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The Role of Generative Artificial Intelligence in Architectural Education and the Design Process: A Systematic Review

Sahel Hakak [1] | **Yasin Khalili** [2]✉

1. B.Sc. in Architecture, Hakim Sabzevari University, Sabzevar, Iran. E-mail: sahelhakak33@gmail.com

2. Corresponding Author, Department of Petroleum and Geoenergy Engineering, Amirkabir University of Technology, Tehran, Iran. E-mail: yassinkhalili.pe@aut.ac.ir

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ABSTRACT

Generative Artificial Intelligence (GenAI) is rapidly transforming architectural education and design by enabling the generation of visual concepts, design alternatives, textual content, and interactive support. This systematic review examines the applications, benefits, challenges, and potential influence of GenAI on creativity, design thinking, and independent decision-making among architecture students. Following the PRISMA 2020 framework, relevant literature was systematically identified, screened, and thematically analyzed. The findings indicate that GenAI can enhance early-stage design exploration, accelerate idea generation, support visualization, and facilitate iterative and personalized learning. However, concerns remain regarding AI dependence, reduced independent reasoning, originality and authorship, academic integrity, technical limitations, and the assessment of individual contributions. The review suggests that GenAI does not inherently improve creativity or design quality; rather, its educational value depends on students' active evaluation, modification, and contextualization of AI-generated outputs. A human-centered approach, in which GenAI supports exploration while students retain control over design decisions, is therefore recommended. Key research gaps include long-term learning outcomes, creativity assessment, AI dependence, instructor roles, assessment strategies, and the technical feasibility of AI-generated architectural solutions.

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Introduction

The rapid development of artificial intelligence (AI) has transformed the generation, organization, and application of knowledge across academic and professional domains. In recent years, generative artificial intelligence (GenAI) has emerged as an important development within this technological transformation because it enables computational systems to generate new content, including text, images, concepts, and design alternatives, in response to user-defined prompts. Unlike conventional digital tools that primarily assist users in representing, modifying, or analyzing predefined information, GenAI can actively participate in the generation and exploration of new possibilities. This capability has attracted particular attention in creative disciplines, including architecture, where conceptual development, visual experimentation, and iterative decision-making are fundamental components of professional practice and education (Alamasi & Asfour, 2026; Jang et al., 2025).

Architectural education traditionally aims to develop creativity, critical thinking, problem-solving, spatial reasoning, and independent design judgment. Students are expected to move through a design process that generally involves understanding a problem, developing concepts, generating alternatives, evaluating possibilities, and refining a final solution. Digital technologies such as computer-aided design, parametric modeling, building information modeling, and digital visualization have already transformed this process. GenAI represents a further technological development because it can generate architectural concepts, visual alternatives, textual descriptions, material combinations, and atmospheric representations within a very short period. As a result, AI is increasingly moving from a passive representation tool toward an interactive component of the conceptual design process (Onatayo et al., 2024; Rane et al., 2023).

The use of GenAI can provide several educational opportunities. Students can generate multiple alternatives rapidly, visualize abstract concepts, explore different formal and stylistic directions, and experiment with design possibilities that may otherwise require considerable time and technical effort. Conversational AI can additionally assist with project requirements, precedent analysis, conceptual development, and the organization of design ideas. These capabilities may allow students to devote greater attention to comparison, evaluation, and refinement rather than repetitive production activities. GenAI may therefore contribute to a more exploratory and iterative design-learning environment (Medel-Vera et al., 2025; Stanimirovic et al., 2026).

However, the integration of GenAI also creates significant educational and professional concerns. Excessive dependence on AI-generated content may reduce students' engagement with independent ideation, critical reasoning, and problem-solving. Architectural education is not simply concerned with producing visually attractive images; it seeks to develop the ability to define problems, understand contextual requirements, generate meaningful concepts, evaluate alternatives, and justify design decisions. Furthermore, AI-generated outputs may contain structural, functional, environmental, material, or contextual inconsistencies that are not immediately apparent from their visual appearance. Ethical issues concerning authorship, copyright, plagiarism, academic integrity, transparency, and appropriate AI disclosure further complicate the integration of these technologies (Demir & Akti, 2024; Lee & Kang, 2025).

