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Enhancing the use of artificial intelligence in architectural education – case study Saudi Arabia

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In the present study, we explored the ways in which Artificial Intelligence (AI) is currently integrated into architectural education in Saudi Arabia, a country undergoing rapid digital and educational transformation. Our main goal was to identify major factors that drive the adoption of AI in the Saudi architectural education. To this end, we analyzed both architecture students' and faculty members' awareness, usage, and perceptions of AI. Our particular focus was on divergencies in the perspectives of these two groups. To this end, a survey was conducted among a total of 160 architecture students and 32 faculty members of the Department of Islamic Architecture at Umm Al-Qura University. The collected data were analyzed using both descriptive and inferential statistics, including regression analysis. The results revealed significant differences between students and faculty in terms of their AI awareness and usage. Specifically, while the surveyed students reported experiencing strong enthusiasm and demonstrated familiarity with AI tools, the participant faculty members were hesitant about using AI in architecture learning contexts, voicing particular concerns about an over-reliance on AI that can, from their perspective, compromise students' creativity. However, despite the aforementioned differences, and acknowledging the urgent need for training programs and workshops aimed at enhancing students' AI-related skills, both groups agreed on the importance of integrating AI in architectural education in the future. Based on these findings, we conclude with a set of recommendations aimed at increasing AI engagement in architectural curricula, with a particular emphasis on various skill development initiatives that could provide both architecture students and faculty with a better understanding of how AI can support and promote creativity in learning and teaching architectural design.

KEYWORDS

architecture, artificial intelligence, education, architectural education, sustainable design

1 Introduction

The recent emergence of digital tools, including Artificial Intelligence (AI), has dramatically reshaped the domain of architectural education, particularly with regard to how design is taught and practiced. Widely used in different domains of teaching architecture and in architectural practice, including but not limited to construction automation and generative design (Alcaraz et al., 2024; Imoh, 2023), AI is now widely used to support various architectural tasks such as design iteration, performance analysis, and visualization. However, as argued by Copeland (2024), AI should primarily be used to support, rather than completely replace, architecture educators. Architects are moving from traditional drafting to digital workflows (Hesham et al., 2023). Ceylan (2021) emphasises that architecture, due to its complexity, is well-suited for AI integration. AI enhances advanced design generation (Bhatt et al., 2016), and its tools now range from rule-based systems to machine learning. Jan and Kacper (2018) note the shift to sophisticated computational tools in design, but many schools struggle to integrate them (Delello et al., 2024). This shift challenges existing pedagogical frameworks.

As AI spreads, once-specialised design skills like parametric and digital design have become basic requirements (Martínez-Ventura et al., 2021; Qian et al., 2023). This necessitates new curricula aligned with emerging tools. Despite AI's promise, many architecture programs lack it in their syllabi. Its future role demands a critical understanding of its potential and the actors driving its development. Ekene et al. (2023) argue that AI digitises conventional teaching, making learning more efficient. Architectural education must include AI to equip students for complex future challenges (Pelletier et al., 2023). Yet, few studies address AI in architectural education in the Middle East. While global reform is accelerating, the gap in regional research leaves questions about cultural and institutional readiness unanswered.

This scarcity of research on AI in architectural education is of a particular concern in Saudi Arabia where, despite the adoption of Vision 2030—a governmental program that mandates rapid digital transformation in higher education—little is known about how AI is actually being adopted in Saudi architecture schools. Seeking to fill this gap in the literature, as well as to explore how Saudi educational institutions can better prepare their graduates for an evolving professional landscape, in the present study, we investigate the integration of AI into architectural curricula in the Department of Islamic Architecture at Umm Al-Qura University, with a particular focus on both students' and faculty staff's awareness, usage, and perceptions of AI tools.

2 Literature review

2.1 Concept of artificial intelligence (AI)

Artificial Intelligence (AI), a term first coined by John McCarthy, can be broadly defined as the engineering and scientific pursuit of developing machines capable of replicating intelligent human behavior in learning, reasoning, and decision making. To date, several explanations of AI have been proposed. For instance, as argued by Jamal and Wejung (2019), AI allows machines—be them computers, robots, or software—to intelligently operate by adapting to situational inputs. Likewise, Shabbir and Anwer (2018) described AI systems as intelligent agents capable of interacting with their environments and optimizing outcomes. From a broader perspective, Mitchell (2019) defined AI as any computational system capable of performing functions that are typically associated with human intelligence. Along similar lines, Hesham et al. (2023) highlighted AI's growing ability to perform complex tasks exclusive to humans, such as language translation, image processing, and decision making. Furthermore, highlighting AI's adaptive nature, Kaplan and Haenlein (2019) emphasized AI's ability to learn from external data, adjust accordingly, and perform tasks through continuous improvement. Previous studies also highlighted how supercomputers equipped with sensors and adaptive behaviors can reshape human engagement with machines (Chen et al., 2020), as well demonstrate intelligence through pattern-recognition algorithms (Sadiku et al., 2021). In the domain of education, AI was argued to be a subfield of computational intelligence capable of creating dynamic, individualized learning experiences (e.g., Imoh, 2023). Overall, the perspective on AI briefly reviewed above suggest that, as a rapidly evolving field, AI can exert a strong impact on educational practices, including those in architectural education.

