Shaping Tomorrow: The Impact of AI on Architectural History and Interior Design Education

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Abstract

Artificial Intelligence (AI) techniques have become popular in architecture and design, and several studies have focused on using these technological advancements to solve various architectural problems. AI is used in various architectural design applications, from intelligent material composition to layout solutions, and it is also vital in supporting the architecture and design education mechanism. A comprehensive understanding of literature is necessary to use these powerful tools in education adequately. This is due to the large volume of research being created and disseminated on this subject as well as the increasing application of AI techniques to address various education design-related questions. This article offers a comprehensive and critical assessment of the study of artificial intelligence applications in architecture and interior design education as a course application in the history of architecture and interior design. The study's conclusions indicate that AI's implications in architecture and design re-imagination are beneficial; however, it was concluded that AI- in its current phase- cannot replace human input and perspective. The students' feedback indicates that critical thinking skills cannot be replaced, and AI complements but doesn't replace their intellect.

Keywords: Architecture Education, Design Education, Artificial Intelligence in Education, Computational Design, AI in Education.

1. Introduction

Incorporating Artificial Intelligence (AI) in architectural education is a departure from conventional teaching approaches. The diverse role of AI includes sustainability analysis, project management, and design processes. Institutions of higher learning gradually incorporate AI ideas into their courses to prepare students for the changing AI-enhanced workforce (Ahmed, 2023).

AI application in the field of architecture and Interior Design

Generative Design and AI-Powered Creativity

By offering various design options, AI-powered generative design algorithms are transforming the architectural design process and inspiring students' creativity to push the boundaries of traditional design. The growing usage of these tools in architectural education allows students to

explore new solutions and improve their designs using data-driven AI insights (Peng & Ye, 2022a).

AI-Powered Sustainability Analysis

In modern architectural practices, sustainability has emerged as a fundamental component. The integration of Artificial Intelligence (AI) introduces powerful simulation tools that encourage the creation of environmentally friendly designs. As a result, architectural education is transforming, equipping students with the expertise to harness AI for comprehensive sustainability assessments. This preparation ensures that the architects and designers of tomorrow can proficiently design and construct buildings that harmonize with our environment (Jan Gehl, 2017).

Project Management and AI

The rise of AI technology is revolutionizing how architectural projects are managed, leading to more streamlined processes and improved productivity. Educational institutions now grant students access to cutting-edge AI applications, enabling them to interact with state-of-the-art design platforms and computational tools for intricate simulations. This training is essential for preparing them to handle the multifaceted nature of project coordination they will face in their future architectural endeavors (Jan Gehl, 2017).

Artificial Intelligence in Interior Design Education

AI's transformative role in interior design education is equally significant, promoting innovative teaching methods and enhancing the learning experience. It can have a substantial role in various interior design phases, including ideation and conceptual design, schematic design, and layout planning, which can save a lot of time and effort for both instructors and students (He et al., 2023).

Innovative Teaching Methods

AI technology can be applied to innovate teaching methods in interior design. This includes using virtual reality to simulate design spaces, allowing students to visualize and interact with their designs in a three-dimensional environment. Additionally, curriculum goals are being redefined to integrate AI into the educational system, preparing students who are familiar with AI, where it is an integral part of the design process (Raza et al., 2023).

Generative AI in Interior Design

Generative AI enables interior designers to rapidly create personalized designs that can adapt to individual preferences. Its implementation in education allows students to experience firsthand the efficiency of AI in generating design concepts, thereby improving productivity and fostering a culture of innovation (Raza et al., 2023).

AI and the Future of Creativity

AI interior design tools can process complex tasks rapidly, pushing the boundaries of creativity and design. The future of interior design education will likely focus on leveraging AI to explore

a broader range of design possibilities, encouraging students to think outside the box and develop unique, innovative design solutions.

Courses and Training

Emerging courses like 'AI for Designers underscore the opportunities presented by AI to enhance design capabilities. These courses indicate a broader trend toward incorporating into the educational curriculum, highlighting the growing importance of AI literacy in the design professions (Bölek et al., 2023; Hanafy, 2023).

Minding the gap between AI and reality- the literature review

Although AI is not a new topic, it has become a hot topic in the last two years and has been highly applied and investigated

Application of AI in Architecture Design and Planning

Initially, AI was used for site design and architectural planning. Over time, it has found its way into actual project planning, simplifying design processes and enhancing efficiency. AI can assist architects by generating design alternatives, optimizing layouts, and even predicting structural performance. Integrating AI with building information modeling (BIM) systems allows for more accurate simulations and better decision-making during the design phase. As AI continues to evolve, it will likely play an even more significant role in shaping the future of architectural design (Peng & Ye, 2022b)(Qian et al., 2023).

