Faculty perceptions and usage of generative AI in geotechnical engineering education

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ABSTRACT: Artificial intelligence (AI) has played a growing role in geotechnical engineering, evolving from early applications in material modeling and data interpretation to modern generative AI (GenAI) systems capable of automating workflows and enhancing education. The integration of GenAI in geotechnical engineering education presents both opportunities and challenges. While recent studies highlight GenAI's potential in problem-solving, instructional support, and professional practice, concerns remain regarding its reliability, impact on cognitive development, and implications for faculty roles. This study examines faculty perspectives on GenAI adoption in geotechnical education, focusing on their familiarity with AI tools, institutional policies, and its influence on teaching and assessment. A survey of academics from various institutions worldwide revealed varying levels of engagement, with 92% of respondents currently not using GenAI in teaching but showing openness to future integration. Faculty concerns include over-reliance on AI for learning, the need for evolving assessment methods, and the accuracy of AI-generated content. Despite these challenges, 81% of respondents recommended or strongly recommended GenAI to their academic peers. Findings suggest that GenAI should be integrated as a complementary tool rather than a replacement for traditional teaching methods, with clear institutional policies and training initiatives to support responsible use. As AI technologies continue to evolve, fostering AI literacy among educators will be essential to maximize its benefits while mitigating risks to academic integrity and cognitive development.

Keywords: Generative AI, Geotechnical education, Academic perspective

1 Introduction

Artificial intelligence (AI) has been applied in geotechnical engineering for decades, beginning with traditional AI and neural networks. Early research, including studies by Chan et al., 1995; Ghaboussi et al., 1991; and Zhou & Wu, 1994, explored the use of neural networks for material behavior modeling, site investigation data interpretation, and pile driving analysis. In recent years, advancements in machine learning (ML) and explainable AI models have expanded AI's role in geotechnical engineering, particularly in geotechnical reliability analysis and hazard prediction (Abdollahi et al., 2024; Chai et al., 2024; Ge et al., 2024; Zhang et al., 2023). The latest phase in AI's evolution–Generative AI (GenAI)–is now being investigated for its potential to automate geotechnical workflows and transform educational practices (Baghbani et al., 2022; Chai et al., 2024; Reddy and Janga, 2025).

GenAI represents a distinct category of AI that extends beyond traditional data analysis and pattern recognition to generate human-like content, including text, code, sound, simulations, 3D objects, images, and videos. It builds on Generative Adversarial Networks (GANs) (Goodfellow et al., 2014) and

draws from large datasets to produce contextually relevant outputs based on user input. Since the launch of ChatGPT in November 2022, numerous other GenAI platforms have emerged, including Magic Write, Claude, Eleven Labs, Microsoft Copilot (formerly Bing Chat), Google Gemini (formerly Bard), DALL·E, Midjourney, Stable Diffusion, Channel, Musico, LLaMA, DeepSeek, Sora, Symphony Creative Studios, Mistral AI's Le Chat, and IBM Watsonx, with new platforms continuing to emerge. At the time of writing this article, OpenAI's 'deep research' model was released as part of a suite of models heralding the era of Agent Based GenAI (AGI) with applications in engineering education. The use of GenAI in geotechnical engineering education and practice is expanding, reflecting broader trends in AI adoption across various disciplines.

Recent studies have examined the role of GenAI in geotechnical engineering and related fields. Shoemaker et al. (2023) evaluated ChatGPT's capabilities by prompting it to answer National Council of Examiners for Engineering and Surveying (NCEES) civil and geotechnical practice exam questions, write a geotechnical data report, develop a Python function to calculate ultimate bearing capacity, and evaluate liquefaction potential using CPT values. Their findings suggest that GenAI tools could serve as virtual geotechnical engineering assistants, addressing labor shortages and supporting professionals in handling complex engineering tasks. Similarly, Reddy and Janga (2025) conducted an online survey to gather qualitative insights into the use of GenAI in education, research, and professional practice within the geotechnical and geoenvironmental engineering community. Their study surveyed faculty, students, industry practitioners, and professionals, capturing perspectives on GenAI's applications and limitations. While these studies highlight GenAI's ability to assist with data processing and engineering problem-solving, they also identify challenges related to specialized training requirements and the reliability of AI-generated outputs.