2.2 AI in architectural education

Several previous studies explored the potential of AI in the context of (architectural) education. For instance, introducing the notion of Artificial Intelligence in Education (AIE), Kengam (2020) and Lee (2020) argued that AIE is essential in present-day educational contexts. While Chen et al. (2020) traced the evolution of AI tools in education—from simple administrative platforms to humanoid robots and intelligent systems—Panigrahi (2020) demonstrated how AI can effectively support flexible and personalized learning environments, especially in developing countries. Several other studies demonstrated how, through enabling virtual classrooms, adaptive learning, and intelligent evaluation, AI can considerably improve the quality of instruction and student outcomes (e.g., Huang et al., 2021; Lazar et al., 2022), as well as deliver dynamic, student-centered educational experiences (Imoh, 2023). In the domain of architectural design education, several authors highlighted the need to integrate digital and computational tools (e.g., Oxman (2008); Ceylan (2020)), while Chassignol et al. (2018) noted that AI tools are already influencing curriculum creation, teaching methods, and student evaluation in architectural education. Collectively, the studies briefly reviewed above highlight how recent advances in AI tools can reshape both general education and architectural education, in particular.

Recent studies support the usage of AI in transforming architectural education by improving creativity and design productivity. Using AI in teaching models improved student outcomes, mainly in work productivity and innovative thinking (Jin et al., 2024). In conceptual design stages, AI tools like Midjourney have assisted students translate written text into visual ideas, enriching form-finding capabilities (Ahmed and Elhakeem, 2024). Similarly, research at Gdańsk University identified three approaches of AI incorporation—semi-traditional, hybrid, and hybrid-interactive—that assist more contextual and creative outputs (Jan et al., 2024). Studies in the use of AI in sustainability studios show increases student engagement with environmental indicators, particularly when paired with organized curriculum support (Petrović and Stanković, 2024). Overall, successful implementation depends on aligning training with architecture education, addressing faculty indecision, and embedding AI within hands-on learning environments. More targeted strategies are needed to ensure architecture schools are not left behind in this educational transformation. However, there remains limited clarity on how to adapt pedagogical models to balance technical innovation with design creativity, especially in underrepresented contexts such as the Middle East.

2.3 Level of awareness and usage of AI tools in architecture

Research on AI-aided architectural design was conducted by Jan and Kacper (2018). The study presented how the authors applied AI algorithms such as swarm intelligence, neural networks, and evolutionary algorithms in architectural practice. Analog input/output methods rooted in automation and vision were also discussed. The study noted that these strategies enable the emergence of new spatial solutions using relatively simple AI-based algorithms, many of which could only be achieved with specialised programs.

Jan et al. (2024) studied the application of AI in architectural education through a green campus development project. The paper examined the need for modifying the design instruction process in response to AI-driven innovations, particularly those related to image generation. In a research-by-design studio in Poland, students who used AI tools achieved more creative and innovative results than those who used conventional methods. Based on the findings, three collaboration approaches were identified: in the semi-traditional method, AI-generated images served as motivation; in the hybrid method, students integrated these images into their design choices; and in the hybrid-interactive method, students used AI in real-time to generate more site-specific outcomes. The study concluded that redefining design instruction to include these methods is essential and demonstrated the strong potential of AI tools—especially image-generation models—in enhancing architectural education.

Jin et al. (2024) also studied the impact of AI-assisted design in a 9-week architectural design and programming course involving 24 international students. The findings showed that the AI-integrated teaching approach positively affected students' learning, efficiency, and creativity. However, the study also revealed inconsistencies in how students used AI tools and issues with the unpredictable nature of AI-generated outputs. The use of AI by students was often disorganised, despite the strong link between AI and architectural programming.

AI in architectural education has been addressed in several studies (Basarir, 2022; As et al., 2018; Qian et al., 2023). This research builds on that foundation by examining students' awareness of AI tools and the extent to which these tools are applied in their design work. The aim is to assess both theoretical familiarity and actual usage in architectural education settings.

2.4 Benefits of the application AI to architecture education

The benefits of using AI in teaching architecture have been consistently highlighted in the literature. For instance, as argued by Ma and Jiang (2023). AI in education indicates to the use of AI technologies in many aspects of the educational practice in both virtual and real-world environments, through smart educational tools and diverse learning scenarios. AI is currently used in education in a variety of ways, including the creation of intelligent teaching structures, chatbots to assist students, machine learning, and natural language processing (NLP) integrated into educational materials. Additional applications include administrative support, student evaluation tools, and teacher training systems.