The relationship between GenAI and creativity is therefore particularly important. AI systems can expand the range of alternatives available to students and stimulate divergent exploration, but the production of numerous novel images does not necessarily represent genuine architectural creativity. Creativity also involves contextual understanding, originality, usefulness, critical judgment, and the ability to transform ideas into appropriate architectural solutions. Consequently, the educational impact of GenAI depends strongly on how students interact with its outputs. When students use AI to explore, question, modify, and develop their own ideas, GenAI may enhance the design process. When students simply select and reproduce generated solutions, the technology may instead reduce independent design engagement (Alamasi, 2025).

Although research examining AI in architecture and design education has expanded considerably, the existing literature remains distributed across different technologies, educational contexts, applications, and research perspectives. Studies have investigated AI-assisted visualization, conceptual design, creativity, student perceptions, learning outcomes, and ethical issues, but their findings are not always consistent. In particular, there remains a need

to clarify how GenAI affects the balance between technological assistance and student autonomy (Albukhari, 2025; Bhullar et al., 2024).

Therefore, this systematic review examines the role of GenAI in architectural education and the architectural design process. The review focuses on four interconnected dimensions: applications of GenAI, educational and design-related benefits, challenges and limitations, and its potential influence on creativity, design thinking, and independent decision-making. By synthesizing the existing literature, the study aims to provide a comprehensive understanding of the current role of GenAI and identify research priorities for its responsible integration into architectural education.

2. Methodology

This study adopts a systematic literature review methodology to identify, organize, and critically synthesize existing research concerning the application of GenAI in architectural education and design. The review follows the principles of the PRISMA 2020 framework to improve transparency, reproducibility, and methodological consistency throughout the literature identification and selection process (Page et al., 2021).

The review was guided by four research questions. The first question examines how GenAI is currently being applied in architectural education and the architectural design process. The second investigates the principal educational and design-related benefits reported in the literature. The third focuses on the technological, educational, ethical, and professional challenges associated with GenAI. The fourth examines how GenAI may influence creativity, design thinking, and students' independent design decision-making (Alamasi & Asfour, 2026).

The literature search was designed to cover multidisciplinary research because GenAI in architecture is studied across architecture, design, education, computer science, human-computer interaction, and digital technologies. Major academic databases considered for the search include Scopus, Web of Science, ScienceDirect, SpringerLink, IEEE Xplore, and Google Scholar. Search terms were constructed by combining GenAI-related terms with architectural and educational terms. Representative keywords included "generative artificial intelligence," "generative AI," "GenAI," "AI-generated," "text-to-image," "architectural education," "architecture students," "design education," "architectural design," "conceptual design," and "design process" (Alamasi & Asfour, 2026).

Studies were considered eligible when they addressed generative AI technologies and their relationship with architecture, architectural education, architecture students, or architectural design. Peer-reviewed journal articles and relevant conference papers were prioritized. Studies were excluded when they focused exclusively on conventional AI without a generative component, addressed unrelated disciplines, consisted primarily of commercial or non-academic content, were duplicates, or did not provide sufficient information to understand their contribution (Jang et al., 2025).

The selection process consisted of identification, screening, eligibility assessment, and final inclusion. Titles and abstracts were initially examined to remove clearly irrelevant studies. Potentially relevant publications were then assessed in greater detail according to the predefined eligibility criteria. The final literature set was analyzed according to publication characteristics, research methodology, GenAI technology, educational context, design stage, application type, reported benefits, challenges, and effects on creativity and design thinking (Onatayo et al., 2024).