In higher education, GenAI is reshaping traditional instructional approaches (Peres et al., 2023). Although concerns persist about AI replacing human educators, research suggests that GenAI complements rather than replaces instructors. Chan & Tsi (2024) surveyed university faculty and students, finding that while GenAI can support teaching and administrative tasks, educators remain essential due to their critical thinking, emotional intelligence, and ability to engage students in meaningful learning – qualities AI lacks. Likewise, a scoping review by Xia et al. (2024) identifies GenAI's growing role in assessment, self-directed learning, and real-time feedback generation. However, their study also raises concerns about academic integrity and the need for institutions to reconsider assessment strategies in response to AI-driven changes. These findings suggest that GenAI's adoption in education should be approached carefully, so it supports rather than diminishes the role of instructors.

Despite these advancements, faculty engagement with GenAI in geotechnical engineering education remains largely unexplored. Understanding how educators perceive and apply these tools is important for curriculum development, instructional strategies, and faculty training, equipping instructors to integrate AI in ways that contribute meaningfully to student learning. Faculty perspectives also provide insight into ethical concerns, data privacy considerations, and accessibility challenges, which influence responsible AI adoption in academic settings. Examining faculty engagement further allows for a deeper understanding of student learning outcomes, helping shape more effective instructional practices that align with evolving educational needs.

This study takes a first step toward addressing this gap by examining faculty familiarity with GenAI applications, the ways in which these tools are used, and their impact on geotechnical engineering pedagogy. The following sections provide an outline of the methodology used in this study, overview of selected institutional policies on GenAI, and other findings on faculty interaction with GenAI tools in the context of geotechnical engineering education.

2 Academic perspective survey

Reddy and Janga (2023) conducted an online survey in 2023 to gather qualitative insights into the use of Generative AI in education, research, and professional practice within the geotechnical and geoenvironmental engineering community. The survey engaged faculty, students, industry practitioners, and professionals, eliciting their perspectives on the application of Generative AI in their respective domains. The study identified key benefits and limitations associated with the use of Generative AI across these sectors.

Building on this approach, the present study employed a similar online survey methodology, but with a specific focus on capturing the academic perspective within the geotechnical community regarding the use of Generative AI in teaching. The survey was directed exclusively at academics and was disseminated among the authors' professional networks, including individuals with experience in teaching geotechnical courses at the undergraduate or postgraduate level. To facilitate candid and unbiased responses, participation was voluntary and anonymous. The survey instrument was designed to evaluate academics' familiarity with diverse teaching methodologies, their understanding of AI and its associated tools, institutional policies on AI, the influence of AI on their pedagogical practices, and their perceptions of how Generative AI affects student learning.

A total of 24 respondents fully completed the survey (Figure 1). Among them, all but one currently hold permanent academic positions across various universities worldwide. These institutions are located in the United Kingdom, China, India, France, Belgium, Italy, Fiji, Iran, Sri Lanka, the United States of America, and Nigeria, reflecting a broad geographical representation. The survey participants came from diverse career stages, ranging from early-career academics to senior faculty members, providing a well-rounded perspective on the topic under investigation. Additionally, approximately 20% of the respondents identified as female, highlighting the gender composition within the surveyed academic cohort.