Furthermore, Ceylan (2021) detailed how AI is transforming architecture through its impact on theory, practice, regulation, and society. The authors demonstrated that AI enables innovative design, improves building efficiency, and streamlines construction using advanced algorithms. Since architectural work frequently involves long-term, interdisciplinary collaboration, numerous concerns have been voiced about AI's potentially adverse impact on professional roles and creative processes. Accordingly, Ceylan (2021) explored how students majoring in architecture perceive the shift towards AI-driven creativity and how they think of AI with regard to their future employment and design identity.

In another relevant study focused on the role of AI in enhancing architecture students' understanding of design inputs, processes, and outcomes, Basarir (2022) proposed a continuum-based learning approach and discussed several potential future directions for AI-based architecture education in the AEC sector. Similarly, in a recent investigation of the advantages of AI in education, Imoh (2023) highlighted AI's ability to solve key challenges, transform teaching methods, and support the achievement of SDG 4.

Finally, in a recent investigation that compared parametric design with machine-generated outputs, Muhammad and Ahmed (2023) identified important inspirational and practical functions of using AI tools in architecture. Based on this evidence, the authors underscored the need to integrate human-centered, culturally sensitive, and environmentally responsible AI into architectural work. A similar point was made by Nermen and Nevine (2024) who, in their framework for AI integration into various design stages, highlighted time-saving benefits of applying AI tools in architectural work.

2.5 Challenges of the application of AI in architectural education

Along with the benefits of using AI in teaching architecture discussed, several previous studies outlined important challenges associated with such use. Overall, compared to other sectors, the use of AI in architecture is still in its infancy, and many tools are yet to be adopted and thorough explored. In addition, as argued by Jamal and Wejung (2019), despite the growing use of AI in the field of architecture, many of AI-based technologies still require considerable human oversight, so most of these technologies remain only partially intelligent.

Another challenge associated with using AI in architectural education, highlighted by Tambuskar (2022) review of both drawbacks and advantages of AI in education using a narrative synthesis method, concerns AI's thoughtful implementation. Without a careful consideration of this potential limitation of AI, its use in education can bring about important privacy, security, and safety concerns. A similar argument was made by Hesham et al. (2023) who conducted a comprehensive review of AIEd (Artificial

Intelligence in Education) resources published between 2018 and 2022. The authors' results of a systematic revive of 60 recent studies selected papers and expert opinions revealed that, while AI has both documented and expected educational benefits, its implementation should take into consideration potential ethical and privacy issues. Likewise, in their study on various studies on the advantages and limitations of AI in education, Apolzan and Cimpineanu (2024) flagged important concerns about bias, trust, cost, and data security, arguing for the need to elaborate appropriate legal and financial frameworks to address these issues.

Furthermore, one more potential limitation of using AI in the field of architecture was highlighted by Softaoglu (2024) who examined how AI could revitalize architectural design through human–robot collaboration. Focusing on the Midjourney robot, the author argued that, although architectural history, language, and semiotics could guide AI toward generating meaningful spatial outcomes, because of the limitations of the library source and language used, AI still faces various ethical and cultural challenges. To understand how artificial intelligence is represented in architectural education, it is helpful to map its intersection with the various phases of the architecureal education process. While some stages—such as planning, progress tracking, social aspects, ideation, creativity, and rendering—are frequently highlighted, others like, efficiency, creativity, ideation, rendering and construction receive less direct attention. The following figure synthesises key findings from the literature and illustrates the scope and depth of AI's educational integration.

Despite such global insights, research on AI in architectural education remains limited within the Middle East and North Africa (MENA) region. Cultural perceptions of automation, institutional frameworks, and policy environments are often overlooked. Figure 1 illustrates how unevenly AI is applied across architectural tasks in international literature—further reinforcing the need for context-specific exploration. In response, this study investigates how Saudi students and faculty engage with AI in their academic and design activities, contributing a culturally grounded perspective to the broader discourse.

3 Methodology

This study was carried out at the Department of Architecture, Umm Al-Qura University, to measure the level of awareness and actual use of AI in improving the skills of students and faculty members. Ethical approval was obtained from the Department of Architecture, Umm Al-Qura University, and the questionnaire was reviewed with a group of faculty members in the department; necessary amend-ments were made based on the reviews. The questionnaire had been further piloted on a small number of respondents in an effort to ensure clarity in the questions and their appropriateness toward realizing the objectives of the study. The survey instrument was structured into four main sections: demographic details, awareness of AI, frequency and types of AI tool usage, and perceptions of AI in architectural education. It included both closed-ended (e.g., multiple choice and Likert scale) and open-ended questions to allow for nuanced responses. The initial draft was reviewed by three faculty members specialising in educational technology and architecture, ensuring content validity. A pilot study was conducted with a small group of 10 students and four faculty members to assess clarity, relevance, and flow of questions. Feedback from this process led to refinements in language, structure, and scaling.