AI in Building Structure Design

AI's application in building structures has gained widespread recognition. It has transitioned from skepticism to dependence due to its convenience. Intelligent building materials, driven by AI, are becoming increasingly relevant. These materials enhance structural functions and challenge traditional design concepts. AI aids in material selection, structural analysis, and optimization, leading to more efficient and sustainable designs (Leach, 2021; Peng & Ye, 2022b).

AI application in architecture and design education

AI has been making significant strides in architecture and design education, transforming how instructors can teach and prepare the next generation of designers. Some research has already started discussing and investigating both positive and negative possible impacts of implementing AI in architecture education. An Eric J. Cesa article discusses the impact of generative AI on design education. It prompts educators to reconsider what to teach and how to teach in light of AI advancements (Mohamed et al., 2023)(Lin, 2021). The summary of the research conducted is shown in Table 1:

Table 1: Literature Review Summary

Title	Takeaway	Authors	Year
Emerging artificial intelligence methods in structural engineering (Salehi et al., 2018)	AI methods like machine learning, pattern recognition, and deep learning can efficiently solve complex structural engineering	H. Salehi, R. Burgueño	2018

	problems, save time, and increase computational efficiency.		
Learning automata based energy-efficient AI hardware design for IoT applications (Wheeldon et al., 2020)	Our new AI hardware architecture, based on learning automata, enables low-energy footprints and high learning accuracy for IoT applications, outperforming existing architectures.	A. Wheeldon, R. Shafik, Tousif, Rahman, Jie Lei.	2020
AI and Education: Grand Challenges (Kay, 2012)	AI in education has evolved from personalized teaching systems for solitary learners to considering other people and the learning context. However, challenges remain in addressing the various Grand Challenges.	J. Kay	2012
A Domain-Specific Software Architecture for Adaptive Intelligent Systems (Hayes-Roth et al., 1995)	The domain-specific software architecture (DSSA) for adaptive intelligent systems (AISs) facilitates application development, promotes functional requirements achievement, and supports system reconfiguration in the subdomain of mobile office robots.	B. Hayes-Roth, Karl Pfleger, P. Lalanda, P. Morignot,	1995
AI art in architecture (Ploennigs & Berger, 2023)	Diffusion-based AI art platforms like Midjourney, DALL-E 2, and StableDiffusion are practical tools for early stages of architectural design, offering powerful tools for visual creativity.	J. Ploennigs, Markus Berger	2022
Quo vadis AI in Architecture? Survey of the current possibilities of AI in the architectural practice (Laura Mrosla, 2019)	AI is increasingly advancing in architectural practice, advancing conception, fabrication, and even motivation and creativity while maintaining human features like motivation and creativity.	Laura Mrosla, P. Both	2019
AI-Design: Architectural Intelligent Design Approaches Based on AI (Likai Wei, 2019)	The AID Model, based on three AI schools, provides a comprehensive overview of AI methods applied to architectural design, analysis, and fabrication, aiding future development and reference for future design work.	Likai Wei	2019
Architectural design training based on artificial Intelligence (Nariman Nejati, 2021)	Artificial Intelligence can enhance architectural design training by exploring design requirements and providing solutions to meet those requirements.	Nariman Nejati, saeede kalantari,	2021
Artificial Intelligence as a pedagogical tool for architectural education: What does the empirical	AI programs in architecture education can effectively increase creativity in concept generation, but they face challenges when	M. Sadek	2023

