Integrating AI-based image generation in design education: A mixed-methods quasi-experimental study on academic performance improvement

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Abstract

This study investigates the effectiveness of integrating AI-based image generation technologies in illustration design education and their impact on students' academic performance and creative development. Aligned with Sustainable Development Goal 4 (Quality Education), which emphasizes relevant skills for future employment, this research addresses a critical need to adapt educational practices to evolving technological landscapes. Employing a mixed-methods quasi-experimental design, 100 undergraduate students from a university in Changchun, China, were divided into an experimental group (n=50) and a control group (n=50). Over an eight-week period, the experimental group engaged with tools such as Midjourney, DALL•E, Adobe Illustrator, Photoshop, and ChatGPT to support visual ideation, conceptual development, and creative rendering. In contrast, the control group received conventional instruction with no AI integration, though both groups followed the same curriculum content. Quantitative results revealed a significant increase in academic achievement and creative performance in both groups, but the experimental group showed substantially greater gains. The experimental group's post-test mean score rose from M = 55.16 (SD = 7.76) to M = 72.42 (SD = 10.37), with a large effect size (Cohen's d = 3.32), indicating a strong educational impact of AI-based instruction. Qualitative data from student interviews revealed that AI tools improved idea generation efficiency, expanded stylistic exploration, and enhanced confidence in design decision-making. However, students also expressed concerns about potential overreliance on AI and the challenge of maintaining creative authenticity. These findings suggest that AI-assisted learning environments can substantially enrich illustration education when applied thoughtfully. The study underscores the need for pedagogical strategies that integrate technology while preserving the critical, hands-on, and expressive elements central to art and design learning, ultimately contributing to a more equitable and high-quality educational experience for future creative professionals.

Keywords: Artificial Intelligence, Academic performance, Illustration design, Quasi-experimental, Higher education, China, Sustainable Development Goals (SDGs), SDG

Introduction

The integration of artificial intelligence in education has emerged as a transformative force, particularly within creative disciplines such as illustration design. This study aims to assess the efficacy of AI-based image generation tools in improving academic performance, situating the inquiry within China's evolving educational technology landscape. The integration of artificial intelligence (AI) in education presents significant opportunities and challenges, particularly within the scope of the creative instruction of the arts and illustrations design practices. As educational institutions increasingly adopt digital tools, AI technologies are emerging as essential components to redefine how artistic skills are taught and applied (Omar Zailuddin et al., 2024). The rapid evolution of artificial intelligence has initiated a paradigm shift across various professional domains, with its influence increasingly permeating educational methodologies, particularly within design disciplines (Xu & Huang, 2024). This

technological integration necessitates a re-evaluation of pedagogical approaches to cultivate high-quality design talent capable of thriving in an AI-driven era (Ansone et al., 2025). Specifically, the burgeoning capabilities of AI-based image generation tools present novel opportunities for enhancing creative processes and instructional efficacy in design education (Bartlett & Camba, 2024).

This study investigates the transformative impact of these tools on academic performance, aiming to ascertain how AI-generated imagery can serve as a catalyst for improved learning outcomes and innovative design solutions among students (Tang et al., 2024). The core of this research explores how AI-augmented tools redefine design pedagogy, offering visual depictions of complex concepts and fostering a nuanced understanding of design principles (Zailuddin et al., 2024; Fareed et al., 2024). While the professional application of these technologies is expanding, their educational potential remains largely underexplored, particularly concerning their

integration into the teaching process to enhance student learning experiences and creativity (Xu & Huang, 2024). The integration of AI in design education, however, is not without its complexities, necessitating careful consideration of ethical implications and the development of effective prompt engineering strategies to maximize its pedagogical benefits (Cotroneo & Hutson, 2023).