3.1 Data collection

It involved 160 students and 32 faculty members who were interviewed using structured questionnaires. The questionnaires were developed in light of the literature on artificial intelligence in education and included key questions related to the awareness

Architectural Process	Coverage Type	AI's Role Implied/Mentioned
Planning & Curriculum Structure	Implied	Influences curriculum planning, assists in design courses/programming.
Efficiency	Explicitly Mentioned	Enhances learning, improves productivity, reduces time and complex tasks.
Progress Tracking	Implied	tracking learning progress and outcomes in an educational context.
Creativity	Explicitly Mentioned	Enhances creativity, fosters innovative thinking
Ideation / Idea Development	Explicitly Mentioned	Generative design, form-finding, contextual output, new spatial solutions
Rendering / Visualization	Explicitly Mentioned	Generating visual ideas, image creation, enhancing visual outputs.
Sustainability	Explicitly Mentioned	engagement with environmental indicators and green project development.
Contextual & Societal Consideration	Implied	role in conducting or informing "social studies"
Construction	Explicitly Mentioned	Automation, streamlining of processes, broader influence in the AEC sector.
Performance Analysis	Explicitly Mentioned	Analyzing and improving building performance.

FIGURE 1
Architectural education processes covered in the AI's role.

level, usage patterns, and perceptions about the usage of artificial intelligence in the architectural field. Data collection lasted for a period of 3 weeks and maintained anonymity for participants to adhere to ethical guidelines. Figure 2 illustrates this comparison between students and faculty in terms of AI awareness, usage frequency, and interest in learning.

3.2 Data analysis

Data are summarized using frequency and descriptive statistics, while similarities and differences between groups are assessed using descriptive and inferential statistical methods. For descriptive statistics, the means and standard deviations, among others, were considered; for the inferential techniques, however, linear regression, Pearson correlation, and Chi-Square tests on the relationships of variables were performed, showing, for example, how demographic factors such as age impact awareness and the use of AI. Analysis was done using [Statistical Software] and all tests of significance at $p < 0.05$ level.

3.3 Data availability

Data collected and analyzed during this study are not publicly available at this time. In the meantime, the data will be made available to any researcher or reviewer upon request through the journal for transparency and verification of the study's result. While the student sample (n = 160) was robust and representative of the department's enrolment, the faculty sample size (n = 32) is relatively small. This reflects the limited pool of faculty available within the department and may constrain the generalizability of findings related to faculty perceptions. This limitation is taken into account during result interpretation.

4 Results

4.1 Descriptive analysis

The descriptive analysis, based on responses from 160 students and 32 faculty members, indicates a significant difference in awareness about AI and the usage of AI between the two groups. Students were found to be more aware and frequent users of AI compared to the faculty.

A regression analysis of students and faculty was performed to depict how the characteristics influence the overall AI experience in education for students and faculty. The independent variables included AI awareness, sources of AI knowledge, frequency of AI usage, skills developed through AI, and impact of AI on practical skills development. The dependent variable was the overall experience with AI in education.

4.1.1 Key findings

4.1.1.1 Model significance

The regression model was statistically significant, $F(5, 191) = 22.394$, $p < 0.001$, and explained 46% of the variance in AI experience ($R^2 = 0.46$). Indeed, all these factors of AI usage, awareness, and skill development combine to create a significant influence on the AI experience for both students and faculty.