Because the selected literature is expected to include qualitative studies, quantitative investigations, experiments, surveys, case studies, conceptual papers, and mixed-method research, a thematic qualitative synthesis is more appropriate than a statistical meta-analysis. The analysis therefore emphasizes recurring themes, areas of agreement and disagreement, methodological limitations, and emerging research directions. Importantly, final numerical values for identified, screened, excluded, and included studies should be reported only after the actual database search and screening process has been completed (Zhang & Zhang, 2025).

Table 1 summarizes the main dimensions used to classify and synthesize studies on GenAI in architectural education and design.

Table 1. Proposed systematic-review framework and classification criteria (Chen & Cheung, 2025; Onatayo et al., 2024; Zhang & Zhang, 2025)

Review Dimension	Classification
AI technology	Text-to-image, conversational AI, multimodal AI, image-to-image, generative design systems
Educational context	Studio courses, conceptual design, visualization, theoretical courses, independent projects

Design stage	Problem definition, ideation, conceptualization, exploration, development, presentation
Primary application	Idea generation, visualization, precedent exploration, design feedback, communication
Educational outcome	Creativity, design thinking, learning support, AI literacy, communication
Major challenge	Dependence, originality, ethics, technical feasibility, assessment, authorship
Student role	Creator, evaluator, modifier, co-designer, passive user
Evidence type	Experimental, survey, qualitative, case study, mixed-method, conceptual

3. Applications of Generative Artificial Intelligence in Architectural Education and Design

GenAI is being integrated into architectural education through a wide range of activities, with particularly strong applications during conceptual and exploratory stages of design. Unlike conventional software that requires students to construct a model before producing a visualization, generative systems can produce preliminary visual or textual representations from relatively limited input. This capability allows students to explore design possibilities before committing substantial time to detailed modeling (Peckham et al., 2025).

One of the most prominent applications is concept generation. Students can provide prompts describing spatial organization, architectural character, site conditions, materials, functions, or environmental qualities and generate alternative conceptual directions. This process can encourage students to consider a wider range of possibilities during early ideation. Rather than developing a single concept sequentially, students can compare several alternatives and identify elements that may contribute to a stronger design strategy.

Text-to-image generation represents another important application. These systems allow verbal concepts to be transformed into visual representations, making them particularly useful when students have difficulty communicating an initial idea through conventional sketches or modeling. AI-generated imagery can support exploration of building massing, façade composition, interior environments, materials, landscape, lighting, and architectural atmosphere (Jang et al., 2025).

GenAI can also support design iteration and transformation. Students can modify an initial concept by changing materials, proportions, environmental conditions, spatial characteristics, or architectural language. This facilitates rapid comparison between alternatives and may encourage experimentation. However, rapid generation should not be interpreted as equivalent to meaningful design development. The student must still determine why an alternative is appropriate and how it responds to the actual design problem.

Another application involves architectural visualization and presentation. GenAI can assist students in creating conceptual renderings, atmospheric images, presentation backgrounds, and visual narratives. Such applications can improve communication, particularly when students need to explain a complex idea to instructors, peers, or external audiences (Alamasi et al., 2026).

Conversational GenAI can provide a different type of support. Students may use conversational systems to discuss project requirements, analyze precedents, organize design concepts, generate questions, explore architectural theories, or obtain feedback on design strategies. This creates the possibility of an interactive learning environment in which AI functions as a conversational design assistant (Buendia-Garcia, 2025; Hong et al., 2024).

Despite these applications, AI-generated content should not be considered an inherently reliable architectural solution. Generated images may contain unrealistic structures, inconsistent dimensions, impossible construction details, inappropriate environmental responses, or misleading material representations. The primary educational opportunity therefore lies not simply in generating outputs but in using those outputs as objects of critical analysis and design development (Alamasi & Asfour, 2026).