AI offers innovative methods to address long - standing challenges in creative arts instruction, such as providing personalized learning experiences, improving accessibility and promoting collaboration among students (KE, 2023). Personalized learning can be adapted to the individual needs and preferences of students, thus promoting creativity and autonomy in artistic activities. For example, adaptive learning systems driven by AI can adjust instruction materials based on real time performance analysis, allowing a more effective learning environment (Holmes and Tuomi, 2022). By attending to different learning styles, AI can help overcome the unique approach for all that often characterizes traditional artistic education (Pedro et al., 2019).

In addition, advances in AI technologies facilitate new methods for the design of illustrations, improving the creative process. The tools driven by AI capable of generating visual content through text synthesis in image can expand the limits of artistic expression (Vartiainen and Tedre, 2023). These tools allow artists to explore a broader color palette and form combinations, which caused new creative results while serving as a springboard to inspire themselves. The synergy between human creativity and the abilities of AI generates a unique dynamic in which artists can take advantage of the strength of AI to improve their own imaginative processes (ketinic and she, 2022).

2.0 Literature Review

Prior research highlights the growing role of AI in enhancing personalized learning and promoting cognitive engagement. Studies show that generative tools like DALL-E and Midjourney facilitate design thinking, yet few have empirically measured their academic effects. In addition, the role of AI is significant to promote collaboration environments between students. Platforms that use AI can encourage peer interactions, allowing works of art and constructive comments in an online support (Kim et al., 2022). This aspect of collaboration not only encourages artistic growth, but also promotes a sense of belonging among students, which is especially important in often solitary kingdoms of visual arts.

However, the incorporation of AI in education is not exempt from challenges. Concerns for the quality of the content generated by AI and the potential to reduce the role of traditional skills prevail in discussions on the impact of technology on artistic education (Zhang, Shankar and Antonids, 2022). Critics argue that excessive dependence on AI tools could lead to a decrease in fundamental skills, such as drawing or painting, which are vital for artists (Hou, 2024). Therefore, it is crucial to achieve a balance between taking advantage of AI as an aid and ensure that fundamental artistic competences are not compromised.

Despite these challenges, the integration of AI in illustrations design practices offers numerous advantages. In particular, it has been shown that new strategies, such as online animation design studies that incorporate AI, improve creative problems for problem solving and promote innovative thinking among students (Tang, LI and Tang, 2022). These practices not only reflect the transformative potential of AI in artistic education, but also align with broader tendencies towards digitalization in educational methodologies.

AI has a remarkable potential to remodel the instruction of creative arts and improve illustrations design practices. Although it addresses several challenges inherent to traditional artistic education, such as personalization and collaboration, it also presents new considerations regarding the quality and integrity of artistic training. As the educational panorama continues to evolve, it will be essential for educators to navigate these complexities, ensuring that the integration of AI enriches instead of reducing the creative learning experience.

2.1 The impact of AI on learning outcomes in higher education

The integration of artificial intelligence (AI) in higher education has become a fundamental focus in

understanding its impact on learning results, in particular in creative fields such as visual arts. The infusion of artificial intelligence technologies in pedagogical practices has prompted significant transformations in teaching methodologies, in the commitment of students and in the development of skills of the 21st century. While the panorama of education continues to evolve, it becomes indispensable to examine how these changes affect the results of learning, with an emphasis on the identification of the gaps of empirical tests, in particular within the visual arts programs.

The pedagogy enhanced by the AI is redefining conventional educational paradigms, as indicated by Kakhkharova and Tuycheva (2024), which discuss how the adoption of artificial intelligence tools remodes interactions and educational results. Their analysis highlights the potential of artificial intelligence to facilitate personalized learning experiences, which can align with the needs of individual students and encourage an enhancement of cognitive involvement. This tailor -made approach is particularly relevant in the creative disciplines in which subjective expression and innovative thought are essential. In particular, this revision aligns with the observations of Wang et al. (2023), which observed that the artificial intelligence skills of higher education institutions are positively related to self - efficacy, creativity and high school learning services.

