A Comparative Study of Two AI-Assisted Architectural Design Studios

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This study examines two different educational approaches to integrating generative Artificial Intelligence (AI) tools in design studios, seeking to characterise their educational benefits for design studio education, namely for handling design problem tasks. We compare two studios integrating AI tools throughout the design process and initiated by characterising future scenarios in urban and natural contexts. Comparisons focus on problem definition, synthesis of solutions and evaluation and refinement by analysing outcomes from 10 students, 5 students at each course. Observations demonstrate AI's support in problem definitions, focusing on back-thinking from altered, future-scenario planning to gain context awareness and explorative, material-based form finding. Insights from this study underscore AI's transformative potential in architectural studio pedagogy and call for further research to enable the beneficial implementation of AI for advancing the design industry and education.

Keywords: *Generative AI, AI-assisted education, Studio, Future scenario planning, Design process, Educational technology*

INTRODUCTION

Generative Artificial Intelligence (AI) tools are rapidly adopted in design industries and education, requiring an understanding of how to integrate them into design studio courses. AI tools are different from other computational design tools whose output is based directly on the designer's actions. Based on trained large language models, these tools provide platforms for the instantaneous generation of endless output of fictive environments (Agkathidis and Yang, 2024), offering new and unexplored opportunities for tackling design problems handled in design studios. Using AI in design studios may hinder learners' creative process, overloading students with too many alternatives to converge on (Habib et al., 2024; Mangasaryan et al., 2024). More research is needed to understand how AI tools can assist learning in design studios.

This paper introduces a comparative study of two educational approaches to integrating AI tools into architectural design studios using future scenario planning, focusing on their potential to assist in students' handling of design problems (Duarte, Celani and Pupo, 2012).

A future scenario planning approach is considered advantageous for policy planning and innovation (Ahmad, 2020). In particular, future context scenarios are often presented in abstract forms, such as text or graphs, lacking representation of their spatial effects on the context (Bursic and Atman, 1997). Such abstract

information may lead to a decrease in empathy (Kim et al., 2020), affecting the quality of the solutions proposed. Existing studies demonstrate AI's effectiveness in identifying economic problems and expanding the scope of design alternatives (Basarir, 2022; Agkathidis and Yang, 2024), indicating their potential to support students' back-thinking in future scenarios. Following these works, this study details the use of AI as a platform for visualising and spatialising future scenarios under two educational approaches set to bridge this educational problem.

Learning how to design

Studio education forms the principal setting for educating students on how to design. Students gain proficiency in handling a design problem-solving task at various stages of the design process (Schön, 1987). It is a creative process focused on changing an existing context to a desired one. This includes gathering information to gain awareness of the existing context, identifying problems, synthesising solutions and evaluating and refining them to obtain a satisfying outcome (Goel and Pirolli, 1992).

Architectural design problems are inherently complex. They involve conflicting societal and environmental factors that require nuanced understanding and undetermined solutions (Rittel & Weber, 1973). This complexity requires designers to apply abductive reasoning to handle unknown or partial information concerning both the problem and solution (Dorst, 2011) through back thinking to complete missing parts in the situation (Rowe, 1991). Thoroughly described by Goel and Pirolli (1992), during problem framing, architects (and also students) use "back thinking," in which they ideate future scenarios illustrating their solution implemented in the context. The process enables evaluating whether the solution meets its goals or requires modifications.

Design representations play a major role in the design process, allowing designers to communicate their ideas externally for further thought and development. Digital tools have expanded these possibilities by offering 3D modelling and rendering tools that allow the refinement of the artefact in advanced design stages. Representations play an active role in the process, depending on the capacities of a given tool to provide a different output in terms of scale, size or material (Schön and Wiggins, 1992). Understanding the role of the representation tool used during the course is imperative to support students' progress.

Scenario-based design

A scenario-based approach enriches the design situation by adding a new context to the existing context, offering new perspectives that stimulate further interaction with the contextual societal and environmental issues, ideation and the generation of alternatives (Achten, 2019; Ahmad, 2020; Jonas, 2001), all of which are encouraged in studio education. In particular, adding a scenario illustrating the context can support the challenge of completing unknown parts of the situation (Dorst, 2011), increase empathy (Kim et al., 2020), and support both problem definition and solution generation. Students using a future scenario approach mentioned a greater understanding of multiple factors in a context (Evans and Sommerville, 2007). This may be even more relevant for students, who lack professional experience.