Figure 1 illustrates an iterative, student-centered workflow in which GenAI supports design exploration while students retain control over evaluation, development, and final decisions

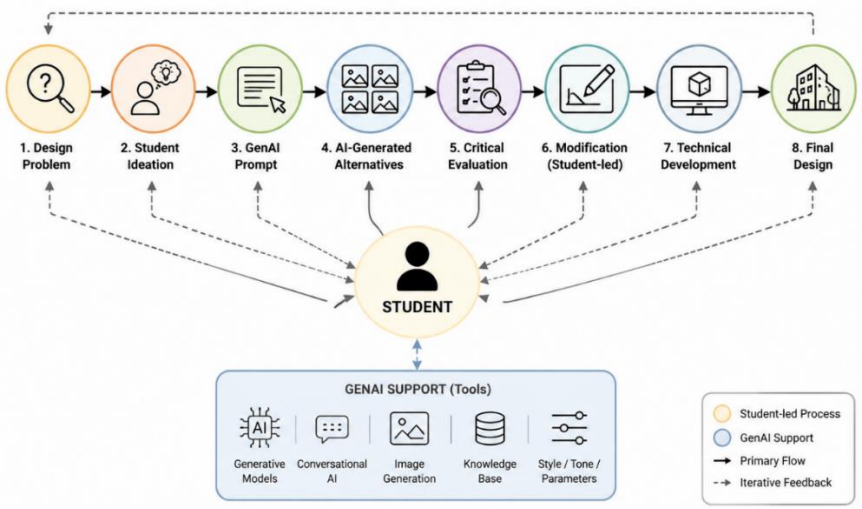

Figure 1. Role of Generative AI across the architectural education and design process.

4. Benefits and Opportunities of Generative Artificial Intelligence in Architectural Education

The integration of GenAI provides several potential benefits for architectural students and educators. One of the most immediate advantages is the acceleration of design exploration. Traditional conceptual development may require repeated sketches, physical models, digital modeling, and rendering. GenAI can provide preliminary alternatives rapidly, allowing students to compare a greater number of possibilities within the same period (Medel-Vera et al., 2025).

A second benefit is the expansion of the design space. Students may use GenAI to explore combinations of forms, materials, spatial arrangements, environmental conditions, and architectural styles that they may not initially consider. Unexpected outputs can function as stimuli for further thinking rather than as final solutions. In this context, AI may contribute to divergent thinking by encouraging students to move beyond their initial assumptions (Chen & Cheung, 2025).

GenAI can also improve visual communication. Students often have difficulty communicating early conceptual ideas before they possess sufficient technical modeling or rendering skills. AI-generated images can provide an intermediate representation that helps students communicate spatial intentions and discuss design alternatives with instructors and peers.

Another opportunity involves iterative experimentation. Because AI-generated alternatives can be produced rapidly, students can test multiple hypotheses and compare their implications. This may support a more experimental learning environment in which failure becomes less costly and iteration becomes easier (Liu et al., 2026).

GenAI may also contribute to personalized learning support. Conversational systems can explain architectural concepts, assist with project organization, provide questions for self-evaluation, and help students identify aspects of their design that require further consideration. Such support can be particularly useful outside formal studio hours, although AI-generated advice must still be evaluated against authoritative architectural knowledge.

The technology may further contribute to the development of AI literacy. As GenAI becomes increasingly relevant to professional architectural practice, students need to understand not only how to operate these systems but also their limitations, biases, ethical implications, and appropriate applications. AI literacy should therefore include prompt development, output evaluation, source awareness, ethical use, and the ability to distinguish between visual plausibility and technical feasibility (Abrusci et al., 2025).

Importantly, these benefits should not be measured only through productivity. Generating more images in less time does not necessarily indicate improved design education. The more meaningful outcome is whether GenAI enables students to ask better questions, compare alternatives more critically, develop stronger concepts, and make more defensible design decisions.

Table 2 presents the principal educational benefits of GenAI and their potential contributions to students' learning and design development.