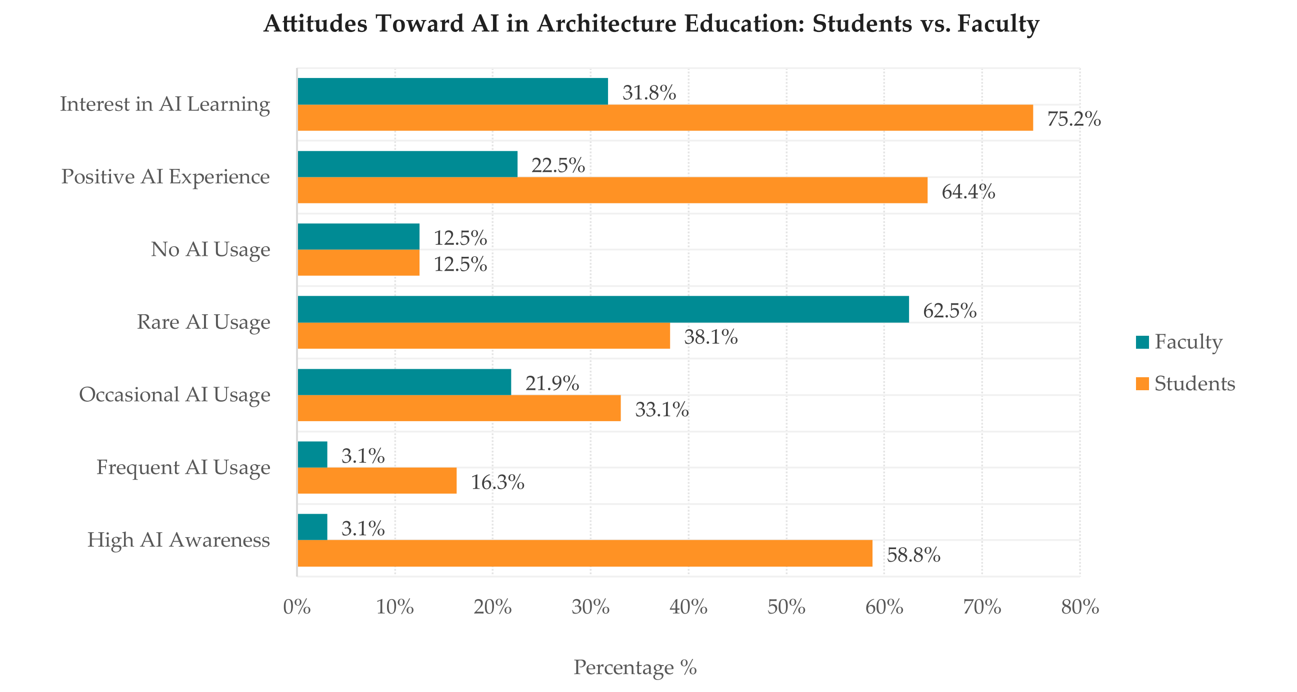

FIGURE 2
Comparison of AI awareness, usage, experiences, and learning interest between students and faculty.

4.1.1.2 AI awareness

AI awareness did not significantly predict overall AI experience, β = 0.157, p = 0.341. This suggests that simply being aware of AI capabilities does not have a significant bearing on how students or faculty perceives their experience with AI in education.

4.1.1.3 Sources of AI knowledge

The sources from which people acquire knowledge about AI, such as the internet, training courses, or peer discussions, did not significantly predict AI experience, β = −0.002, p = 0.99. The type of source to learn about AI therefore has an insignificant positive impact on the total AI experience of students and faculty alike.

4.1.1.4 Frequency of AI use

Frequency of AI use proved to be a strong predictor of a positive AI experience, β = 0.464, p = 0.007. This suggests that the greater the frequency of AI use in educational activities, the more likely students and faculty are to report having a positive experience.

4.1.1.5 Skills developed through AI usage

The development of skills through AI usage was significantly related to the overall AI experience, β = 0.389, p = 0.023. This shows that as students and faculty gain more AI-related skills, satisfaction and confidence in using AI increases.

4.1.1.6 Impact of AI on practical skills development

The influence of AI on developing practical skills (e.g., in architecture) did not show a significant result on the overall AI experience, β = 0.060, p = 0.701. While AI may improve practical skills, this improvement is not related to a more positive AI experience for either group. Table 1 presents the regression results highlighting the relationship between AI-related variables and practical skills development.

4.1.2 Interpretation of results

4.1.2.1 AI awareness

The results show that AI awareness does not influence the overall experience of students or faculty. Improved satisfaction appears to require more practical engagement with AI.

4.1.2.1.1 Sources of AI knowledge. The medium through which students and faculty acquire AI knowledge (e.g., training programs, internet, and peer discussions) was not a major determinant of their AI experience quality.

4.1.2.1.2 Frequency of AI use. Both students and faculty who used AI more frequently reported significantly better experiences. This reinforces that regular use of AI tools is crucial for user satisfaction.

4.1.2.1.3 Skill development through AI. Acquiring AI-related skills positively influenced the overall experience, especially for faculty. The more skills developed through AI, the better the user experience.

4.1.2.1.4 Impact on practical skills development. The improvement of practical skills, such as in architecture, did not significantly affect the overall AI experience, suggesting that practical skills alone do not improve the AI user experience.

4.2 Development proposals analysis

4.2.1 Points of agreement and divergence between faculty and students on the use of AI in architecture education synergy between points

1. AI as a Vital Component in Learning: Both students and personnel are fully convinced of the necessity of AI in the architectural sector. A common assumption is that AI plays a key role in the learning process and is by no means a technology option for the future, but it is rather a necessary element of the learning process to keep up with the pace of modern technology.
2. The Lack of Educational Opportunities: They all agree that workshops, courses, and resources must be provided to raise awareness about AI applications in architecture. Thus, a mutual understanding of the relevant issue, which is the capability of universities and other institutions to nurture their students' skills in this area, is evident.
3. The Use of AI as a Supporting Tool and not as a Replacement: Both teachers and students argue that AI action should constitute a support and not a replacement for human

TABLE 1 Regression results for students and faculty.