Generative artificial intelligence in design

AI technology has emerged as a powerful tool for manipulating existing information to generate new design ideas. By providing a platform to synthesise endless new alternatives, AI can potentially alter the design process (Chen et al., 2024). Existing studies demonstrate AI's effectiveness in framing economic problems and expanding the scope of design alternatives and form-finding (Leach, 2021; Basarir, 2022;

Agkathidis and Yang, 2024; Özorhon et al., 2025), indicating their potential to support students' back-thinking in future scenarios and cope with ill-structured design problems. A recent study explored the integration of AI in future scenarios, offering students ready-made AI-generated post-disaster scenarios as a fictive design context (Mangasaryan et al., 2024). Exploring the role of AI in this given future context has shown support in generating unexpected design concepts. Based on these studies, this study assumes that AI can potentially support studio education by providing a platform for visualising and spatialising future scenarios.

Considering the challenges faced by studio educators and the augmenting availability of AI in design studios, we ask how AI can support students in learning the design process in the design studio.

METHOD

We employ outcome analysis, comparing the implementation of AI in the course stages by reflecting on the design outcomes from two studio courses, Arch-1 and Arch-2. Stages conform to the design process categories (Goel and Pirolli, 1992). Outcomes are classified according to the description of each design process category (Sopher et al., 2019). When both AI and traditional non-AI tools are used, "output" and "input" signify the process. Table 1 describes the principles for outcome analysis.

The courses were taught during a single semester at two architecture faculties. Each course took a different approach to integrating AI during the course. Arch-1 incorporated AI into existing design courses of the advanced years in the undergraduate program and introduced supportive mandatory courses on computational design and modelling. Arch-2 introduced AI at the graduate level, offering standalone AI courses rather than integrating them into design studios. These approaches reflect different strategies for integrating AI-assisted education with institutional and disciplinary frameworks.

Both courses integrated AI from early course stages in scenario design. Arch-1 students were required to design a scenario of their choice, whereas Arch-2 students had to account for an environmental post-disaster scenario. Archi-1 used AI during the early and final course stages, whereas Arch-2 used the technology constantly throughout the semester. The AI platforms used were text-to-image for the early stages and style transfer, image-to-mesh in the late stages.

The data included the outcomes of ten students (Five students from each course) produced in the midterm and final reviews. Further, we describe the advantages and challenges encountered for each category when using AI as described in Table 1.

Table 1
Principles of outcome analysis.

Design process category		Outcome representations
Analysis	Context awareness	The context will represent the altered scenario, showing a difference from the context of the existing site
	Problem framing	Problems addressing the altered scenario or the existing situation
Synthesis	Ideating	Variability of preliminary ideas
	Form finding	The scale and geometry of the forms generated will resemble to or address either the existing or the altered context
Evaluation	Development	Overall geometry and its parts, addressing physical constraints (Feasibility).
	Refinement	Variability of materials and textures.
	Rendering	Structural coherence, and accuracy

OBSERVATIONS

The comparative analysis of the outcomes according to the use of AI and traditional tools manifests key differences between the two educational approaches. Figure 1 presents the design process practices applied and the

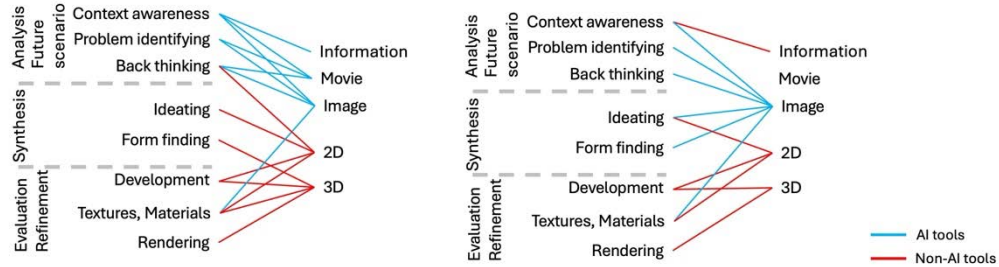

Figure 1
The integration of AI and traditional non-AI tools throughout the design process in Arch-1 (left) and Arch-2 (right).

outcomes produced using AI and traditional tools in Arch-1 (left) and Arch-2 (right). Arch-1 students used movie-prompting for future scenario activities, enriching context awareness and identifying problems.

Information gathering by Arch-2 was done using search engines, whereas most Arch-1 students relied on text and graph prompting. Although the graphs generated raised a large scope of problems concerning the context, without a clear source of the information, their reliability couldn't be verified.

Analysis of outcomes produced by ten students across the two studios reveals key differences between the two approaches as described in the following subsections. Figure 2 demonstrates 3 outcome analyses classified into each category for Arch-1 (left) and Arch-2 (right).

