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Students' and Educators' Awareness and Perceptions of Generative Artificial Intelligence in Architecture, Engineering, and Construction Education

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ABSTRACT: The rapid advancement of artificial intelligence (AI) is reshaping conventional educational paradigms, making it critical to integrate AI effectively and efficiently into Architecture, Engineering, and Construction (AEC) education. Specifically, Generative AI (GenAI) tools enable personalized learning and adaptive instruction within learner-centered learning environments. However, the perceptions of students and educators regarding this radical transition remain underexplored. This study investigated the perceptions of GenAI among AEC undergraduate students and faculty members, focusing on their awareness and attitudes toward integrating GenAI into AEC curricula. Surveys were conducted with 100 AEC undergraduate students and 33 faculty members from Sep to Nov 2024. The results revealed that most students were highly interested in GenAI and have begun utilizing it for both coursework and self-learning, even though they preferred learning the content in traditional methods first before utilizing GenAI. Nonetheless, they are significantly less enthusiastic about job positions that heavily integrate GenAI. AEC educators showed that the majority agreed that GenAI would help student learn better and believe it can be selectively adopted in AEC classes based on the course content. However, they also expressed concerns that the risk of diminishing students' critical thinking and problem-solving skills. The results underscore the need for careful curricula development to bridge this gap between enthusiasm and caution, preparing students for the GenAI-driven future of the AEC industry. This study also highlights current student and faculty perspectives on GenAI in AEC education, thereby emphasizing the importance of fundamental discussions on the effective integration of GenAI into AEC education.

1. INTRODUCTION

The adoption of the fourth industrial revolution technologies is reshaping Architecture, Engineering, and Construction (AEC) education, prompting institutions to integrate digital tools and innovative pedagogies into teaching and learning processes (Zhu et al. 2024). AEC programs increasingly incorporate building information modeling (BIM) (Wang et al. 2020), virtual and augmented reality (VAR) (Tan et al. 2022), and AI-driven tools (Onatayo et al. 2024) into their curricula to prepare students for technology-driven workflows. For example, interactive learning experiences, such as virtual construction site tours (Spišáková et al. 2020), allow students to engage with real-world scenarios in controlled environments. This transformation ensures that AEC graduates are equipped to leverage emerging technologies and contribute effectively to the evolving built environment.

Among these educational changes, the recent introduction of Generative AI (GenAI) tools, such as large language models (LLMs), has created new opportunities for AEC education. GenAI tools offer personalized learning and adaptive instruction, enabling students to clarify complex concepts in learner-centered environments (Baidoo-anu and Owusu Ansah 2023). These tools can also facilitate brainstorming sessions, preparing students for real-world challenges while promoting creativity and critical thinking (Memmert and Tavanapour 2023), and offer novel avenues for activity-based learning (Al Shloul et al. 2024). GenAI tools thus hold the potential to advance education by making rich learning resources accessible to students and fostering a more inclusive and forward-thinking workforce.

AEC education is inherently interdisciplinary, requiring integration of engineering expertise, social science, and design aesthetics (Badawi and Abdullah 2021; Irizarry et al. 2012; Nae 2017). Consequently, AEC students must navigate highly variable project-based scenarios that demand independent critical thinking and adaptability (Iulo et al. 2017; McCord Kieren et al. 2024; TW Chan and Sher 2014). Integrating GenAI into AEC education requires a careful approach to ensure that technology serves as a supportive tool without diminishing students' independent problem-solving skills. However, limited research has specifically explored how aware AEC students and educators are of GenAI and how they perceive its use in learning and teaching. To understanding these perceptions, this study specifically aims to address the following research questions:

1. How do AEC students and faculty currently use and perceive GenAI tools (like ChatGPT) for their learning and teaching?
2. What are the possible benefits and drawbacks of using GenAI tools in AEC education?