Predictor variable	Students (β, Sig.)	Faculty (β, Sig.)	Combined result (β, Sig.)
AI awareness	−0.123, p = 0.091	0.157, p = 0.341	0.157, p = 0.341
Sources of AI knowledge	0.218, p = 0.001	−0.002, p = 0.99	−0.002, p = 0.99
Frequency of AI usage	0.416, p < 0.001	0.464, p = 0.007	0.464, p = 0.007
Skills developed through AI	0.023, p = 0.761	0.389, p = 0.023	0.389, p = 0.023
Impact of AI on practical skills development	0.248, p = 0.001	0.060, p = 0.701	0.060, p = 0.701

architects by consolidating their capacity for innovation and problem solving. It should be used as a limited time-saver for tasks that do not require much of a guidance and the life skill of thinking critically is practiced by architectural schools.

4.2.2 Points of disagreement

1. The Level of Knowledge and Understanding: The faculty members are the ones who seem to have the biggest knowledge about the concepts of AI as compared to the students. Nonetheless, scholars show more enthusiasm for AI equipment with many of them driven by their inquisitive nature and their desire to pursue new technologies.
2. Innovation Versus Static Utilization: Even though the students are powered up by the ideas of what the technique that AI has, the faculties on the other hand are weary with the truth that learners might over-rely on AI thus diminishing the role of AI in the creative idea and the innovation of the design field. This view comes from the fear that the students will simply follow automated tasks and not be given the chance to show how innovative they become.
3. Importance of Technical vs. Pedagogical Aspects: AI application in designing, modeling, and automation are more often the areas of emphasis for students, with the associated technical increase in contrast with the one discussed by teachers whose main concern remains with the risk of the development of the educational system and the learning achievements due to the use of AI.

5 Discussion

The findings from this study offer critical insights into how Artificial Intelligence (AI) is being integrated into architectural education, revealing substantial differences in how students and faculty engage with this technology. While students tend to be early adopters, faculty show much more hesitation. This contrast between groups provides a compelling case for rethinking how AI is introduced, taught, and integrated within architectural programs, with significant implications for both curriculum design and future research directions. It is also important to interpret the faculty-related findings cautiously due to the limited sample size (n = 32), which, while reflective of the department's actual size, may restrict broader generalization across institutions or academic ranks—especially given the observed divergence between student and faculty perspectives on AI.

5.1 AI awareness and usage: theoretical and practical gaps

The disparity in AI awareness—58.8% among students versus only 3.1% of faculty—strongly aligns with Rogers' Diffusion of Innovation Theory (2003), which posits that different age groups adopt technologies at varying rates. Accordingly, in our results, the surveyed students, who showed enthusiasm for integrating AI into their architectural learning, clearly represent early adopters of AI. By contrast, the surveyed faculty members, who belong to an older generation group, exhibited reluctance, which was underpinned by their lack of formal training or exposure to AI technology.

One key takeaway from these findings is the need for structured and targeted training for faculty. While younger students are quick to see the potential in AI, faculty may need clearer demonstrations of AI's practical and pedagogical value. According to Venkatesh et al. (2003), perceived usefulness and ease of use are key factors in technology adoption, and faculty may currently view AI as complex or irrelevant to their established teaching methods. This contrast is also evident when comparing other fields like business education, where technology adoption is more common due to its clear practical benefits (Teo, 2011). To close this gap in architectural education, it will be essential to develop training programs that clarify the specific advantages of AI in design education.

5.2 Practical engagement over awareness: implications for learning

Along with the need for structured and targeted training for faculty discussed above, our results also highlight the importance of enhancing faculty's *practical engagement* with AI tools. Specifically, as posited by Kolb's (1984) Experiential Learning Theory (1984), the frequency of use of a technology is a strongest predictor of the corresponding positive experience with that technology. Likewise, Venkatesh et al.'s (2003) Technology Acceptance Model (TAM) highlights that actual adoption of and satisfaction with a technology are driven by its perceived ease of use and usefulness, not just awareness. What the aforementioned theoretical proposals highlight is that mere awareness of architecture students and, more importantly, of faculty staff about AI tools does not suffice—instead, this awareness should be consistently strengthened via regular engagement with AI tools. Said differently, hands-on experience with AI is essential to a successful integration of AI into the architectural classroom.

Similar conclusions about the imperative active use of AI tools in the classroom were previously made in other fields of education, such as engineering. For instance, Xu et al. (2020) convincingly demonstrated that engineering students' engaged use of AI tools considerably improved their learning outcomes (Xu et al., 2020).

What this suggests is that institutions providing architectural education should focus on increasing their students' and faculty staff's engagement with AI through its real-world applications, such as via embedding AI into design studios, projects, or courses. Obviously, strengthening AI's use in both academic and project-based settings would require considerable investment into appropriate resources and training.