Table 2. Major benefits of GenAI in architectural education (Abrusci et al., 2025; Chen & Cheung, 2025; Liu et al., 2026; Medel-Vera et al., 2025)

Benefit	Potential Contribution	Educational Significance
Rapid idea generation	Produces multiple concepts quickly	Expands early-stage exploration
Design-space expansion	Introduces unexpected alternatives	Encourages divergent thinking
Visualization	Converts abstract ideas into images	Improves communication
Iterative experimentation	Enables rapid modification	Supports learning through experimentation
Personalized assistance	Provides interactive explanations and suggestions	Extends learning beyond studio hours
AI literacy	Develops understanding of AI capabilities and limitations	Supports future professional practice
Presentation support	Produces conceptual visual material	Strengthens design communication
Feedback and reflection	Enables discussion of design alternatives	Can support critical evaluation

5. Challenges, Limitations, and Implications for Design Thinking

Despite its potential benefits, GenAI creates substantial challenges for architectural education. One of the most important concerns is student dependence on AI-generated solutions. If students repeatedly obtain complete concepts from AI systems, they may become less engaged in the cognitive processes required for independent ideation and problem-solving. The issue is therefore not whether AI is used, but whether students remain intellectually responsible for the design process (Yang et al., 2024).

A related concern is the potential reduction of independent design thinking. Architectural design requires students to formulate problems, establish priorities, negotiate constraints, compare alternatives, and justify decisions. These activities represent important learning outcomes in themselves. If AI performs too much of this reasoning, students may produce polished results without developing equivalent design competence.

The relationship between GenAI and creativity is also ambiguous. AI can generate visually diverse and apparently novel alternatives, but novelty alone does not guarantee creativity. Architectural creativity requires meaningful responses to context, function, culture, environment, materials, and human needs. Furthermore, systems trained on large collections of existing images may reproduce established patterns, potentially encouraging visual homogenization (Alamasi & Asfour, 2026).

Technical reliability represents another limitation. AI-generated images frequently prioritize visual appearance over engineering feasibility. Elements such as structural systems, circulation, dimensions, building services, environmental performance, and construction methods may be inconsistent. Students must therefore possess sufficient architectural knowledge to identify and correct these limitations.

Ethical concerns are equally important. The use of GenAI raises questions about authorship, copyright, plagiarism, academic integrity, transparency, and disclosure. Educational institutions must determine when AI assistance constitutes acceptable support and when it represents inappropriate substitution of student work. Clear institutional policies and transparent reporting of AI use are therefore increasingly important (Gruenhagen et al., 2024).

GenAI also creates challenges for student assessment. Evaluating only the final image or presentation may make it difficult to determine the student's actual contribution. Process-oriented assessment may provide a better solution by examining sketches, iterations, prompts, design alternatives, critical reflections, revisions, and explanations of design decisions (Xia et al., 2024).

The role of instructors is consequently changing. Rather than focusing exclusively on technical production, educators increasingly need to guide students in evaluating AI outputs, identifying limitations, understanding ethical issues, and defending their design decisions. The instructor may become more of a critical mentor and evaluator of the design process.

A useful educational model is therefore:

Design Problem → Student Idea → AI Exploration → Critical Evaluation → Student Modification → Design Decision → Architectural Solution

This model emphasizes that GenAI should expand students' capabilities without replacing their intellectual responsibility (Yang et al., 2024).

Figure 2 contrasts student-led AI-assisted design with AI-dependent design and highlights their different implications for creativity, critical thinking, learning, and student agency.

Table 3 summarizes the key challenges associated with GenAI and corresponding strategies for its responsible integration into architectural education.