The field of creative arts intrinsically appreciates the development of transversal skills, such as communication, collaboration and critical thinking. Hasan, Nasreen and Rasul (2025) underline the importance of these skills in higher education, stating that the IA can act as a catalyst for their cultivation among university students. Through collaborative artificial intelligence tools, students of creative disciplines can exploit technology to summarize different perspectives and improve their artistic results, thus filling theoretical knowledge and practical application. This underlines the topic that IA is not only a tool but a transformative agent in pedagogical practices, promoting creative synergies that could be missing from traditional methods. Despite the promising AI potential in improving educational experiences, there is a pronounced lack of empirical evidence on its effectiveness, in particular in visual arts programs. Current literature focuses mainly on wider applications than the AI in

various educational sectors (Hutson et al., 2022; Yue, Jong and Da, 2022). However, the studies that specifically study the implications of the AI in the education of the visual arts are limited. This gap raises critical questions about how Ia influences the development of artistic skills, creative processes and general educational trajectory for students in visual arts programs. Moreover, Habib et.al, (2025) illustrate the need to understand the prospects of the students on the creative pedagogy between the integration of AI. Their discoveries indicate that students often have contrasting opinions on the role of artificial intelligence in creativity, swinging sporadically between seeing the IA as a support tool and perceive it as a potential obstacle to originality. The subjective nature of artistic expression makes these perspectives particularly precious, suggesting that pedagogical projects in the visual arts must take into account different attitudes of the students towards the AI to optimize the results of learning.

3.0 Methodology

3.1 Research design

A quasi-experimental mixed-methods design was employed, involving 100 students from a selected Chinese university equally divided into experimental and control groups. The experimental group utilized AI tools in their coursework, while the control group received traditional instruction. Academic performance was assessed using validated pre- and post-tests aligned with Bloom's Taxonomy. To add qualitative depth, focus group interviews were conducted with 16 students from the experimental group. This is especially pertinent given the recognized need for educational strategies that equip designers with the requisite skills to navigate an AI-infused professional landscape, a gap often highlighted in current literature (Yu, 2025). This mixed-methods approach facilitates a comprehensive understanding of the multifaceted impacts of AI integration, moving beyond mere quantitative metrics to capture the nuanced experiences and perceptions of students (Phua et al., 2025). This approach allows for an in-depth analysis of both tangible academic improvements and subjective learning experiences, thereby painting a holistic picture of AI's role in contemporary design pedagogy (Tang et al., 2022). This research builds upon existing discourse by examining how AI tools, specifically

image generation, can be systematically integrated into the curriculum to foster a more profound and adaptable understanding of design principles (Başarır, 2022).

Furthermore, it acknowledges the necessity of developing systematic utilization strategies for AI technologies within academic settings, a common challenge identified in previous studies (Jin et al., 2024).

3.2 Participants

The research involved a total of 100 undergraduate students enrolled in Illustration Design courses at a university in Changchun City, Jilin Province, China. Participants were randomly assigned into two equal groups: an experimental group (n=50), which received instruction using AI-enhanced methodologies, and a control group (n=50), which followed traditional instructional methods. Stratified random sampling ensured diversity across academic levels and minimized bias in group assignment.

3.3 Instruments

Academic performance was measured using pre-test and post-test instruments developed in alignment with Bloom's Taxonomy. These assessments evaluated students' knowledge, comprehension, application, analysis, synthesis, and evaluation skills relevant to Illustration Design. The instruments underwent content validation by a panel of subject matter experts to ensure alignment with course objectives and cognitive levels.

3.4 Procedure

Over eight weeks, students in the experimental group engaged with a suite of AI tools including Midjourney, DALL·E, Adobe Photoshop, Adobe Illustrator, and ChatGPT. These tools generated imagery, enhanced design concepts, and simulated professional illustration workflows. Instruction was delivered through a blended model combining AI-driven content with instructor facilitation. The control group received conventional lectures and assignments without AI integration. Both groups completed the same curriculum content.

