative and quantitative survey questions to gather insights from faculty and students. It delves into various aspects such as the extent to which educators embrace or oppose the use of genAI, specific use cases in teaching and research, and the ethical considerations surrounding the use of these technologies. Additionally, the research discusses students' perspectives on the advantages and potential misuse of genAI tools in their education, providing a balanced view of the impact of these technologies on engineering education. Through these two perspectives of educators and students analysis, the study aims to contribute valuable insights into the evolving role of generative AI in the academic landscape.

The study uses surveys with both qualitative and quantitative questions to collect data from faculty and students, aiming to provide a comprehensive view of the impact of generative AI tools on engineering education.

Background and Literature Review

Advanced education promotes adaptability, innovation, and creativity, aligning specialists with these demands [2]. Integrating engineering design into technology teacher education can enhance curricula and instructional strategies, improving educational experiences by emphasizing analytical skills, problem-solving, and collaboration, though it requires significant curriculum and teacher preparation changes [3]. The rapid growth and increasing attention generative AI have received in university engineering programs since the release of ChatGPT by OpenAI in November 2022 is notable [1]. The integration of generative AI in teaching and educational research within engineering disciplines includes analyzing how educators and learners understand and utilize these tools, examining the potential benefits and challenges, and identifying educators' perceptions of these technologies [1].

AI methodologies support educational praxis and teacher metacognition, aiding teachers' professional development through detailed, context-specific reflection and adaptive decision-making [4]. Generative AI, as an advanced innovative tool, can transform engineering education by creating content, enhancing personalized learning, and updating curricula efficiently [5]. However, potential biases and ethical issues need to be addressed, and user-friendly AI tools should be developed for education [5]. From the learner's perspective, AI can improve teaching effectiveness, learning outcomes, and accessibility, but also raises concerns about data privacy, algorithmic bias, and the changing role of educators [6]. Ethical frameworks and regulatory mechanisms are necessary to ensure transparency, accountability, and fairness in AI use in education [6]. From the educator's perspective, generative AI can improve personalized learning, create innovative instructional materials, and reduce instructors' workloads, enhancing student engagement and understanding of complex concepts [7]. However, concerns about potential inaccuracies, privacy issues, and reduced cognitive engagement suggest the need for ethical guidelines and investigation of long-term impacts [7]. Future research should develop context-

specific ethics guidelines and establish a network of safety champions to enhance the quality of engineering education [8].

AI Useful Cases for Both Engineering Students and Educators

There are several useful cases of AI for both engineering students and educators, namely: 1) the impact of Generative Artificial Intelligence (GAI) tools, which set the stage for how AI is transforming various aspects of education; 2) Personalized Immersive Learning, providing valuable insights and personalized feedback to students; 3) AI in teacher metacognition, helping educators understand and improve their teaching practices; 4) collaborative learning techniques facilitated by AI, promoting teamwork and knowledge sharing among students; 5) enhancing reflective practices, enabling both students and teachers to reflect on their learning and teaching processes; 6) integrating professional skills into the engineering curriculum, with AI playing a supportive role in this integration; and 7) addressing the ethical challenges in engineering education, ensuring that the implementation of AI is done responsibly and ethically.

1. Impact of Generative Artificial Intelligence (GAI) tools

Osunbunmi et al. (2024) investigates how integrating Generative Artificial Intelligence (GAI) tools in engineering education can enhance communication and collaboration between students and educators [9]. By collecting data through interviews, observations, focus groups, and various course materials, the research aims to demonstrate the effectiveness of GAI in improving learning outcomes and critical thinking skills [9]. Despite potential challenges like the learning curve and ethical concerns, the study provides valuable insights for future research on the long-term impact and ethical implications of GAI in education [9].

2. Personalized Immersive Learning

Zhang [10] investigates the integration of machine learning and metaverse technologies to create secure, personalized learning environments. By conducting a literature review and theoretical analysis, the research highlights the potential of these technologies to enhance preschool education through immersive experiences and robust cybersecurity [10]. However, the study's reliance on existing literature limits its generalizability, suggesting a need for future empirical research to validate the proposed framework in real-world settings [10].