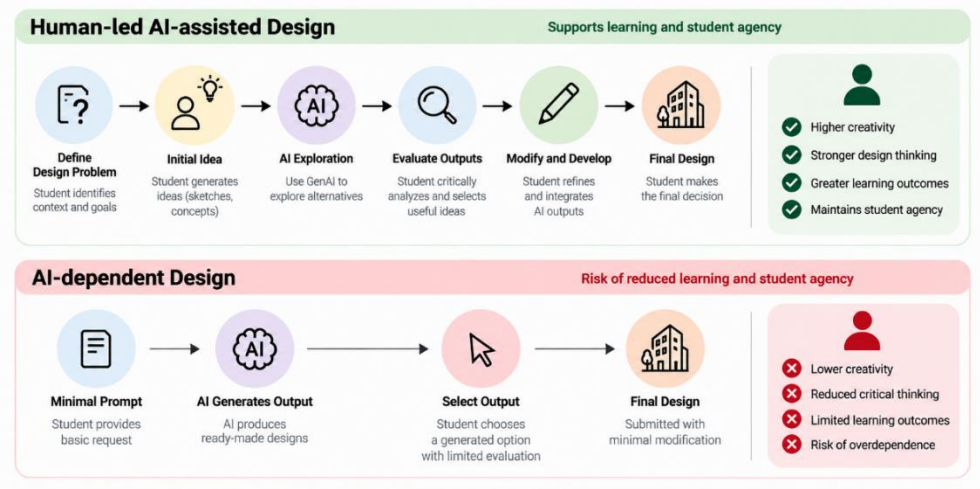

Figure 2. Human-led versus AI-dependent architectural design.

Table 3. Challenges, educational implications, and potential responses (Gruenhagen et al., 2024; Xia et al., 2024; Xia et al., 2025; Yang et al., 2024).

Challenge	Potential Impact	Recommended Educational Response
AI dependence	Reduced independent ideation	Require student-generated initial concepts
Reduced critical engagement	Passive acceptance of outputs	Require comparison and justification of AI alternatives
Standardized outputs	Reduced originality	Encourage diverse prompts and personal transformation
Technical inaccuracies	Unrealistic architectural solutions	Integrate technical verification
Copyright and authorship	Unclear ownership and attribution	Establish AI disclosure and authorship guidelines
Academic integrity	Difficulty identifying student contribution	Use process-based assessment
Unequal AI literacy	Different levels of access and skill	Provide structured AI-literacy training
Assessment difficulty	Final outputs may not reflect learning	Evaluate design reasoning and iteration
Changing instructor role	Need for new pedagogical strategies	Train educators in critical AI integration

6. Discussion

The reviewed literature indicates that GenAI is becoming an increasingly influential component of architectural education, particularly in conceptual development, visual exploration, and design communication. Its ability to generate alternatives rapidly provides students with opportunities to explore a broader design space and experiment with ideas that might otherwise require substantial time and technical skills.

However, the findings suggest that technological efficiency should not be equated with educational effectiveness. A student who generates hundreds of AI images may not necessarily demonstrate stronger creativity or design competence than a student who develops a smaller number of carefully considered alternatives. The central educational issue is therefore the quality of interaction between the student and the technology (Medel-Vera et al., 2025).

The distinction between AI-assisted design and AI-dependent design provides a useful framework for interpreting the literature. In AI-assisted design, the student maintains control over the design problem, evaluates AI-generated

suggestions, and modifies outputs according to architectural requirements. In AI-dependent design, the student increasingly delegates ideation and decision-making to the AI system. The first approach can support learning and experimentation, whereas the second may undermine independent design reasoning.

The influence of GenAI on creativity should similarly be interpreted cautiously. The technology can provide unexpected combinations and increase the number of alternatives available to students, potentially supporting divergent thinking. Nevertheless, creativity in architecture extends beyond visual novelty. A creative architectural proposal must demonstrate contextual relevance, functional suitability, meaningful spatial relationships, and a defensible design rationale. Therefore, future educational studies should evaluate creativity using multidimensional criteria rather than counting the number or novelty of AI-generated alternatives (Chen & Cheung, 2025).

The findings also indicate that critical evaluation is becoming increasingly important. GenAI systems can produce convincing outputs that may contain subtle technical or contextual problems. Students therefore need to develop the ability to question AI-generated information and verify it using architectural principles, technical knowledge, environmental analysis, and contextual understanding.