5.3 Concerns about creativity: addressing faculty hesitation

An important qualitative finding in our results was that, unlike students, the surveyed faculty staff voiced a serious concern that over-reliance on AI could hinder architectural students' creativity, or their ability to develop independent, creative solutions. This hesitation about AI use should be meaningfully addressed in educational settings.

Overall, the aforementioned concern of the surveyed architectural staff resonates with broader debates on the role of automation in creative fields (Autor, 2015) and reflects a broader pedagogical tension between innovation and creativity. Indeed, while the faculty staff acknowledged that AI is capable of introducing new forms, workflows, and design solutions, they were concerned that the automation of these outputs increased the risk of short-circuiting internal cognitive processes that underpin creative development.

This concern of the surveyed architectural staff may arise from several earlier theories. For instance, as posited by Amabile (1996) Componential Theory of Creativity, creativity arises from the interplay between domain-relevant skills, creativity processes, and intrinsic motivation. All these components may be compromised by architectural students' heavy reliance on AI tools. Another relevant theoretical framework—Csikszentmihalyi (1999) Systems Model of Creativity (1999)—highlights that creativity arises from the interaction among elements that AI cannot replicate independently—namely, from individual skills, disciplinary norms, and social validation in the creative act. Taken together, the aforementioned two theoretical frameworks highlight that, although AI may support innovation, true creativity arises from deeply engaged, iterative problem-solving and meaning-making.

However, in more recent research, appropriate use of AI was convincingly demonstrated to enhance creative thinking by offering new perspectives (Anderson et al., 2018). This highlights the need for a balanced approach to AI integration in education—the one where AI is positioned not as a shortcut to outcomes, but as a co-creative partner that stimulates, rather than replaces, the design process. An important practical implication of this finding is that future training programs on the use of AI in educational contexts should focus on how to incorporate AI in ways that would stimulate creativity, without reducing the importance of human input in design processes.

Another reason underlying the surveyed faculty members' hesitancy towards AI adoption is related to educators' concern that students' over-reliance on AI tools could result in bypassing essential design thinking stages and uncritical acceptance of AI-generated outputs—that is, skipping the learning process of how to design to merely choosing what to accept from among multiple AI-generated proposals. This potential challenge was also mentioned in recent architectural education literature warning about "design shallowing" – that, is, situations when students skip the iterative process of problem-solving and experimentation. From the applied perspective, addressing these concerns requires not only technical training, but also pedagogical frameworks that would meaningfully embed AI within creative workflows, ensuring that students genuinely learn with AI, rather than passively use its outputs.

5.4 Implications for curriculum design and AI skill development

Another major finding in our results concerns the strong interrelationship between AI skill development and positive experiences with using AI in architectural education. This finding largely aligns with previous research demonstrating that the belief that a system will improve performance is a major factor in its adoption (Venkatesh et al., 2012), What this suggests for the context of architectural education is that there is a clear need to provide both students and faculty with structured opportunities to build AI-related skills. Along with improving students' and educators' proficiency with AI tools, such opportunities will also increase the perceived value of AI tools in design practice.

More concretely, taking into account the evidence showing that structured training programs can significantly improve technology acceptance (Schoonenboom, 2014), educational institutions offering undergraduate programs in architecture should consider implementing curriculum enhancements that focus on introducing AI tools that are directly relevant to architecture, such as parametric design or AI-driven modeling. Relevant curriculum enhancements can include—but are not limited to—structured workshops, courses, or labs. Collectively, these innovations in architectural curricula can provide both students and faculty with the hands-on experience they need to feel comfortable integrating AI into their work.

5.5 Broader implications for AI adoption in architectural education

On a broader level, the results of the present study point to a certain imbalance in how all actors involved in architectural education perceive emerging technologies like AI. One of the solutions to bridge this gap students and educators is introducing a more collaborative approach to integrating AI into the curriculum. This could involve introducing joint projects that would concurrently tap on students' technical proficiency with AI tools and educators' pedagogical expertise, thereby fostering a shared understanding of AI's potential. An alternative path towards encouraging a stronger faculty engagement with AI could also involve, according to Rogers (2003) Diffusion of Innovation Theory, offering targeted incentives such as professional development credits or research grants that would ensure a smoother and more widespread integration of AI in architectural education.

The identified imbalance in architecture students' and educators' perceptions of utility of AI tools in the learning process should also be viewed through the lens of the Saudi and Gulf context. The observed faculty members' hesitation towards decentralized, tool-based learning can also be explained through the historical emphasis of Saudi educational systems on instructor authority and standardized content delivery. Educators' resistance to AI-based instruction can also be underpinned by cultural values in the Gulf—such as preference for human-led mentorship, sensitivity to technological automation, and emphasis on group conformity. This specificity of the Saudi educational context should be carefully considered in future AI integration strategies.