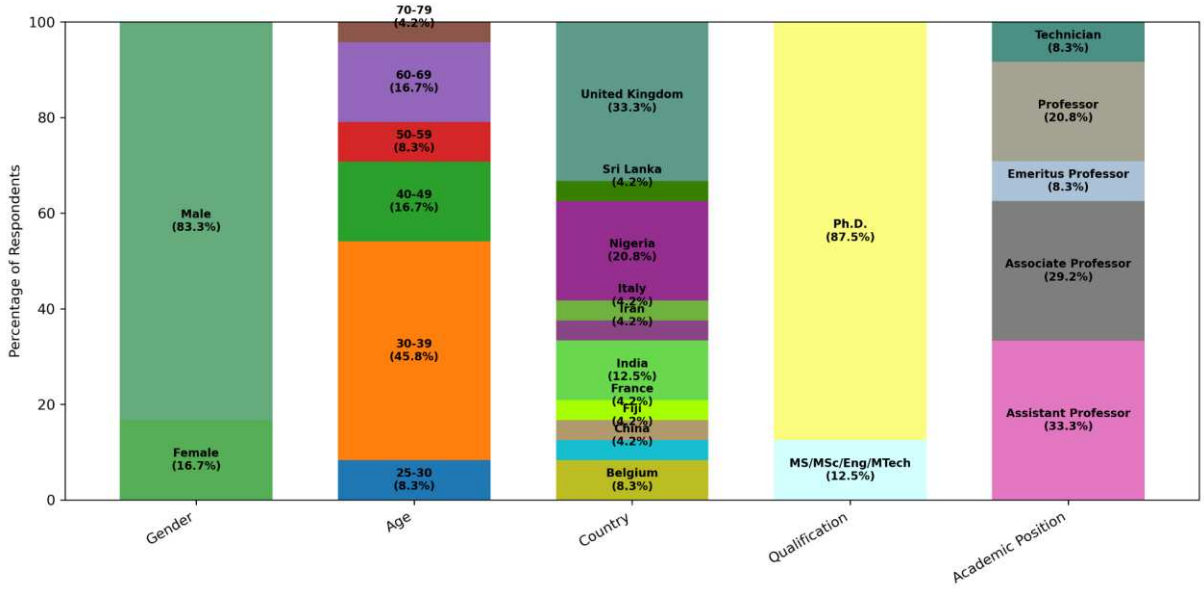

Figure 1. Distribution of respondents by academic position, age, country, gender, and qualification

3 Institutional policies on GenAI

There is a growing interest in generative AI within the civil engineering community, both in professional practice and academic education. Universities across Europe, the UK, and the USA are actively formulating policies to regulate the integration of generative AI tools in education, particularly concerning student engagement. The overarching aim seems to be to capitalise on AI's potential to enhance learning while simultaneously upholding academic integrity and ethical standards.

In the UK, the Russell Group, which represents 24 leading universities, has established key principles that promote AI literacy, ensuring that both staff and students are equipped with the requisite knowledge to use AI responsibly. These guidelines also encourage the adaptation of teaching and assessment methods to facilitate ethical and equitable AI integration (Russell Group, 2023). Institutions such as the University of Oxford, Imperial College London, and Durham University have introduced specific policies that advocate for responsible AI use, emphasising its role in augmenting—rather than replacing—critical thinking and independent learning (University of Oxford, 2024; Imperial College London, 2024).

In the United States, universities have adopted varied approaches towards the integration of generative AI in education. Some institutions, such as Cornell University and Columbia University, have delegated decision-making authority to individual academics, allowing them to determine the extent to which AI

tools are incorporated into their teaching. Conversely, Colorado State University has imposed restrictions on generative AI usage in line with its interim policy (Wall Street Journal, 2024). In contrast, Arizona State University and California State University have actively encouraged AI adoption in educational settings, recognising its potential to enhance student engagement and learning experiences. Notably, both institutions have partnered with OpenAI to integrate ChatGPT for personalised learning across their campuses, signalling a major shift towards AI-driven education (Graziano, 2024; Reuters, 2025).

Across Europe, prominent institutions such as ETH Zurich, Université Libre de Bruxelles, and the University of Copenhagen have begun implementing frameworks that foster AI-driven innovation while maintaining rigorous academic standards (ETH Zurich, 2024). These universities highlight the importance of continuous policy evaluation and refinement to keep pace with rapid technological advancements, ensuring that AI remains a tool for enhancement rather than a compromise to academic excellence.

Findings from our survey (more details below) indicate that academics in the UK, USA, and Europe generally possess awareness of the existence of their respective institutional policies on generative AI, which primarily advocate for responsible usage. However, a considerable number of respondents from institutions in Nigeria, India, and Sri Lanka reported that their universities had not yet established policies governing the use of AI tools in education for either staff or students. Additionally, respondents from Fiji noted that their institution had implemented a stringent policy that strictly prohibits the use of generative AI in any educational capacity. Interestingly, the survey also revealed that many academics, despite being aware of generative AI tools, were unfamiliar with their own institution's policies on their usage.