The role of architectural educators is consequently evolving. In an AI-supported studio, instructors may spend less time teaching repetitive representation tasks and more time supporting conceptual reasoning, critical evaluation, ethical decision-making, and design justification. This shift does not reduce the importance of educators; instead, it increases the need for pedagogical strategies that help students use AI responsibly (Jang et al., 2025).

Assessment represents another major implication. Conventional evaluation based primarily on the final presentation may become insufficient because AI can generate visually sophisticated outputs with limited student effort. Assessment should increasingly examine the process of design development, including initial ideas, iterations, AI interactions, evaluation criteria, modifications, and the reasoning behind final decisions (Stanimirovic et al., 2026).

Figure 3 presents the relationships among GenAI capabilities, design exploration, critical evaluation, student agency, and creativity under key educational moderating factors.

Figure 3. Conceptual framework linking GenAI, creativity, design thinking, and student agency.

7. Research Gaps and Future Research Directions

Despite the rapid expansion of research on GenAI in architecture, several important gaps remain. First, there is a need for more empirical comparative research. Studies should directly compare conventional design education with AI-assisted approaches using consistent measures of creativity, learning outcomes, design quality, and student engagement.

Second, current evidence provides limited understanding of the long-term effects of GenAI use. Short-term experiments may demonstrate improved productivity or increased student enthusiasm, but they cannot determine whether prolonged AI use strengthens or weakens independent design competence. Longitudinal studies are therefore required to examine whether students become more capable designers or increasingly dependent on AI assistance (Alamasi & Asfour, 2026).

Third, future research should develop standardized frameworks for assessing creativity in AI-supported design. Evaluation should distinguish between visual novelty, originality, contextual appropriateness, functional quality, environmental performance, and the student's own intellectual contribution.

A fourth gap concerns student agency and independent decision-making. Future studies should investigate measurable indicators of AI dependence, such as the proportion of AI-generated content, frequency of AI interaction, degree of student modification, and the extent to which final decisions originate from the student rather than the AI system (Rane et al., 2023; Xia et al., 2025).

The role of architectural educators also requires greater investigation. Research should examine effective teaching strategies, instructor competencies, curriculum integration, and methods for teaching students to critically evaluate AI-generated design content.

Assessment and academic integrity represent additional research priorities. Universities need evidence-based approaches for determining acceptable AI use, documenting AI assistance, evaluating individual contributions, and distinguishing legitimate AI-supported learning from inappropriate substitution of student work.

Technical integration also remains underexplored. Much current research focuses on image generation, while future studies should examine stronger connections between GenAI and BIM, parametric modeling, computational design, environmental simulation, structural analysis, and building-performance assessment. Such integration could move GenAI from visual concept generation toward more technically informed architectural design support (Jang et al., 2025).

Finally, research should consider cultural and geographical diversity. Architectural education is influenced by local traditions, environmental conditions, social expectations, and educational systems. International comparative studies could determine whether the benefits and risks of GenAI are consistent across different educational and cultural contexts (Alamasi & Asfour, 2026).

Table 4 identifies major research gaps and proposed priorities for advancing evidence-based GenAI integration in architectural education.

Figure 4 identifies interconnected research priorities and supporting dimensions that can guide responsible, human-centered, and evidence-based GenAI integration.