6 Conclusion

In this study examines the integration of AI tools into architecture education at Umm Al-Qura University. Focusing on two groups of actors involved in the education process—namely, architecture students and faculty staff—we investigated how these two groups differ with regard to their attitudes, awareness levels, and actual usage related to AI tools. The data from 32 faculty members and 160 students were collected using a structured questionnaire and a mixed methods approach. The results revealed substantial differences between the two groups in terms of AI engagement and familiarity. Specifically, while the surveyed students demonstrated greater awareness about, more frequent usage of, and a greater interest in AI-based training, the participant educators voiced concerns about AI's effects on creativity and teaching. We also found that two strongest predictors of positive educational experiences with AI tools were frequency of AI use and appropriate development of AI-related skills.

Along with underscoring AI's growing role in architectural education, the results of our analysis also highlighted key challenges in training, awareness, and institutional preparedness that need be addressed to ensure that academic outcomes align with evolving industry demands, especially as Saudi Arabia advances its Vision 2030 agenda. Specifically, we found that, although the surveyed students reported feeling eager to use AI tools, their continued engagement was hindered by the lack of formal exposure and instructional support. Accordingly, our findings highlight the need for curriculum reform that would effectively balance innovative design thinking with technology integration. In addition, faculty concerns about AI should be comprehensively addressed via fostering an inclusive AI learning environment, as well as through targeted training and collaboration.

7 Recommendations

- Integrate AI into Daily Educational Practice

Based on the results of the present study, several practical recommendations can be formulated. First, our findings clearly suggest the need to improve practical AI use. To this end, the first priority is to integrate AI tools into both students' and educators' daily practices. Appropriate action frameworks should prioritize immediate, tangible impact, especially within modular courses. This can be achieved via encouraging hands-on experimentation and applied learning. A relevant initiative to this end would be introducing a new elective course titled "Computational Creativity in Architecture" that would focus on generative design, parametric modelling, and algorithm-assisted form-finding. Students enrolled into this course would engage with platforms such as Grasshopper (enhanced with AI plugins), Hypar for AI-driven design workflows, or Revit Dynamo using predictive analysis models. These and other relevant tools could be integrated into project-based learning, AI-guided research assignments, or even real-time classroom applications to foster creativity, critical thinking, and technical proficiency.

- Provide AI Pedagogical Training for Faculty

Second, our results highlight the need to establish AI teaching for faculty. This can be achieved via creating dedicated training specific to teaching AI, as well as via the development of an AI pedagogical training program that would incorporate hands-on workshops with tools such as ChatGPT for conceptual ideation, Midjourney or DALL·E for visual design prompts, and RunwayML for video and presentation augmentation. Other relevant modules may also include ethical considerations, bias in AI-generated content, and instructional scaffolding for design review using AI-generated alternatives. Such programs could respond to faculty apprehensions about AI lowering creativity and may be framed in terms of how AI can work alongside—rather than within—creative processes.

- Promote Collaborative AI Design Projects

Our third recommendation is to promote collaborative AI design projects among students and faculty. Motivate joint AI-driven projects in making of design tasks. Ideally, they should be able to transfer their knowledge about technology and potentially be taught some pedagogical tactics. Blend SEO Purpose with AI in Curriculum Planning.

- Embed AI Purposefully into Curricula

Fourth, there is a clear need to design AI-centered curricula that support, rather than replace, creative thinking. Streamline routine processes while preserving critical and reflective thinking in design education.

- Establish Student-led AI Innovation Hubs

Fifth, based on the results, we argued for the need to encourage AI Innovations through student-led institutions, such as student AI hubs where students would have facilities to work with and explore their own projects on AI by showing the outputs of their work with other students as well as with faculty. These hubs could be modelled after innovation labs in digital media departments, equipped with advanced GPUs, access to paid versions of generative tools, and design challenge themes (e.g., "AI for Urban Resilience" or "Heritage & Generative Design"). Collaborative work could be supported by mentorship from AI-savvy faculty and architecture tech firms in the region. This is meant to create a hub of creativity and adoption to guide students in creating AI-powered projects.

- Incentivise Faculty Engagement with AI

The sixth recommendation is to actively encourage faculty to engage with AI. Implement incentive programs for faculty such as AI research grants, PD credits, or recognition of impact on AI-driven teaching innovation. These incentives need to focus on decreasing the barriers to adoption and incentivizing faculty to get more involved with AI.

Finally, our results underscore the urgent need for the development of AI skill training programs. Create workshops and courses about practical AI skills for students and faculty alike. These should include hands-on applications like AI in architecture, such as design automation, data visualization, and simulation.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Umm Alqura University Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

AA: Conceptualization, Resources, Validation, Writing – review and editing, Data curation. AM: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft.

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The author(s) declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

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