These findings highlight the significant divergence in AI policies across higher education institutions worldwide. While some universities have embraced AI integration and are actively shaping policies to regulate its use, others lack any formal guidelines, resulting in inconsistencies in how AI is perceived and utilised in education. The absence of standardised policies across different regions suggests the need to normalise regulations on generative AI usage to ensure a uniform educational framework that maintains comparable academic standards globally. As AI continues to evolve, establishing well-defined, universally recognised guidelines will be crucial in fostering equitable access to AI-enhanced learning while safeguarding academic integrity and innovation.

4 Survey results and discussion

4.1 Familiarity with Generative AI Apps

The results of the survey reveal a range of familiarity and engagement with GenAI among respondents. Participants indicated that they are either not familiar with GenAI or have only a basic understanding of its functionality, suggesting that there is a gap in awareness and exposure to the technology, probably from a lack of exposure to new technology or perhaps from the rapidly changing nature of AI developments. A portion of respondents (50% of individuals surveyed) expressed openness to learning more but admitted to having little understanding of how AI works, highlighting a need for clearer communication and education on its practical applications. A group of individuals (45% of individuals surveyed) reported being somewhat familiar with GenAI but have not yet integrated it into their work or teaching, indicating potential for growth with hands-on experience. As shown in Figure 2a, 92% of individuals surveyed declared that they do not use any GenAI Apps for their teaching activities. On the other end of the spectrum, a few respondents (8% of individuals surveyed) stated that they currently use GenAI and its capabilities, mostly for improving readability of academic text, for improving visualisation of graphs and data representations, for developing part or entire portions of lecture notes or for generating feedback reviews for student projects. Some acknowledged that there is still room for deeper exploration of advanced features. Interestingly only 5% of individuals surveyed do not intend to use GenAI in the future (Figure 2b).

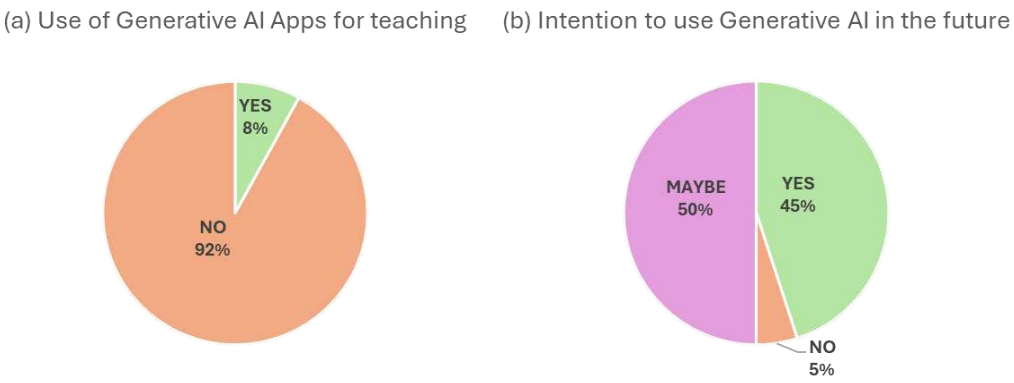

Figure 2. Survey results: (a) current use of Generative AI Apps for teaching and (b) intention to use Generative AI in the future.

Respondents indicated that the most commonly used Generative AI applications are ChatGPT, Google Gemini, and Co-Pilot. Their popularity can be attributed to several factors, such as their user-friendly interfaces and widespread availability, making them accessible to a broad audience. Additionally, they offer free access with optional premium plans, allowing users to explore their capabilities before committing to a subscription. Notably, Co-Pilot appears to be particularly favored, likely due to its seamless integration with Microsoft Office products, making it a preferred choice among professionals. Similarly, Google Gemini benefits from being embedded within Google's ecosystem, enhancing its appeal to users already familiar with Google's suite of tools.