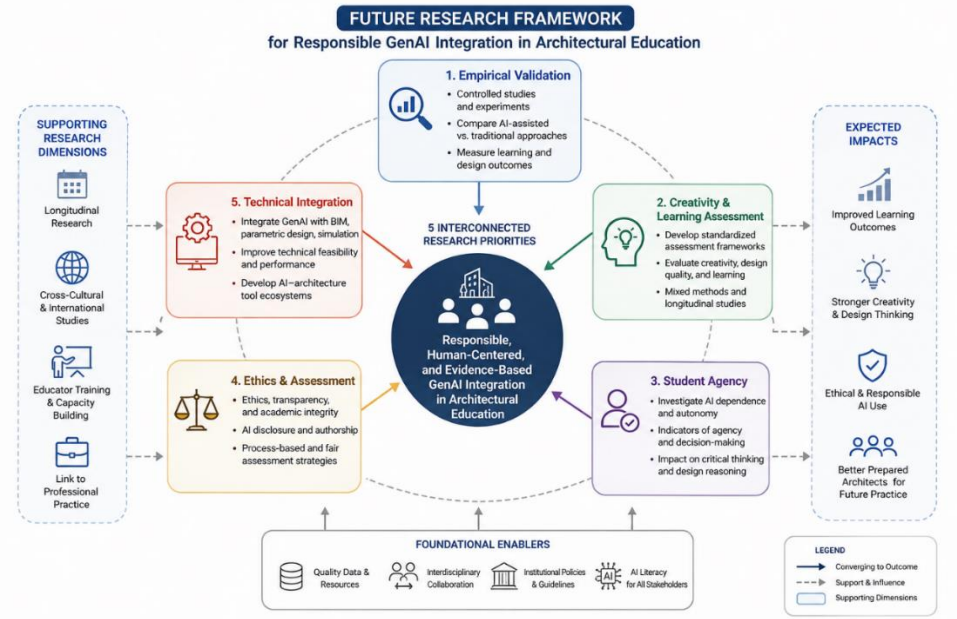

Figure 4. Future research framework for responsible GenAI integration in architectural education.

Table 4. Research gaps and future priorities for GenAI in architectural education (Alamasi & Asfour, 2026; Chen & Cheung, 2025; Rane et al., 2023; Xia et al., 2025).

Research Gap	Current Limitation	Future Research Priority
Long-term effects	Limited longitudinal evidence	Conduct multi-semester and multi-year studies

Creativity assessment	Inconsistent evaluation criteria	Develop standardized multidimensional metrics
Student independence	Limited measurement of AI dependence	Develop indicators of student agency
Comparative evidence	Few controlled comparisons	Compare AI-assisted and conventional workflows
Instructor role	Limited pedagogical guidance	Develop educator training and teaching frameworks
Assessment	Final products may conceal AI contribution	Develop process-based assessment models
Ethics	Inconsistent institutional policies	Establish transparent AI-use and disclosure frameworks
Technical feasibility	Strong focus on visual generation	Integrate AI with BIM and simulation tools
Cultural context	Limited geographical diversity	Conduct cross-cultural comparative studies
Professional transition	Unclear relationship with professional practice	Study AI competencies required for future architects

8. Conclusion

Generative Artificial Intelligence is emerging as an important technology in architectural education and the design process. Its ability to generate concepts, visualize alternatives, support experimentation, and provide interactive assistance can expand design exploration and create new opportunities for teaching and learning. In particular, GenAI can reduce the time required for early-stage visualization and allow students to investigate a wider range of design possibilities.

However, the integration of GenAI also introduces significant challenges. Excessive dependence on AI-generated content may reduce independent ideation and critical reasoning, while technically unrealistic outputs, concerns about originality, authorship, copyright, and academic integrity create additional educational challenges. The production of visually sophisticated designs should therefore not be considered sufficient evidence of improved creativity or learning.

The findings of this review support a human-led and AI-assisted model of architectural education. In this model, students remain responsible for defining design problems, generating and evaluating ideas, interpreting AI outputs, making design decisions, and developing the final architectural solution. GenAI functions as a complementary tool that expands exploration and visualization rather than replacing human creativity and judgment.

Future research should move beyond short-term demonstrations of AI capability and investigate its long-term effects on creativity, learning, design thinking, and student independence. Greater attention is also required for process-based assessment, ethical frameworks, educator preparation, technical integration, and cross-cultural educational contexts. Ultimately, the successful integration of GenAI into architectural education will depend not simply on the sophistication of AI systems, but on the ability of educational institutions to establish learning environments in which technology strengthens rather than substitutes human creativity, critical thinking, and architectural judgment.

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