In order to answer these questions, we conducted a systematic survey of AEC students and educators regarding GenAI. We gathered responses from 100 AEC undergraduate students and 33 AEC educators and analyzed their awareness, current usage, and attitudes toward integrating GenAI into AEC curricula. This study sheds light on how today's AEC students and faculty view GenAI in education, highlighting areas of alignment and divergence in their perceptions. By examining both groups, the research provides better understand for developing informed strategies to incorporate GenAI into AEC programs. In summary, the contributions of this study include empirical data on potential perception gaps between students and faculty. These findings offer a foundation for fundamental discussions on how GenAI should be integrated into AEC education to prepare students for an AI-driven future.

2. LITERATURE REVIEW

Integrating GenAI in AEC education has been gaining attention as educators explore its potential to enhance student learning experiences. Recent studies have indicated that GenAI tools such as ChatGPT can improve students' comprehension of complex concepts and facilitate personalized learning environments In architecture education, Jin et al. (2024) applied an AI-embedded teaching model, revealing both the benefits of AI-assisted architectural programming and challenges of inconsistent tool usage among students. Similarly, in civil engineering, Uddin et al. (2024) reported that student interactions with ChatGPT enhanced the thoroughness, detail, and informativeness of their written responses. Additionally, studies in construction education have examined AI's impact on safety training. For example, Uddin et al. (2023) found that GenAI-supported hazard recognition significantly improved student learning outcomes. Collectively, these findings highlight GenAI's potential to support AEC students in enhancing students' learning experience.

Despite the positive effects of GenAI on student learning, its application as a learning support tool requires careful consideration and strategic implementation due to its potential negative impacts, Key concerns include the risk of student over-dependence on AI, various ethical considerations, and the possible diminishment of essential competencies such as problem-solving skills. Some fear that the overuse of AI may reduce opportunities for students to engage in traditional learning methods that build foundational knowledge (Talha Junaid et al. 2024). Furthermore, educators emphasize the importance of a selective approach to GenAI integration, considering factors such as course content, student grade level, and learning objectives (Oblitas et al. 2024). Given these diverse perspectives, further research is necessary to

determine how GenAI can be optimally implemented to support AEC education while mitigating potential drawbacks such as diminished critical thinking or self-efficacy. Our literature review revealed limited research on the current awareness, perceptions, and use of GenAI tools among AEC students and educators. Therefore, this study aimed to examine how both AEC students and educators understand and perceive GenAI in their learning, teaching, and future careers, emphasizing the need for fundamental discussions on its effective integration into AEC education.

3. METHODOLOGY

3.1 Survey Development and Distribution

This study employed a cross-sectional survey design to investigate to measure AEC students' and educators' perceptions of using GenAI in learning and teaching practices.. Two anonymous surveys were constructed for students and educators using Qualtrics. The surveys included a mix of closed-ended items—using 5-point Likert scales to assess familiarity with, attitudes toward, and perceived benefits or challenges of AI—and open-ended questions designed to gather detailed, qualitative insights. Participants were recruited through professional networks and academic mailing lists. Data collection was conducted from September 2024 to November 2024. The study proposal was approved by the Institutional Review Board (IRB) at University of Arizona (U of A) (STUDY00005129) and Texas A&M University (TAMU) (IRB 2024-1222). The approved informed consent form was provided to participants prior to their participation, and signed informed consent forms were obtained from all participants. Details of each survey are provided below.

- **Survey for AEC Students:** The survey questionnaire for students consists of a total of 18 questions, including 6 questions related to demographic information and 10 questions assessing students' understanding of GenAI, experiences in GenAI tools, and perceptions toward the use of GenAI in their learning and professions. We invited undergraduate students from the Department of Civil and Architectural Engineering and Mechanics at the University of Arizona (U of A) and the Department of Construction Science at TAMU.

- **Survey for AEC Educators:** We prepared 15 questions about educators' teaching background; experiences in employing GenAI tools and integrating them into their courses; and perceptions of the integration of GenAI in AEC education, especially regarding benefits and caveats. Additionally, we incorporated the expected learning outcomes defined by the Accreditation Board for Engineering and Technology (ABET), presented in Table 1, to assess GenAI's impact on those outcomes.