Additionally, institutions appear to be proactively addressing AI integration, with almost half of the participants highlighting guidance for departments to develop their own policies for GenAI use. The fact that the university provides guidance for departments to create their own policies shows a proactive approach toward managing AI technologies. It also suggests that the institution is recognizing the need for regulation or best practices in the face of new AI technologies, ensuring that departments are informed and aligned with institutional goals while safeguarding ethical considerations and academic integrity. It is important to note that the majority of survey participants (67%) were either unsure (29%) or confirmed the absence (38%) of existing institutional or university policies or recommendations. The majority of participants also recognized the growing importance of GenAI, predicting that its role in education and professional fields will continue to expand in the coming years, underscoring the need for ongoing training and support. This forward-looking perspective suggests an understanding that education and professional development in AI will be critical in adapting to technological shifts. Educational institutions and workplaces might want to prepare for this by planning long-term strategies to integrate AI training into curricula and professional development programs. In summary, these comments reveal a range of familiarity with generative AI, from complete unfamiliarity to more advanced usage. They highlight the varying levels of understanding and engagement that exist, suggesting that a tailored approach to learning and professional development will be required. Institutions and organizations can help bridge these gaps by offering resources, training, and support that cater to both those who are new to AI and those who are already proficient, ensuring that the benefits of GenAI are accessible to all.

4.2 Impact on teaching methods

On the teaching side, GenAI is proving to be a valuable asset in administrative and instructional tasks. Educators are increasingly utilizing GenAI to automate the creation of lesson plans, design assignments, and grade student work, which allows instructors to dedicate more time to interactive, student-centered teaching methods. Figure 3a and 3b illustrate respondents' opinions on GenAI as a teaching aid, and its impact on the role of teachers. A majority (63%) viewed GenAI as a valuable tool for assisting instruction, while 29% remained uncertain or had reservations. Only 8% found it not useful for teaching. Furthermore, 29% of respondents believed that Generative AI could negatively impact the role of teachers in the future, whereas the remaining 71% either disagreed (33%) or were unsure (38%).

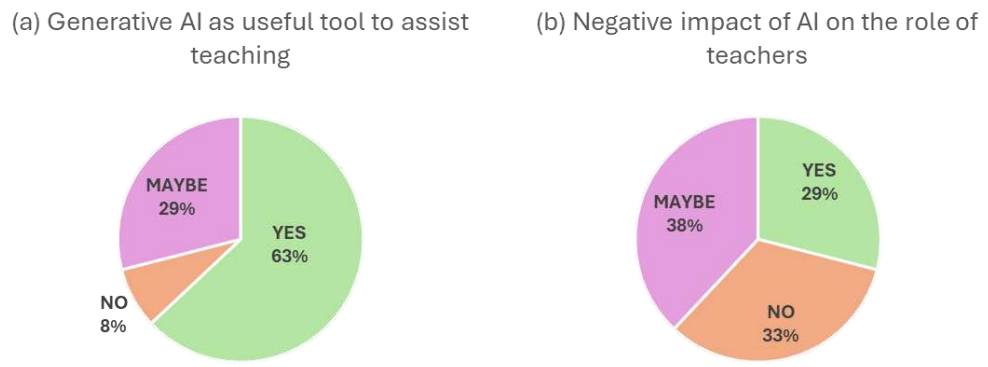

Figure 3. Survey results: (a) respondents opinion of generative AI as useful tool to assist teaching; (b) respondents opinion on negative impact of generative AI on the role of teachers in the classroom in the future.