The role of AI in problem definition, context awareness and ideation using future scenarios

Arch-1 integrated AI in the initial course stage of problem definition, achieving context awarenwss in backthinkning through a combined approach between AI output and traditional (non-AI) site analysis. Firstly, text prompts AI were integrated to generate images and videos illustrating an altered future scenario context. Arch-1 scenarios included environmental and social aspects represented in images and movies. These have led to the identification of key problems concerning climate and food threats and the densified urban population. Students generated a densified context, addressing a wide variety of environmental problems, including walkability, vegetation, and natural light. They also identified social problems, such as the loss of belongingness or individual identity.

The outcomes produced were very different from the existing urban context at the given site. This indicates a shift in the students' awareness from a familiar context to an altered context. Second, students analysed the real context of the design site using traditional field trips and documentation. The combined approach of site analysis taken by Arch-1 facilitated back-thinking from future to real site settings, which supported ideating preliminary solutions, bridging and shifting between the context's two states. Most Arch-1 projects used AI to identify and represent problems, whereas few projects used it to represent more positive scenarios. While supporting the altered context, they experienced difficulties in back thinking. Similar to the other projects, this design prompting has led to the development of an architectural solution which relates to the altered context.

At Arch-2, students engaged in a game-like environment where participatory design methods shaped architectural scenario development through collaboration in prompt writing, driving the design process through game-driven exploration.

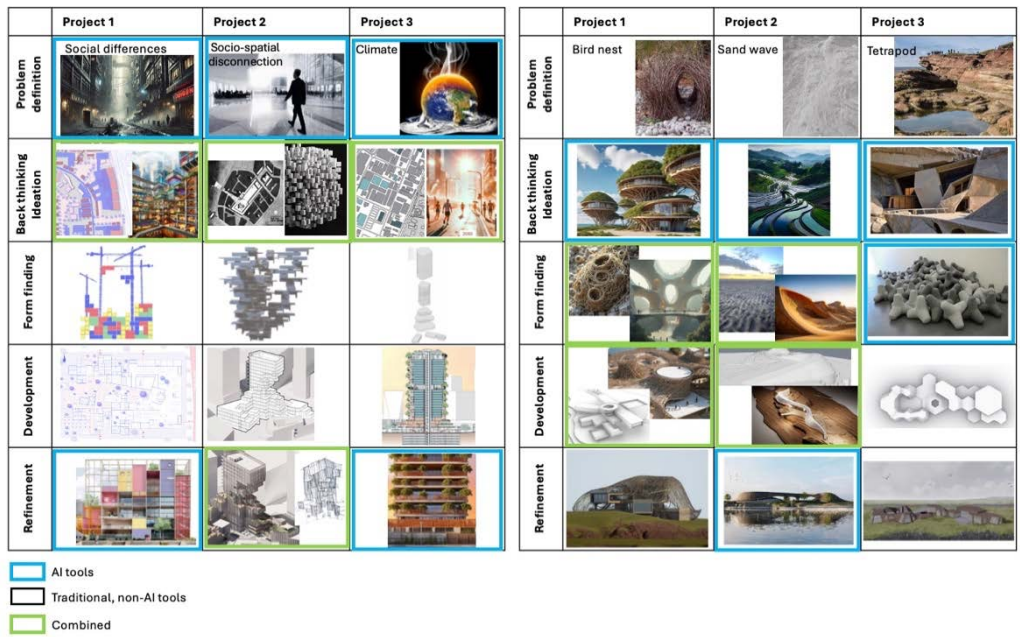

Figure 2 Outcome analysis according to the design process categories in Arch-1 (left) and Arch-2 (right).

AI was used to represent futuristic post-disaster context variables, as exemplified in Figure 2 (bottom). Using AI-driven scenario generation, students explored a wide range of environmental disaster scenarios—water, earth, air, fire, and spirit. These tools expanded the scope of problem definition and supported ideation, fostering greater awareness of long-term environmental impacts. However, because the given site was non-urban, the future scenarios produced tended to lack depth in addressing societal or cultural issues.

Students employed AI to reinterpret images of the real context, initiating the design process through "back-thinking"—moving from imagined futures to current site conditions. This approach encouraged abstract, experiential design responses. The prompts developed at the early stage, often derived from environmental observations (e.g. topographic features, flora, and fauna), were reimagined through AI, resulting in AI tools enabled students from both courses to obtain highly realistic representations at this preliminary design stage, in which student representations are commonly abstract (Lawson, 2005).

The role of AI in synthesising design solutions

During this phase, students develop new design concepts into architectural solutions. The form-finding in Arch-1 and Arch-2 differed due to their use of tools. Arch-2 students used AI for form-finding, while Arch-1 students preferred traditional non-AI tools to deal with the problems identified (Figure 1).