Table 1. ABET learning outcomes and their keywords

| ABET learning outcomes	Keyword
An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Problem-solving
An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Comprehensive point-of-view
An ability to communicate effectively with a range of audiences	Communication
An ability to recognize ethical and professionally responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and social contexts	Ethical and professional responsibilities
An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Collaboration
An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions	Analytical skills
An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	New knowledge application

3.2 Survey Respondents
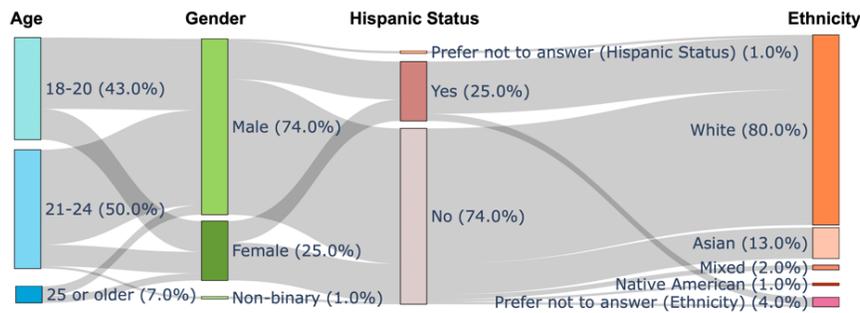
Figure 1. Demographic background of student participants
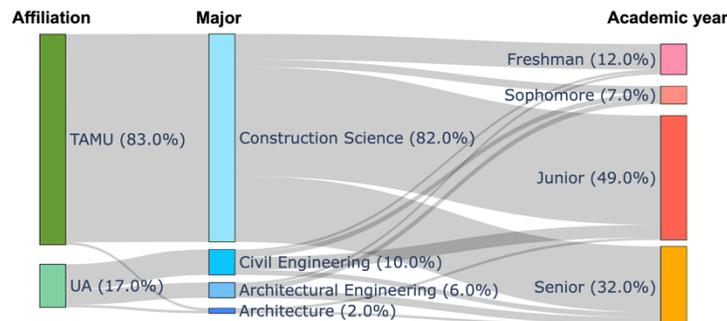

Figure 2. Academic background of student participants

A total of 100 AEC student participants participated in an online survey.

- **Demographic background (Figure 1):** The student participants were categorized into three age groups: 21–24 years (50%, n = 50), 18–20 years (43%, n = 43), and 25 or older (7%, n = 7). In terms of gender distribution, 74% of the participants identified as male (n = 74), 25% as female (n = 25), and 1% as non-binary or third gender (n = 1). This distribution indicates that most respondents were within the typical undergraduate age group and predominantly male and provides insights into how undergraduate AEC students perceive GenAI for their learning. Given this demographic composition, it is also important to consider the participants' academic standing, as their level of study may influence their perspectives on AI integration. Almost half of the participants were juniors (49%, n = 49), followed by seniors (32%, n = 32), freshmen (12%, n = 12), and sophomores (7%, n = 7). We conducted a descriptive statistical analysis on the responses from student participants.

- **Academic background (Figure 2):** The majority of the survey participants were from TAMU (83%), majoring in Construction Science (82%), followed by the ones from U of A majoring in Civil and Architectural Engineering. In each institution, one student majored in Architecture. Regarding academic standing, juniors formed the largest group at 49%, followed by seniors at 32%, freshmen at 12%, and sophomore at 7%.

A total of 42 faculty members in AEC disciplines participated in this survey and we excluded nine responses due to their incomplete responses. The survey responses indicate that most AEC educators have relatively short teaching experience, with a significant portion in the early stages of their careers (20 educators having less than six years of teaching experience). However, a smaller but notable group has substantial experience in the field.

Quantitative responses were analyzed using descriptive statistics, while qualitative data were subjected to thematic analysis to identify key concerns and benefits of integrating AI into AEC education

4. RESULTS AND DISCUSSION

4.1 Responses from AEC Student Participants

The survey results indicate that students' perceptions of GenAI integration into AEC education showed varying degrees of agreement and interest across multiple dimensions. The responses to Figure 3 (a) indicated a range of familiarity levels among students, with the majority falling between neutral and familiar (66%) and small number of students are very familiar with GenAI (34%). The responses to Figure 3 (b) showed which GenAI tools students have used. A total of 84 students reported using ChatGPT, 12 students indicated experience with Copilot, and 4 students stated that they had used MidJourney.