As shown in Figure 4, survey participants mostly agree that GenAI can positively or extremely positively affect professional correspondence, academic writing and the redaction of course material. AI tools can generate simulations and case studies based on real-world scenarios, which are particularly beneficial in geotechnical engineering, where students can apply theoretical knowledge to practical problems. These AI-generated materials can also be personalized based on individual learning progress, creating a more adaptive and tailored educational experience for students. Despite these benefits, educators expressed concerns about AI's potential role in diminishing the development of essential skills such as critical thinking and problem-solving. Some expressed fear that over-reliance on AI could result in students who are less capable of approaching complex engineering challenges independently. A respondent recommended that "*Generative AI should be used as a tool [and] outputs must be critically evaluated. It should be used as an assistant rather than something that replaces intellectual work."*

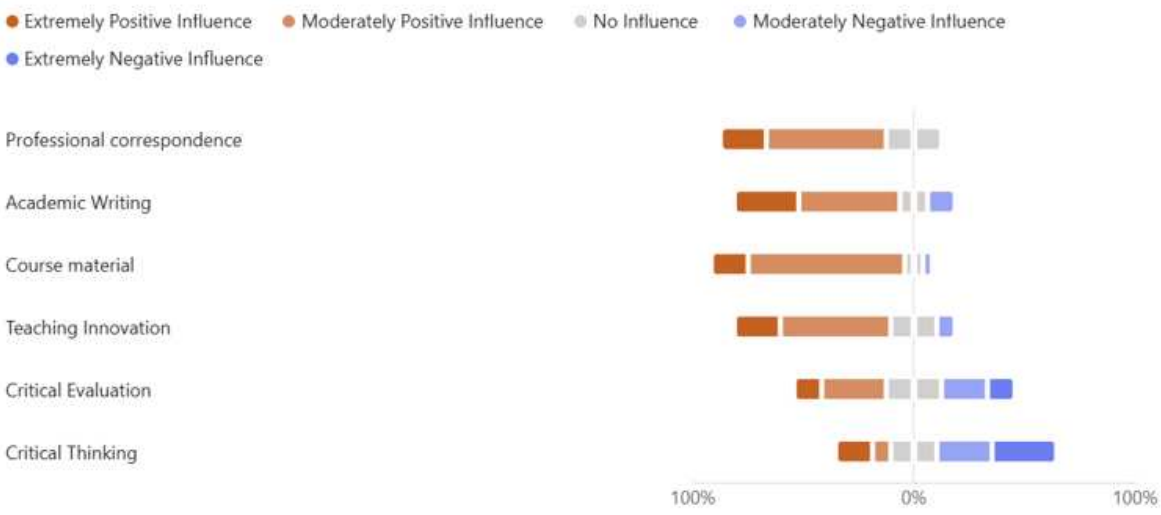

Figure 4. Survey results on the effect Generative AI has on one's teaching skills.

The challenge, therefore, lies in ensuring that AI tools are used as supplements to traditional methods rather than as replacements for fundamental educational practices. Educators also highlighted concerns about the accuracy and reliability of AI-generated content, especially in a technical field like geotechnical engineering, where precision is paramount. A respondent posited that "*Generative AI is quick but often incorrect (it generates information, not knowledge). Its accessibility will trump its accuracy".* There is a risk that AI-generated resources might contain errors or lack the nuanced understanding required for highly specialized technical problems, potentially leading to misunderstandings or misapplications of core concepts. According to respondents, it is necessary to maintain a balance between AI-enhanced

learning and traditional problem-solving exercises by ensuring that AI-generated materials align with academic standards and do not oversimplify complex topics; and by detecting AI-generated assignments, as students may submit AI-assisted work without understanding the content.

The survey respondents emphasized the importance of ensuring that students are trained to critically evaluate AI-generated outputs, understanding the limitations and potential biases inherent in the technology. Institutions must provide clear guidelines and policies for the ethical use of AI in academic settings, including training students to use AI responsibly in both academic and professional contexts. AI should be viewed as a tool to enhance, rather than substitute, traditional learning methods, encouraging active learning through AI-assisted simulations rather than passive content consumption.

4.3 Challenges, considerations, and concerns

Survey participants raised several key concerns regarding the integration of GenAI into geotechnical engineering education and higher education in general. Despite worries about its potential negative impact on teachers' roles (Figure 3b: 38% "Maybe" and 29% "Yes"), a majority of participants (81%) still support its adoption, with 54% recommending and 27% strongly recommending its use to academic colleagues. Some of the concerns raised are summarized below.