Arch-1 students produced familiar geometric forms that aligned with structural issues raised from the context, presenting greater feasibility yet carrying a limited speculative exploration for alternative morphologies. Projects 1 and 2 (Figure 2, up) based form finding on the geometry found in their AI output, using it as inspiration source to

synthesise a form. In contrast, Arch-2 students (Figure 2, bottom) employed AI-assisted form-finding, generating a wider range of alternatives but facing challenges in decision-making due to the large volume of options, similar to prior findings (Mangasaryan et al., 2024). Transitioning from AI images of concepts to synthesising solutions in traditional 3D modelling tools challenged the Arch-2 students, leading to translation and fidelity issues.

Differences are observed in the development and refinement of solutions due to the use of AI. At Arch-2, AI played a central role, using it constantly in iterative cycles, supporting modifications and further development. The approach and the limited capacities of AI resulted in traditional representations, such as floor plans and sections being mildly developed. Arch-1 use of AI during scenario planning indirectly shaped their form-finding.

These differences reflect a structured, practice-oriented methodology in Arch-1 versus an exploratory, tool-driven approach in Arch-2.

In the final course stage, dedicated to the refinement and rendering of materials, Arch-1 used AI through image-to-image for material and style search, leaving the geometry unchanged. This expanded the scope of existing solutions that were previously based on traditional non-AI tools, offering new knowledge which most students lack. Some results, such as project 3 (Arch-1, Figure 2, up), or project 3 (Arch-2, Figure 2, bottom) were inconsistent with the scenarios planned, demonstrating greater challenges in back-thinking at this stage.

DISCUSSION

This study explored AI's role in the design process stages through two pedagogical approaches of integration. Considering the significance of scenario-based learning and the role of the context in facilitating the comprehension of incomplete situational knowledge, we explored the AI's potential in supporting these needs in the design process. As uniquely observed, the integration of AI tools in early design stages through future scenario planning could expand problem definition by providing a more informed representation for back-thinking (Kim et al., 2020). This preliminary outcome aligns with the advantages found in future scenario planning or policy change. (Ahmad, 2020).

Observations suggest that while AI enhances creativity through design alternatives and problem framing, it also introduces challenges in decision-making (Agkathidis and Yang, 2024; Mangasaryan et al., 2024). In addition to these understandings, the outcome analyses exhibited learner difficulties in synthesising site specificity and translation of AI output into architectural solutions, considered challenging in design problem solving (Rittel and Webber, 1973). This contributes new and more articulated knowledge to the challenges faced by AI-assisted studio education. Balancing AI-driven activity with structured methodologies is essential to ensuring both creativity and usefulness in design education.

Using AI in urban contexts, where style references and scalability aid decision-making, may support design development better, compared to natural settings, often generating out-of-scale solutions. This challenge warrants further exploration.

The research has several limitations. The sample of students was limited and heterogeneous, comprising undergraduate and graduate students. Additionally, some students within the same group did not strictly adhere to their own protocols.

CONCLUSIONS

This study explored the Integration of AI, a cutting-edge new technology, in architectural education across two institutions to reveal its potential and challenges in studio pedagogy. While this paper explores two distinct studio approaches at different stages of AI usage, the sample set is limited, preventing the formulation

of larger conclusions. Nonetheless, several key issues have emerged.

First and foremost, using AI tools in early design stages through future scenario planning was found supportive in transitioning between back-thinking future and present site situations, contributing to problem framing. Furthermore, the design process is enhanced as future scenarios are not limited to the desired situation (Goel and Pirolli, 1992) but also include problems to be solved.

The extensive production of alternatives produced by AI tools requires instructional framing through task design and tool management, directing students throughout the design process stages and scaffolding desired outcomes.

When applied to urban contexts, AI proves supportive due to its larger scale and broader references. However, in natural environments, where references and scale are more constrained, AI-generated solutions can sometimes result in out-of-scale designs. This emerging challenge may affect landscape design and its education, calling for more research to bridge this gap.

Another significant issue is the evaluation and refinement stage. Often, the final product representation generated by AI does not accurately reflect the intended design conceptualised. AI tends to produce images that are more generic, lacking the originality that might be achieved through traditional, less information-based tools, possibly hindering creative thinking. This discrepancy emphasises the need for more research within the educational context to assess AI-assisted learning processes and advance design learning and teaching to an information-based and generative education.

As an actionable insight, this work concludes that while AI offers substantial potential for enhancing architectural pedagogy by expanding scenario-based thinking and diversifying early-stage ideation, its successful integration demands structured syllabus design following the design process, and context-aware applications in the case of architecture education. To extend its educational value, future work should focus on embedding AI within a broader pedagogical strategy—linking design back-thinking, evaluation, and representation—and exploring its role in developing collaboration and creative confidence in studio-based education across varied learning environments.

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