evidence tell us? (Mohamed et al., 2023)	comparing their designs to traditional methods.		
The Application of "Artificial Intelligence +" in the Construction of Architectural Majors in Higher Vocational Colleges (Wei, 2020)	Integrating AI into architectural majors in higher vocational colleges can improve students' professional skills, change learning environments, promote education reform, and help them find employment in the construction industry.	A. Wei	2020
Application of AI technology in interior design (Lin, 2021)	AI technology can improve interior design by providing solutions for storage problems in bedrooms, kitchens, and children's items, bringing first-class experiences for users.	Zixuan Chen, Xiang Wang	2020
The Application of Digital Technology in Interior Design Education(Chuanrong et al., 2016)	Digital technology in interior design education enhances operability, convenience, and efficiency compared to traditional teaching methods, resulting in more realistic and humanized interactive virtual displays.	Chen Chuanrong, Tang Heng-liang	2016
The Application of Computer-Aided Technology in Interior Design (Lin, 2021)	Computer-aided design software effectively changes the traditional interior design mode and promotes education in the field.	Siqi Lin	2021
Teaching Interior Design in Augmented Reality (Dreimane et al., 2022)	Augmented Reality (AR) technology enhances interior design education by enabling new, engaging, diverse learning experiences while strengthening learner motivation and knowledge transfer to new contexts.	Lana Frančeska Dreimane, Zinta Zālīte-Supe	2022
AICRID: AI-Empowered CR For Interior Design (Yeo et al., 2023)	AICRID automates 3D model generation and facilitates interactions in interior design AR by enabling users to generate and interact with virtual furniture using their voices.	Jin Qi Yeo, Yidi Wang, Shawn Tanary.	2023
Computational Technology and Artificial Intelligence (AI) Revolutionizing Interior Design Graphics and Modelling (Samuel et al., 2022)	AI and computational technology revolutionize interior design graphics and modeling, enhancing efficiency, creativity, and client satisfaction in the design-build process.	A. Samuel, N. Mahanta, Antoine Casel Vitug	2022
Application Research of Interior Design Style Migration from the Perspective of Artificial Intelligence (Li et al., 2023)	AI-based style transfer algorithms can effectively translate design elements into personalized interior design proposals, enhancing user experience and advancing interior design efforts.	Yangyang Li, Li Sun	2023

Can AI Function As A New Mode of Sketching(Tong et al., 2023)	AI integration in first-year design education can enhance students' ability to combine orthographic projections and AI-generated images, potentially benefiting their future studies.	Hakan Tong, Ahmet Türel, Habibe Şenkal	2023

2. Case Study Overview

The primary objective of the assignment was to bridge the gap between traditional architectural eras and contemporary AI methodologies. Students were tasked with selecting a historical building and using keywords from different architectural periods to evaluate its design elements. By doing so, they aimed to understand how AI could impact architectural analysis and interpretation. In this study, students were allowed to use three AI tools: Mid-Journey, Prome-AI, and OpenArt. Moreover, an AI tool was used to extract valuable information from visuals, enabling the extraction of relevant keywords. The image-to-text analysis was used to examine the tool's understanding of the generated Image keywords and description compared to the opposite process used (text-to-image), as shown in Figure 1 below:

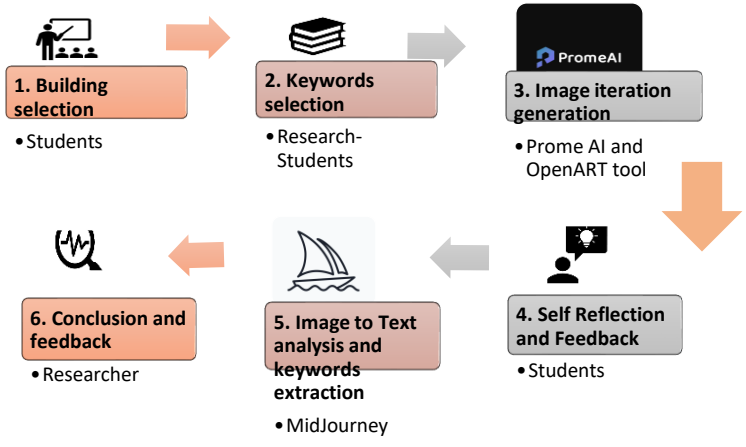

Figure 1: Case Study Method Overview

3. Methodology

Students who were assigned this talk studied several architectural civilizations, including the Rococo, Renaissance, Classical (Greek and Roman), and Egyptian eras.

a. Building Selection: Each student chose a historical building from the Baroque era.

The selected building served as the canvas for applying AI techniques.

b. Keyword Selection: A compiled list of relevant keywords associated with each period (e.g., "ornamentation," "symmetry," "vaults," "columns," etc.).

They applied the collected keywords to identify architectural features and patterns within the building.

The main keywords are summarized in Figure 2 below:

Figure 2: Keyword Selection word cloud

c. Image iteration generation: Students used AI algorithms (Prome AI and OpenART) to analyze images of their chosen building. Generated image examples with associate keywords are shown in Appendix 1.

d. d. Self-Reflection and Feedback: By comparing the AI-generated insights with their existing knowledge, students assessed the impact of AI on historical building analysis.