Familiarizing Educators with Generative AI: There is a clear need for educators to understand both the capabilities and limitations of GenAI. Successfully integrating these tools into teaching requires time and careful adaptation, as they introduce both opportunities and challenges. The role of educators may shift from being the primary source of knowledge to a facilitator guiding students in the effective and responsible use of AI.

Impact on Human Cognitive Abilities: As GenAI assumes tasks traditionally performed by humans, concerns arise about its potential impact on cognitive development, critical thinking, and problem-solving skills. A survey participant explicitly said "*it [GenAI] will spoil the creativity of the user"*. With the emergence of advanced GenAI models, such as OpenAI's Deep Research, which has the capability to generate full doctoral dissertations (Maynard, 2025), these concerns are both valid and increasingly relevant. As GenAI continues to develop more sophisticated reasoning abilities, there is a growing risk that novice users may engage with these tools before undergoing rigorous learning experiences, potentially hindering intellectual growth. The key challenge is finding a balance—leveraging AI for efficiency while ensuring students remain intellectually engaged in deep reasoning and deep learning. Over-reliance on AI for cognitive tasks may diminish mental agility, as deep learning, creativity, and overall intellectual development is typically expected to stem from struggle, discovery, and problem-solving.

Evolving Assessment Methods: Assessing in New Ways: Traditional assessment strategies may become less effective as GenAI can generate responses at a level comparable to top-performing students. This underscores the need to rethink how we evaluate learning. Relying solely on fact-based or recall-driven questions is no longer sufficient. Instead, assessments should emphasize critical analysis, creativity, and applied knowledge—areas where human insight remains essential.

Balancing Speed and Accuracy: While GenAI provides rapid access to information, its responses do not always guarantee accuracy. The convenience of AI-generated content may lead to over-reliance on speed at the cost of accuracy, increasing the risk of misinformation. Strong critical evaluation skills are required to verify the validity of AI-generated outputs.

The Urgency to Experiment: given the rapid development of generative AI, there seems to be a perceived urgency for educators to experiment with these technologies to fully understand their strengths, limitations, and ethical implications. This experimentation can provide valuable insights into how AI can complement traditional teaching methods and potentially unlock new ways of engaging with students.

It must be noted that these current perceptions, challenges, and concerns about usage of GenAI are based on the current state of the technology, academic exposures, and institutional policies. Considering that both academics and institutions across the globe are actively evaluating the impacts of AI in education, and the industry is constantly developing and updating the technologies, it is imperative that the academic exposure and institutional policies will change in future and subsequently even the academic perception on using it.

5 Conclusions

The integration of GenAI in geotechnical engineering education is at an early yet transformative stage, with the potential to enhance educational outcomes and reshape instructional approaches. However, its adoption must be carefully managed to ensure that AI serves as a complementary tool rather than a replacement for traditional learning. A balanced approach is essential, where students leverage AI for efficiency while maintaining the ability to think critically and solve problems independently. Survey findings indicate both enthusiasm and caution among faculty, highlighting the need for structured AI adoption strategies that prioritize responsible use, faculty training, and evolving assessment methods to align with AI-driven learning environments. Educational institutions should actively foster AI literacy, equipping students with the skills to use AI tools effectively, critically assess outputs, and refine their understanding. This involves integrating AI literacy into curricula, ensuring ethical and informed usage while maintaining rigorous academic standards. Key concerns include the potential over-reliance on AI for problem-solving, the accuracy of AI-generated outputs, and its long-term impact on cognitive development and student engagement. However, when thoughtfully implemented, GenAI can support instructional tasks, streamline administrative processes, and enhance student learning experiences. As AI adoption expands, institutions must establish clear guidelines, ethical frameworks, and targeted professional development programs to equip educators with the skills needed to navigate this technological shift. Additionally, further research into GenAI's long-term effects on cognitive development, academic assessments, and professional growth will be crucial in shaping its role in geotechnical education. As technological advancements continue to evolve, educational practices must adapt accordingly, ensuring that future engineers are well-prepared for an increasingly automated and data-driven world.

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Survey Form & Data

The survey form is available at: https://forms.office.com/e/08Ci74T8Z1. The data used in this study is available upon request.

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