The responses to Figure 3 (c) presented students' use of GenAI for their learning for both coursework and self-learning. Only a small portion of student participants reported never using GenAI tools – 5% for coursework and 13% for self-learning, while 37% and 30%, respectively, indicated that they rarely use them. A notable portion of students (28% for coursework and 23% for self-learning) stated using these tools about once a week, whereas 24% in both categories reported using them a few times a week. Daily use was less common, with 6% of student participants relying on GenAI for coursework and 10% for self-learning. The responses to Figure 3 (d) reflect AEC students' attitudes toward using GenAI in their learning. 74% of students indicated that they prefer acquiring knowledge through traditional learning methods before using GenAI, while only 26% of students stated that they prefer using GenAI as a primary tool for acquiring knowledge. Lastly, the responses to Figure 3 (e) demonstrated that AEC students were more positive on integrating GenAI into AEC curriculums as a total of 55% either chose 'strongly agree' or 'agree'.
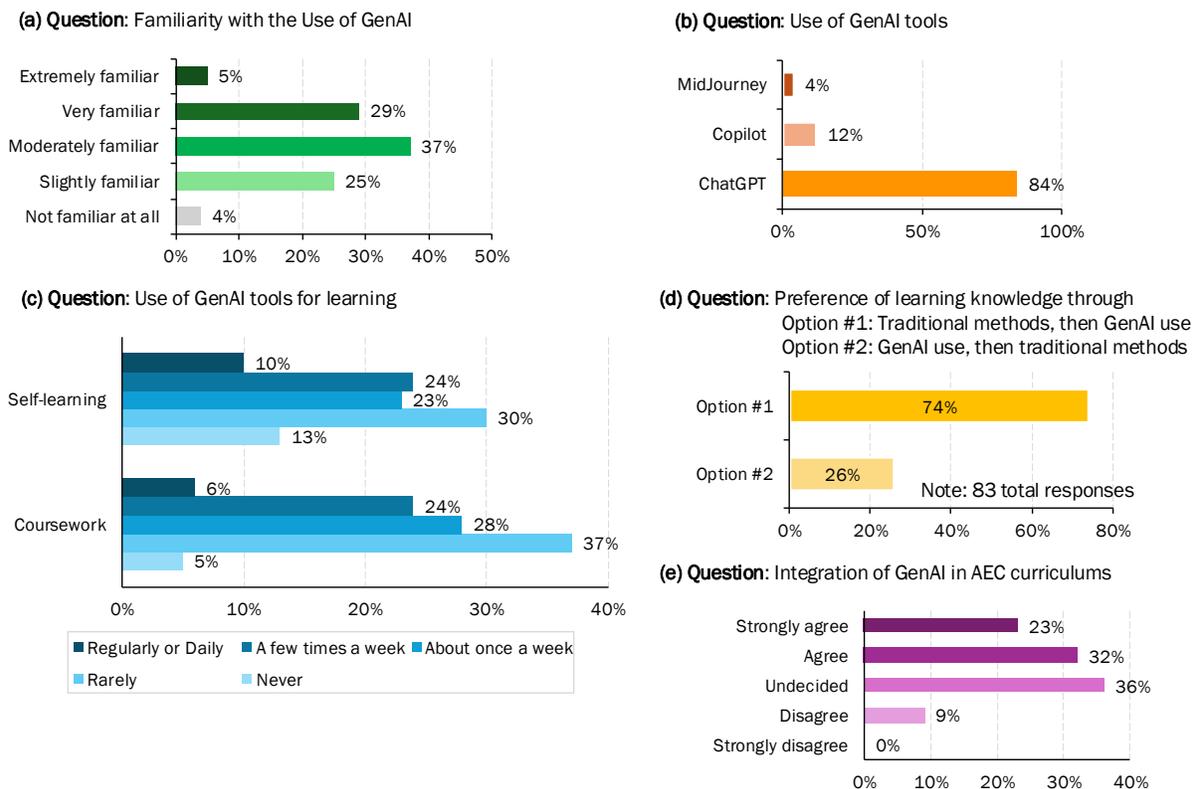

Figure 3. AEC students' understanding of GenAI and experiences of using GenAI. Note that only 83 responses were gathered for the Question (d) in the figure.