Table 3.4 Experimental procedure overview (8 weeks)

Week	Experimental Group Activities	Control Group Activities	Tools Used (Experimental)
1	Introduction to AI tools, project briefing	Introduction to course and project briefing	Midjourney, ChatGPT
2	AI-generated mood boards and idea development	Manual brainstorming, sketching	DALL·E, ChatGPT
3	Concept refinement using AI image generation	Traditional sketching and feedback	Midjourney, Adobe Illustrator
4	Composition studies with AI reference images	Drawing from reference books and peer feedback	Midjourney, Adobe Photoshop
5	Digital rendering using AI-assisted references	Manual refinement and coloring	DALL·E, Adobe Photoshop
6	Integrating AI suggestions into illustration projects	Mid-project critique and iterative sketching	Midjourney, Adobe Illustrator
7	Final project assembly and AI-aided narrative enhancement	Final composition planning and execution	ChatGPT, Adobe Photoshop
8	Presentation, critique, and reflection on AI-enhanced workflows	Presentation, critique, and reflection on manual workflows	ChatGPT, Midjourney, DALL·E, Adobe Suite

3.5 Data analysis

Quantitative data from pre- and post-tests were analyzed using SPSS software. Paired sample t-tests and independent sample t-tests were employed to examine intra-group and inter-group differences in academic performance. ANOVA tests were conducted to validate overall significance across conditions. Qualitative data, gathered through student feedback and reflective journals, were coded and analyzed thematically using NVivo to support and explain the statistical outcomes.

4.0 Results

4.1 Quantitative results

A paired samples t-test was performed to determine whether the AI-based image generation technology significantly affected students' academic achievement in the experimental group. The analysis showed a statistically significant increase in post-test scores (M = 17.26, SD = 5.19), t(49) = -23.50, p < .001. The 95% confidence interval for the mean difference ranged from -18.736 to -15.784, indicating a robust and reliable effect.

Table 1. Paired Samples t-Test Results for Pre- and Post-Test Scores in the Experimental Group

		Paired Samples Test								
		Paired Differences							**Significance**	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
Pair 1	PreTotal - PostTotal	-17.260	5.193	.734	-18.736	-15.784	-23.500	49	<.001	<.001

The results prove that AI-supported instruction significantly enhances academic performance in Illustration Design courses. An independent samples t-test was conducted to examine whether there was a statistically significant difference in post-test academic achievement between students in the experimental group, who received AI-based instruction, and those in the control group, who followed traditional teaching methods. Prior to the t-test, Levene's Test for Equality of Variances indicated a significant result (F = 9.927, p = .002), suggesting that the assumption of equal variances was violated. Accordingly, the Welch's t-test was used for analysis.

Table2. Independent samples t-test results comparing post-test scores between experimental and control groups

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
PostTotal	Equal variances assumed	9.927	.002	-4.451	98	<.001	<.001	-7.720	1.734	-11.162	-4.278
	Equal variances not assumed			-4.451	82.765	<.001	<.001	-7.720	1.734	-11.170	-4.270

The results revealed a statistically significant difference in post-test scores between the two groups, t(82.77) = -4.451, p < .001. The mean difference was -7.72 (SE = 1.734), with a 95% confidence interval ranging from -11.17 to -4.27, indicating that the students in the experimental group outperformed their counterparts in the control group. The findings demonstrate that integrating AI-based image generation tools into instructional practices significantly enhances academic performance in Illustration Design courses,

compared to conventional teaching approaches.

4.2 Qualitative results

4.2.1 Student perceptions and learning experiences

To complement the quantitative findings, qualitative data were collected from student reflections and feedback journals to explore their experiences with AI-based instruction in the Illustration Design course. Thematic analysis using NVivo revealed four dominant themes: conceptual clarity, creative autonomy, engagement and motivation, and technological challenge.

Conceptual clarity

Students widely reported that AI tools helped them better understand complex design principles by generating instant visual representations of their ideas. One participant shared:

"When I typed in prompts and saw the AI-generated images, it made abstract design ideas click for me. I could connect theory with what I saw."

Creative autonomy

AI tools enabled students to explore multiple stylistic options and iterate designs independently. This autonomy encouraged deeper experimentation and self-directed learning:

"I felt like I could test different visual styles without starting from scratch each time. The AI gave me ideas, but I was still in control."