3. AI in Metacognition

Porayska-Pomsta [4] examines the ethical considerations of using AI in engineering education, incorporating views from both students and educators. Porayska-Pomsta [4]explores how AI methodologies can support educational practices and teacher metacognition, focusing on evidence-based practice to enhance educators' reflective abilities. It highlights the potential of AI to improve teachers' professional development through detailed, context-specific reflection, while also noting the limitations in generalizability and practicality [4]. Future research is suggested to develop scalable AI tools for everyday educational use and to determine the optimal levels of formal specification needed for effective metacognition support [4].

4. Collaborative Learning Techniques

Ralston et. al [11] provides insights importance of collaborative learning techniques both engineering students and educators. The study at the University of Louisville aimed to encourage faculty to adopt collaborative learning techniques and analyze their impact on teaching practices and student outcomes. Using a multiple case study approach, data was collected through interviews, reflections, course documents, and observations [11]. Findings indicated that collaborative learning improved student engagement and understanding, and faculty satisfaction, despite limitations such as a small sample size and specific context. Future research should explore the long-term impacts and scalability of these techniques [11].

5. Enhancing Reflective Practices

Du et. al [12] explores the development of critical reflection among Chinese university instructors during a six-month Problem-Based Learning (PBL) program in Denmark. Using progressive portfolios, team project reports, and focus group interviews, the study provided both qualitative and quantitative insights into the participants' reflective processes [12]. Significant improvements were noted in instructional and pedagogical knowledge, though curricular knowledge reflection remained limited. Future research should investigate the long-term impacts of PBL programs and compare individual versus team-based professional learning activities [12].

6. Integrating Professional Skills into Engineering Curriculum

Brunhaver, et. al [13] explore the transformative potential in engineering education from both student and educator perspectives. The study aims to bridge the gap between educational programs and professional practice by examining the competencies required in the workplace [13]. Through interviews with students and newly hired engineers, it was found that while technical skills are well-covered, professional skills like communication and teamwork are often learned on the job. The study highlights the need for integrating these skills into the curriculum and suggests future research to address these educational gaps [13].

7. Ethical Challenges in Engineering Education

Swartz [8] investigates the ethical dilemmas in Engineering Education 4.0 at a University of Technology in South Africa, focusing on issues like unintended negative consequences of technology, discrimination, and educator agency. Using a survey with Likert-scale and open-ended questions, data from 68 engineering educators revealed consistent ethical concerns, including reduced contact time, compromised online assessment integrity, and privacy issues [8]. Despite limitations such as a low response rate and data from a single university, the study underscores the need for context-specific ethics guidelines and safety champions to improve engineering education. Future research should aim to develop these guidelines and best practices through workshops [8].

Methodology

The survey methodology for this study employed a mixed-methods approach, combining quantitative and qualitative questions to capture a comprehensive understanding of engineering faculty perceptions and use of generative AI tools. A structured survey was developed and distributed directly to engineering faculty teaching at both undergraduate and graduate levels at Kennesaw State University. The survey included closed-ended questions to gather quantitative data on AI adoption rates, frequency of use, tasks performed, and perceived impact on teaching and research effectiveness. Open-ended questions provided qualitative insights into faculty experiences, challenges, and ethical concerns regarding generative AI integration. This combination of data types allowed for a nuanced analysis of trends, patterns, and sentiments, ensuring a holistic understanding of how generative AI is shaping engineering education at KSU.

A total of 16 respondents participated in this study, representing engineering faculty teaching at both undergraduate and graduate levels at Kennesaw State University. While participation varied slightly by question, with response rates ranging from 10 to 16, the overall engagement was sufficient to identify key trends and sentiments. For quantitative questions, response counts were consistent, enabling reliable analysis of adoption rates, tool usage, and perceived impacts. For qualitative questions, particularly in open-ended responses, 5 faculty members provided detailed feedback, offering valuable insights into challenges, ethical concerns, and suggestions for generative AI integration. This response distribution allowed for both statistical analysis and rich narrative exploration of faculty perspectives.

Faculty Survey

The intent of the faculty survey is to understand generative AI adoption and usage by educators. The following questions are asked in the survey.