In the student survey, we included additional questions to examine not only students' perceptions of using GenAI for learning but also their awareness of and interest in AI-related job positions in their future career paths in AEC industry (Figure 4). Interestingly, students reported that they tended to be interested in

exploring GenAI in AEC fields (62% said either 'definitely yes' or 'probably yes'). Also, 68% of students also said that GenAI would play a significantly role in AEC fields (Figure 4 (b)). However, they were not interested in job positions integrating GenAI in AEC fields – the majority (89%) said either 'probably not' or 'definitely not'. These results might imply that students see the potential of GenAI in AEC fields; however, they are less confident in this new technology and unsure about considering it as a job. In other words, AEC education is responsible for properly preparing professionals who are adaptive to emerging technologies, especially GenAI.
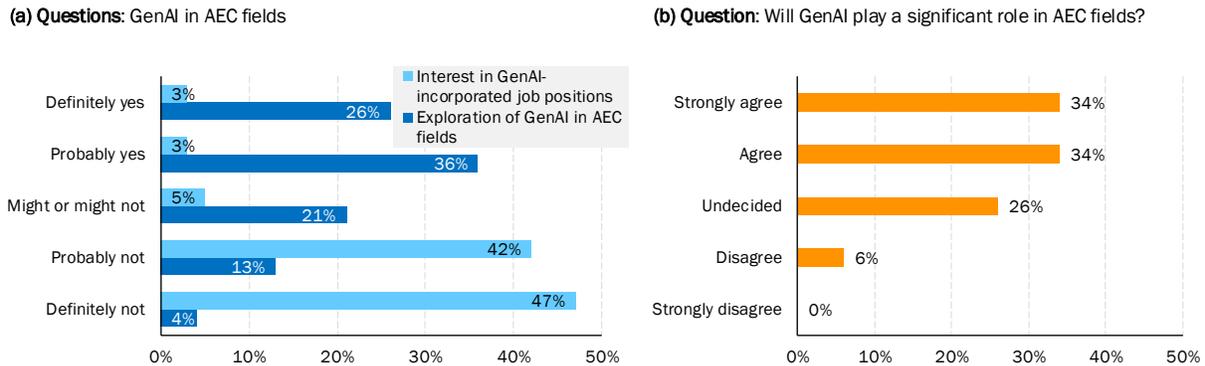
(a) **Questions**: GenAI in AEC fields

(b) **Question**: Will GenAI play a significant role in AEC fields?

Figure 4. AEC students' perspectives on GenAI's role in AEC fields and interests in job positions that incorporate GenAI

4.2   Responses from AEC Educator Participants

As in Figure 5 (a), familiarity with GenAI technologies varies among AEC educators, with most possessing at least some level of awareness or experience, while only a few have advanced knowledge or no exposure at all. In terms of GenAI tool usage (Figure 5 (b)), the overall trend showed that most AEC educators tend to use a limited number of GenAI tools, with the majority relying on one or two tools, while fewer educators explored more extensive use of multiple tools (37% used more than three tools).

(a) **Question**: Familiarity with GenAI technologies

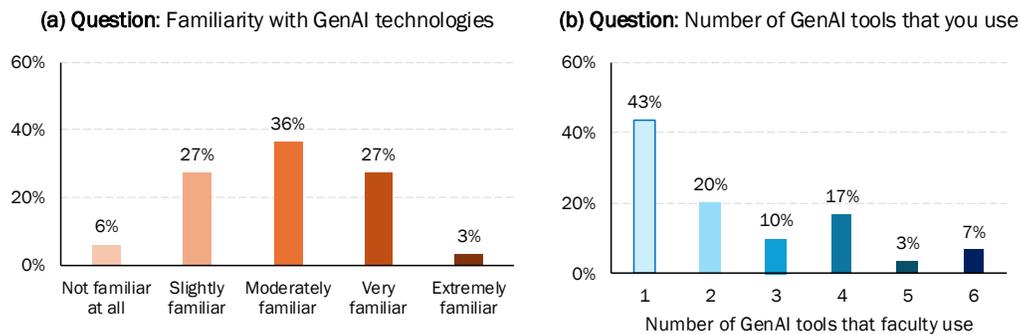(b) **Question**: Number of GenAI tools that you use

Figure 5. AEC educators' teaching background and familiarity and experience with GenAI.