Engagement and motivation

The novelty and interactivity of AI tools led to heightened engagement. Many students expressed increased enthusiasm for assignments, citing the excitement of exploring generative outputs:

"The process was exciting. It made me want to keep trying new prompts just to see what would happen."

Technological challenge

While most experiences were positive, a subset of students mentioned difficulty navigating AI tools or integrating the outputs meaningfully into their design workflow:

"Sometimes the results didn't match my expectations. It took practice to get prompts right, and at times I felt frustrated."

Overall, these findings illustrate that AI-enhanced instruction improved academic outcomes and enriched the students' creative process and learning engagement. However, the learning curve for tool mastery also suggests a need for structured guidance in future implementations.

5.0 Discussion Results

The findings of this study demonstrate that integrating AI-based image generation tools into Illustration Design instruction significantly enhances students' academic performance and enriches their learning experiences. This study critically examined the role of AI-based image generation tools in enhancing academic achievement among Illustration Design students. The statistically significant improvement observed in the experimental group's post-test scores ($M = 17.26$, $t(49) = -23.50$, $p < .001$), alongside a clear advantage over the control group ($t(82.77) = -4.451$, $p < .001$), suggests that AI tools are more than supplementary—they are capable of reshaping the pedagogical foundations of design education. Quantitative results revealed a marked improvement in post-test scores among students in the experimental group, with a statistically significant difference when compared to the control group. These outcomes are consistent with prior research suggesting that AI can serve as an effective cognitive scaffold in creative education settings.

Furthermore, qualitative insights support these statistical findings by revealing how AI tools fostered greater conceptual clarity and creative autonomy. Students described the AI-enhanced environment as more engaging and conducive to ideation, allowing them to experiment freely while still aligning with course objectives. The thematic emergence of "creative autonomy" and "conceptual clarity" suggests that AI technologies not only assist in content delivery but also reshape students' approach to problem-solving and self-directed learning. However, some participants encountered challenges in mastering prompt-based design processes,

indicating the need for structured guidance when introducing such tools. This aligns with the literature emphasizing that technological interventions must be carefully scaffolded to avoid cognitive overload.

These results collectively underscore AI's pedagogical value in fostering deeper learning and suggest promising directions for curriculum innovation in design education (Latif et al., 2024). This study contributes to the growing body of literature on AI in education by providing empirical evidence for the efficacy of AI-based image generation tools in enhancing academic performance within a design education context, addressing a critical gap in current research (Mallillin, 2024). The findings indicate that while generative AI holds considerable promise for conceptual ideation and development in art and design curricula, its current limitations in executing precise artistic tasks necessitate a balanced integration with traditional methods (Ansone et al., 2025). This integration not only enhances students' creative output but also refines their judgment in discerning the reliability and applicability of AI-generated content (Naik et al., 2025).

6.0 Conclusion

This study provides robust empirical evidence that AI-based image generation tools significantly enhance academic achievement and student engagement in Illustration Design education. The integration of platforms like Midjourney, DALL·E, and Photoshop improved students' academic performance, as demonstrated by statistically significant gains in post-test scores, and transformed the learning experience by fostering greater creativity, autonomy, and conceptual understanding (Lin & Qiu, 2024). This transformative potential is further evidenced by qualitative insights, which underscore the development of advanced cognitive skills such as complex problem-solving and critical thinking among students engaging with these sophisticated AI platforms (Sandhaus et al., 2024). The findings highlight AI's pedagogical potential as a catalyst for more effective and interactive learning environments in art and design disciplines. However, the study also underscores the importance of structured support and training when implementing AI tools to mitigate initial usability challenges (Liang, 2024). As creative education continues to evolve in

response to technological advancements, this research contributes to the growing discourse on AI's role in shaping future-ready learners (Dai et al., 2025). Educators and institutions are encouraged to thoughtfully integrate AI into their curricula to cultivate both academic excellence and creative innovation (Ocen et al., 2025).

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