They explored whether AI could reveal hidden connections, highlight overlooked details, or provide novel perspectives, as shown in the feedback word analysis summary in Figure 3:

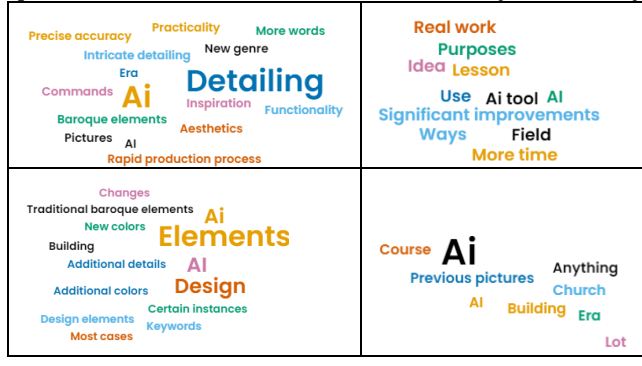

Figure 3: Students Feedback Word Cloud

The students' self-reflection was recorded at the end of the assignment (In written and oral format). A total of 87 students feedback was collected, transcribed and the conclusion is summarized below:

1. The AI tools are a quick way to generate design ideas

2. The AI tools sometimes applied unnecessary changes to the design, although the transcripts mention specific changes only

3. Students described the tools as "a baby" several times that needed to be told what to do and what not to do several times to perform the task properly.

4. The tools failed several times to anticipate changes to the given images and provided a completely new image instead.

5. The tools generated images with better lighting effects, shade and shadow, materials, and color renderings.

6. The tool sometimes provides inaccurate results (it was seen in columns, arches, architectural style, architectural elements, materials, and even colors). If the applicator/user is unaware of the topic, expectations, and the style explored, results can be misleading.

7. The AI tools cannot replace human inputs, design inputs, and intellectual skills.

8. AI facilitated cross-era comparisons: The students started to mix styles. However, they also began to become more creative using the blending tools where they explored mixing styles of buildings and imagined famous 21st-century architects' effects on the ancient structures

e. Image to Text analysis and keyword extraction

Mid-Journey AI tool is used to run Image Analysis. It allows for describing images through visual features. To better understand the abilities and drawbacks of the tool, the below categories of tool understanding were established based on the results from approximately 350 images generated and analyzed, as shown in Table 2:

- High= detected and described in 70% or more of the images
- Average= detected and described 50-69% of the images
- Low= detected and described in less than 49% of the images

Table 2: Image-to-text analysis and keyword extraction

Identifiable elements	Accuracy/frequency of identification	Example of the text description
The architecture style	High	Baroque, minimalism, classical architecture
Materials	High	Marble, wood, decorative plasterwork
Colors	High	The white, accent of gold, green walls
Proposed Architect/Painter Style	High	Leonardo davinci, Zaha Hadid, Snoheta
Interior elements/components	High	Altar, arched windows, symmetrical fireplace, carpet, chandelier
Building type	High	Church, basilica
Building Location	Medium	Rome, Vescovado, Italy
Building Name	Low	St Peter's Basilica, the hall in Versailles palace
Influences	Low/Missing	

In addition to the above, some observation findings were recorded, including:

- Used influences from other styles were not identified in any of the images: some of the unidentified keywords included effects from movie characters (ex. Dr. Strange), mixing of building types/style/names (ex. Pyramids Vs. la Sapienza)
- Some wrong information in the description of the images was detected, including the wrong building name, location, and architect/artist.
- Adding multiple keywords (more than 4 per iteration) sometimes led to a misleading image description of the image (ex. Church described as a mosque)

4. Case Study Conclusion

This case study demonstrates that AI can enrich architectural education by fostering interdisciplinary connections, revealing hidden patterns, and challenging conventional interpretations. As AI evolves, educators must address ethical concerns while harnessing its potential to transform architectural analysis and design. From the experience, some advantages of AI-generated images can be summarised as follows:

- Time-Saving Capabilities
- Cost-Effective Solution
- Unlimited Iterations

However, some disadvantages of AI-generated images are:

- Potential for Refinement (the generated images may require modifications and refinements)
- They do not always meet the expectations of the designer
- Without a human designer's expertise, making necessary changes to AI-generated photos can be challenging.

5. Final thoughts and future research

In conclusion, implementing AI in architecture and interior design education is pivotal for developing future professionals with the skills to navigate an AI-enhanced landscape. The literature suggests a positive trajectory, with AI catalyzing creativity, efficiency, and a deeper understanding of design iterations and modification. The experience showed that AI tools can help generate design iterations and modifications quickly and easily. However, the lack of understanding of the tools' abilities and drawbacks can lead to design solutions that lack the style and basic design understanding. Consequently, professionals must use AI tools to evaluate and judge the generated outcomes. It was also evident from the experience that AI tools cannot replace human intellect, creativity, and understanding. As AI continues to evolve, its role in

shaping the educational frameworks of these disciplines will undoubtedly expand, offering exciting prospects for the future of design education.

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