When asked about AEC educators' use of GenAI tools in teaching, fewer than half of the educators (36%) reported having integrated these tools into their courses (Figure 6). However, a larger number (63%) expressed interest in incorporating them in the future. Most educators believe that the inclusion of GenAI tools in AEC courses should be dependent on course content rather than being universally applied, while only a small number support full integration across all courses or limiting it to graduate-level education. Regarding the most effective level to introduce GenAI, responses suggest that its application would be most beneficial in later undergraduate years or at the graduate level, with fewer educators advocating for its introduction at earlier academic stages.

(a) Question: Use of GenAI tools for your courses
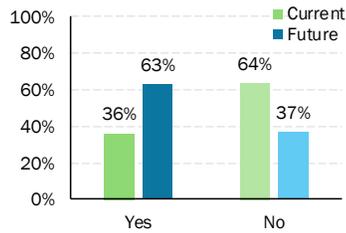
Note: Future: 27 total responses

(b) Question: Should AEC courses consider incorporating GenAI tools?
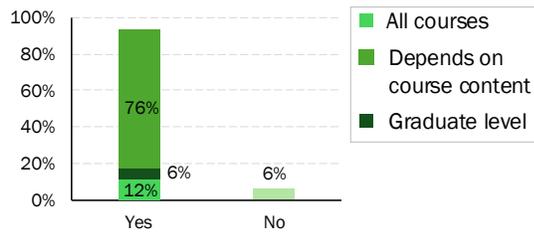
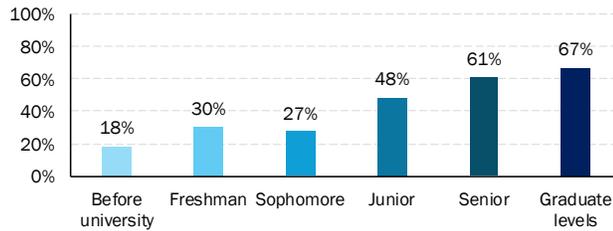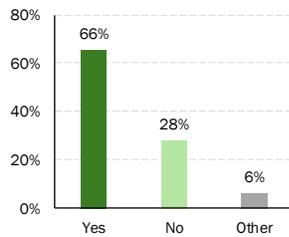(c) Question: At which level would it be more effective to apply GenAI (multiple choices allowed)

Figure 6. AEC educators' perspectives and experiences in adopting GenAI tools in AEC education.

(a) Question: Does the use of a GenAI tool help students learn better compared to traditional methods?

(b) Question: ABET learning outcomes positive impacted by GenAI in AEC education.
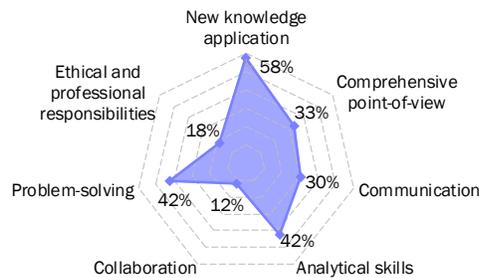
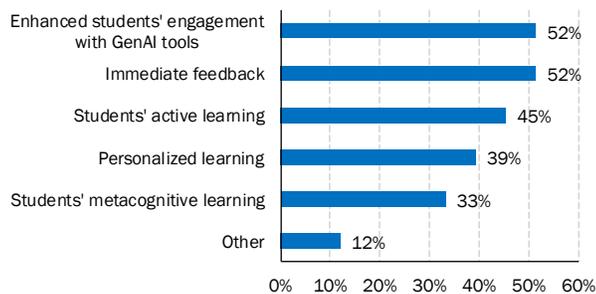(c) Question: Potential benefits of integrating GenAI into AEC courses