Q1. Have you adopted generative AI tools in your teaching or research?
- Yes
- No [If No, skip to Q17]

Q2. Which platform(s) do you use? [ChatGPT, Perplexity, GIMINI, CLOD, MS Co-Pilot, Others]

Q3. How frequently do you use these tools?
- Daily
- Weekly
- Monthly
- Rarely

Q4. What specific tasks do you use generative AI tools for? [Multiple choice, select all that apply]
- Creating course materials
- Grading

- Research assistance
- Other [With text entry option]

Q5. On a scale of 1 to 5, how would you rate the overall impact of generative AI tools on your teaching effectiveness?
[1 = No impact, 5 = Significant positive impact]

Q6. On a scale of 1 to 5, how would you rate the overall impact of generative AI tools on your research effectiveness?
[1 = No impact, 5 = Significant positive impact]

Q7. What challenges have you encountered while using generative AI tools? [Multiple choice, select all that apply]
- Technical issues
- Ethical concerns
- Resistance from colleagues
- Other [With text entry option]

Q8. How do you perceive the role of generative AI tools (e.g., ChatGPT) in engineering education?
- Very positive
- Positive
- Neutral
- Negative
- Very negative

Ethical Considerations

Q9. What ethical concerns do you have regarding the use of generative AI tools in education? [Multiple choice, select all that apply]
- Academic integrity
- Data privacy
- Bias in AI-generated content
- Other [With text entry option]

Q10. Do you have any additional comments or suggestions regarding the use of generative AI tools in engineering education? [Open-ended]

This revised version is optimized for a Qualtrics digital survey by:

1. Adding a screening question to direct respondents to the appropriate section.
2. Using question logic to skip irrelevant questions based on previous responses.
3. Grouping related questions together for a more logical flow.
4. Specifying question types (e.g., multiple choice, open-ended) for easy implementation in Qualtrics.
5. Providing clear instructions for scale questions.
6. Ensuring consistency in question formatting and response options.
7. Including options for "Other" with text entry where applicable.

This structure will make the survey more efficient to administer and easier for respondents to complete, while still collecting all the necessary data

Discussion and Analysis

This section examines the responses collected from engineering faculty regarding their adoption, use, perceptions, and challenges related to generative AI tools in teaching and research. The analysis identifies emerging trends, areas of concern, and opportunities for improvement in generative AI integration within engineering education.

Adoption of Generative AI Tools

A significant majority (**71.43%**) of respondents have adopted generative AI tools in their teaching or research (Q6). This trend reflects growing interest and acceptance of these tools among engineering faculty, particularly as AI becomes increasingly mainstream. However, **28.57%** of respondents have not yet adopted generative AI. This group likely faces barriers such as technical proficiency, ethical concerns, or skepticism about AI's relevance and accuracy in their work.

Preferred Generative AI Platforms

Among faculty who use generative AI, **ChatGPT** emerged as the dominant platform, with **56.25%** of respondents favoring it (Q7). Gemini (**25%**) and Co-Pilot (**18.75%**) also showed moderate adoption, but tools such as Claude and Perplexity were entirely unused. This preference for ChatGPT likely stems from its widespread accessibility, ease of use, and name recognition. The limited use of alternative platforms suggests that institutional promotion or individual exploration of diverse tools remains an area for improvement.

Frequency of Tool Usage

In terms of usage patterns (Q8), **50%** of respondents use generative AI tools weekly, while **40%** engage with them daily. This regular usage indicates that generative AI is becoming embedded in faculty workflows. However, the absence of monthly users and the small percentage of rare users (**10%**) suggest a polarization: faculty either integrate AI frequently or avoid it altogether. This trend highlights a gap between early adopters and those who remain hesitant.

Tasks Performed with Generative AI

Faculty primarily use generative AI tools for **research assistance (36.36%)**, **brainstorming (31.82%)**, and **creating course materials (27.27%)** (Q9). These tasks align with the strengths

of generative AI, such as content generation, idea development, and reducing time spent on repetitive tasks. Notably, AI is not used for grading, reflecting concerns about accuracy and trust in AI for evaluative processes. Faculty also identified additional uses, such as writing research proposals, underscoring AI's utility in administrative and research-focused contexts.

Perceived Impact on Teaching and Research Effectiveness

Faculty responses regarding generative AI's impact on teaching (Q10) and research effectiveness (Q11) show mixed but generally positive perceptions. For teaching effectiveness, the mean score of **2.20** on a 5-point scale suggests moderate improvements. Faculty find AI helpful for inspiration, brainstorming, and content creation but acknowledge its limitations.