Figure 7. AEC educators' perspectives on GenAI's positive impacts on student learning

Most educators (66%) believed that GenAI tools like ChatGPT can improve student learning compared to traditional teaching methods, though some remained skeptical (Figure 7 (a)). Regarding ABET-defined learning outcomes (Figure 7 (b)), educators identified GenAI tools as particularly beneficial for acquiring and applying new knowledge, solving complex engineering problems, and conducting experimentation and data analysis. While GenAI tools were also seen as helpful for enhancing communication and engineering design skills, fewer educators perceived benefits in areas like teamwork and ethical decision-making,

suggesting that these aspects may require additional instructional considerations. Also, educators identified several potential benefits of integrating GenAI into AEC courses (Figure 7 (c)), particularly in enhancing student engagement and providing immediate feedback. They also recognized its potential to support personalized and active learning while fostering a more dynamic educational environment.

Despite the perceived benefits, educators expressed several concerns about integrating GenAI into AEC courses (Figure 8 (a)). The most common concern was that students may become overly reliant on AI, potentially diminishing their critical thinking and problem-solving abilities (91%). Other concerns include doubts about AI's accuracy (73%), the risk of student cheating (61%), and the potential reduction of human interaction in the learning process (33%). Some AEC educators also worry that AI could hinder collaborative learning and create a dependency that negatively impacts student growth.

Additionally, educators identified ABET learning outcomes that could be negatively impacted by GenAI integration (Figure 8 (b)). Problem-solving skills, ethical decision-making, and teamwork were among the most commonly cited areas of concern. Educators expressed concern that AI could undermine students' ability to independently tackle complex engineering problems (58%, 19 out of 33) and their capacity to make informed ethical decisions (48%, 15 out of 33). Communication and experimentation skills were also mentioned as potentially vulnerable to AI overuse, reinforcing concerns about AI diminishing human-centered learning experiences.

(a) **Question**: Concerns about integrating GenAI into AEC courses.

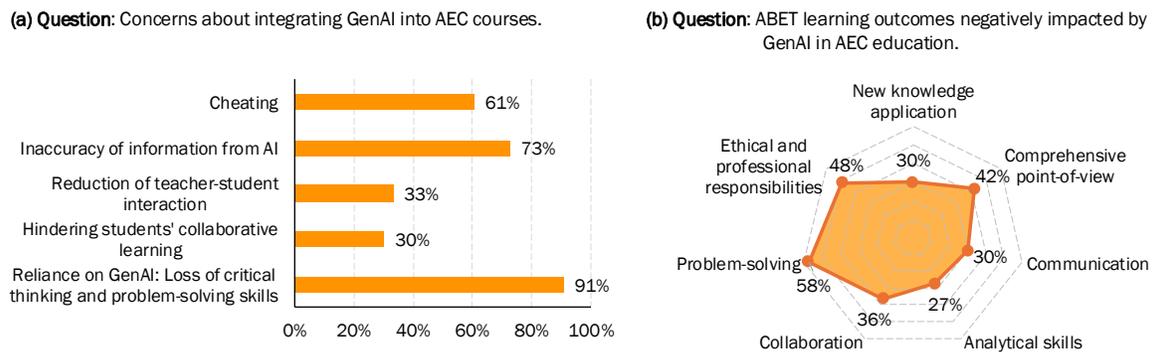(b) **Question**: ABET learning outcomes negatively impacted by GenAI in AEC education.

Figure 8. AEC educators' perspectives on GenAI's negative impacts on student learning

These concerns align with some of the perceived benefits of AI integration, presented in Figure 7. While many educators believe AI can enhance problem-solving abilities, others worry about the loss of independent reasoning. Ethical and communication skills were also viewed as both positively and negatively impacted, suggesting differing perspectives on AI's role in professional and interpersonal development. This contrast highlights the complexity of GenAI adoption in AEC education, emphasizing the need for a balanced approach that maximizes benefits while mitigating potential drawbacks. The key finding was that the faculty indicated that AI should be selectively integrated into AEC education based on the grade level, course, and learning content. These results highlight significance of the formal inclusion of GenAI in AEC education.

4.3   Discussion, Implications, and Limitations

The survey results provide AEC students' and educators' perspectives on GenAI, revealing both enthusiasm and caution. In general, we found that students are eager to leverage GenAI in their learning, while educators see promise in GenAI but are concerned about its negative effects. These findings align with emerging research on GenAI in education (Baidoo-anu and Owusu Ansah 2023), while also offering unique insights specific to the AEC context. The results also highlight discrepancies between students' acknowledgment of GenAI's importance in AEC and their reluctance to pursue "GenAI-centric" careers (68% expect GenAI to be significant in the field, yet 89% are not interested in GenAI related jobs in the AEC industry). This specific gap has not been reported in prior literature and may be unique to the current transitional period. It suggests that while students see GenAI as inevitable in the industry, they may have limited knowledge about GenAI's role in future job markets. Another interesting finding is that both students

and educators expressed that GenAI integration should be selective and context-dependent. Educators tend to believe GenAI's educational use should be determined by course content.

While this study provides valuable insights, it has several limitations that must be acknowledged. First, the sample size is relatively modest, and the student respondents were drawn from only two universities. Thus, the findings may not generalize to all AEC programs. Second, the study is based on self-reported perceptions at a single point in time. Given how fast GenAI technology and its adoption are evolving, perceptions could shift even within a short time period. Third, we focused on descriptive analysis of survey results and did not perform detailed statistical tests. Detailed statistical analyses could yield deeper. Lastly, this study focuses on students' and educators' perceptions regarding the use of GenAI in AEC education. Solutions to mitigate ethical challenges associated with the adoption of GenAI will be explored in future research.

5. CONCLUSION

This study addressed the critical research question of how AEC students and educators perceive the use of Generative AI tools in their learning and teaching. Through surveys of 100 undergraduate students and 33 faculty members in AEC fields, we have uncovered current levels of GenAI awareness, usage, and attitudes among these groups. The main contribution of this study lies in identifying the gap between students' and educators' perceptions: AEC students are open to the use of GenAI for educational purposes, while AEC educators are cautiously supportive, endorsing the benefits but mindful of the risks. These findings establish a baseline understanding that can inform educators, curriculum developers, and administrators as they navigate the integration of AI technologies into AEC education. Furthermore, while this study particularly focused on AEC students and educators, its findings also offer valuable insights into how GenAI can be more effectively implemented across broader educational contexts.

Key findings include the observation that AEC students are highly interested in GenAI, and many of them are already using AI tools like ChatGPT for coursework and self-learning activities. However, most students prefer to learn foundational content through traditional methods first before turning to GenAI, indicating a desire to use AI as a supplementary aid rather than a primary teacher. While they recognized its growing significant in the AEC industry, they expressed significantly less enthusiasm for job positions that incorporate GenAI. This indicates that students see the technology's importance but are hesitant to embrace it in their own career plans. This suggests that careful consideration is needed regarding how AEC education can enable students to gain positive hands-on experience with GenAI during their studies.

Similarly, AEC educators has begun incorporating GenAI tools in their courses and generally view these tools as valuable for student learning. However, they also expressed concerns about potential drawbacks. Notably, educators indicated that unregulated GenAI use could negatively affect several ABET-defined student outcomes (e.g., problem-solving skills, ethical and professional responsibility, and teamwork). This reveals that the integration of GenAI in coursework must be done in a way that still allows students to achieve key learning outcomes.

In conclusion, this study provides a foundational understanding of AEC students' and educators' perceptions of GenAI at this early stage of its educational adoption. This study contributes to the literature by documenting the ambivalent perceptions within the AEC academic community regarding 'problem-solving,' which was perceived as being both positively and negatively influenced by GenAI. The findings highlight the importance of a balanced approach to GenAI integration. For example, maximizing the benefits of personalized learning and efficiency offered by GenAI tools while mitigating the risks of dependency and ethical concerns. One possible guideline for adopting GenAI in AEC education is to tailor its application according to specific course levels and content areas. This work lays the groundwork for further discussion and research aimed at developing curricula that keep pace with technological advancements while preserving the core values of education.

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