Research effectiveness received a slightly higher variability in responses, with a mean of **2.50**. While **40%** of faculty reported significant positive impacts, others expressed limited benefits, possibly due to accuracy issues or the difficulty of integrating AI tools into research workflows.

Challenges with Generative AI

Faculty reported significant challenges when using generative AI tools (Q12), with **50%** citing ethical concerns, such as academic integrity and bias in AI-generated content. Technical issues, including reliability and accuracy, were noted by **20%** of respondents, highlighting a recurring theme of distrust in AI outputs. Additionally, **10%** reported resistance from colleagues, which may reflect broader institutional or cultural skepticism toward AI adoption.

Faculty Perceptions of Generative AI

The overall perception of generative AI tools (Q13) is positive, with **50%** of respondents expressing a "very positive" view and **40%** reporting a "positive" outlook. Only **10%** of respondents expressed neutrality, and none reported negative perceptions. These findings suggest that most faculty recognize generative AI's potential to enhance teaching and research, particularly when used as a supplementary tool.

Ethical Concerns in AI Usage

Ethical considerations remain a priority for faculty, as reflected in Q14. The most significant concerns include **academic integrity (34.78%)**, **bias in AI content (34.78%)**, and **data privacy (26.09%)**. These concerns align with broader academic discourse on the responsible use of AI and emphasize the need for clear guidelines and institutional support to address ethical challenges.

Sentiment Analysis of Qualitative Feedback

The responses to Q15 provide qualitative insights into faculty experiences with generative AI tools. Sentiment analysis revealed a mix of **negative**, **neutral**, and **positive** perceptions:

- **Negative sentiment** emerged from concerns about reliability and accuracy, particularly when generative AI produced incorrect references or unsupported content.
- **Neutral sentiment** focused on AI's role as a supplementary resource, emphasizing the importance of maintaining traditional learning and critical analysis.
- **Positive sentiment** highlighted AI's potential for inspiration, brainstorming, and problem-solving, provided its limitations are acknowledged.

For example, one faculty member expressed frustration:

"Many times I noticed that what I was getting from ChatGPT was wrong... It even generated wrong literature review and references!"

Another respondent provided constructive feedback:

"Generative AI should be used as a supplementary resource, not a replacement for traditional learning."

This sentiment analysis underscores the need for improved accuracy, proper training, and foundational AI education to build confidence and trust among faculty.

Summary and Conclusion

Summary and conclusion of the above analysis is presented in this section.

- Generative AI tools are increasingly adopted by faculty, with ChatGPT leading as the preferred platform.
- AI is used primarily for research assistance, brainstorming, and creating course materials, but not for grading or evaluative tasks.
- Ethical concerns, technical issues, and accuracy limitations are significant barriers.
- Faculty view AI as a valuable supplementary tool, provided its limitations are addressed.

These findings highlight both the promise and the challenges of integrating generative AI into engineering education. Moving forward, institutions should focus on addressing ethical concerns, improving tool reliability, and providing faculty with the foundational knowledge needed to use AI effectively.

The key ethical findings from the survey revealed significant concerns among engineering faculty regarding the use of generative AI tools in education. The most prominent ethical issues identified were:

- Academic Integrity (34.78%): Faculty expressed concerns about the potential misuse of generative AI, particularly in enabling plagiarism, generating unoriginal content, or undermining independent critical thinking among students.
- Bias in AI-Generated Content (34.78%): Respondents highlighted the risk of inherent biases in AI outputs, which could perpetuate inaccuracies or misrepresentations, particularly in technical or sensitive educational contexts.
- Data Privacy (26.09%): Concerns were raised about the confidentiality and security of data, especially when using AI tools that require inputting potentially sensitive or proprietary information.
- Other Concerns (4.35%): One respondent mentioned "AI consciousness," reflecting broader philosophical or speculative worries about the role and limits of AI tools in education.

These findings underscore the need for institutional guidelines and ethical frameworks to ensure responsible use of generative AI in engineering education. Addressing faculty concerns with AI such as issues of bias, academic honesty, and data privacy will be critical for building overall faculty trust and promoting the effective integration of AI tools in teaching and research.

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