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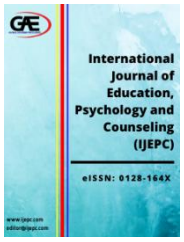

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FOSTERING CREATIVITY IN COMPUTER GRAPHICS EDUCATION THROUGH AN AI-SUPPORTED TEACHING MODULE

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Abstract:

Creativity is a critical competency in Computer Graphics (CG) education. However, university instruction remains largely technique-oriented and insufficiently supportive of creative thinking. This study develops and evaluates an Artificial Intelligence (AI)-supported teaching module designed to enhance creativity among undergraduate CG students. Grounded in contemporary creativity theory and constructivist instructional design, the module integrates AI as a cognitive scaffold across four stages of the creative process: ideation, exploration, refinement, and reflection. A Design-Based Research (DBR) approach was employed, involving iterative development and implementation in an undergraduate CG course. A mixed-methods design was adopted, with quantitative data collected using a validated self-report creativity scale (pre–post design, n = 96) and qualitative data obtained from student reflections, project artifacts, and instructor observations. Quantitative data were analyzed using paired-samples t-tests, and qualitative data were analyzed using thematic analysis. The findings indicate a statistically significant improvement in students' creative thinking and originality following the intervention ($p < .05$). Qualitative results further reveal enhanced ideation fluency, increased willingness to experiment, and deeper reflective engagement. The study demonstrates that AI, when positioned as a supportive cognitive partner rather than a substitute for human creativity, can effectively foster creative learning. This research contributes a process-oriented AI-supported pedagogical model and provides empirical evidence for integrating AI into creative education.

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Artificial Intelligence; Computer Graphics; Creativity Development; Digital Media Education

Introduction

Creativity has become a core competency for graduates in digital media–related disciplines, particularly in Computer Graphics (CG), where professionals are expected to integrate technical expertise with innovative visual thinking and conceptual problem-solving (Mishra et al., 2024; Habib et al., 2024). Creativity is widely defined as the ability to produce work that is both novel and appropriate (Runco & Jaeger, 2012), and is influenced by domain knowledge, motivation, and social context (Amabile, 1996; Boden, 2004).

Despite these expectations, CG education in many universities remains predominantly technique-oriented, focusing heavily on software mastery, procedural accuracy, and standardized production workflows (Liang et al., 2026; Zhang & Li, 2023). Such approaches often limit opportunities for divergent thinking, conceptual exploration, and reflective learning, which are essential for the development of creativity (Beghetto & Kaufman, 2014). Consequently, students may demonstrate technical competence while lacking confidence in ideation, originality, and independent creative judgment (Mishra et al., 2024).

In parallel, recent advances in AI, particularly generative and intelligent support technologies, have introduced new possibilities for creative education (Zawacki-Richter et al., 2023; Castillo-Martínez et al., 2024; Ratul et al., 2025). AI tools can assist learners in generating visual ideas, exploring design alternatives, and receiving formative feedback throughout the creative process (Su & Mokmin, 2024; Liang et al., 2026). When embedded within sound pedagogical structures, AI has the potential to function as a cognitive scaffold that enhances creative thinking rather than replacing human creativity (Harry & Sayudin, 2023). Nevertheless, without intentional instructional design, AI integration risks encouraging surface-level production or overreliance on automated outputs (Chen et al., 2020).

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In response to these challenges, this study develops and evaluates an AI-supported teaching module to foster creativity in undergraduate CG education. Rather than treating AI as a standalone technological tool, the module embeds AI within a structured pedagogical framework aligned with stages of the creative process (Mishra et al., 2024). Using a Design-Based Research (DBR) methodology, this study examines how AI-supported instruction influences students' creative thinking, engagement, and learning experiences, thereby contributing to research on AI-enhanced creative pedagogy in digital media education (Anderson & Shattuck, 2022).

Literature Review

Creativity in Computer Graphics and Digital Media Education

Creativity in CG and digital media education is commonly conceptualized as the capacity to generate original visual ideas, engage in iterative experimentation, and transform abstract concepts into meaningful digital artifacts (Beghetto & Kaufman, 2014; Mishra et al., 2024). Note that research in art and design education emphasizes that creativity is not an innate trait. Rather, it is a developable capability shaped by instructional context, learning tasks, and feedback mechanisms (OECD, 2023).

Other than that, empirical studies indicated that CG instruction frequently prioritizes technical skill acquisition over creative cognition, often resulting in teacher-centered demonstrations and outcome-driven assessment practices (Zhang & Li, 2023). Such environments may constrain students' willingness to take creative risks and limit opportunities for divergent thinking (Habib et al., 2024). Scholars therefore advocate pedagogical approaches that integrate open-ended projects, reflective practice, and formative feedback to foster creativity in CG education (Beghetto, 2023).

Artificial Intelligence in Creative and Art Education

The rapid development of AI has significantly reshaped educational research and practice, particularly in higher education contexts that emphasize complex cognitive and creative skills (Zawacki-Richter et al., 2023). AI technologies in education commonly include intelligent tutoring systems, adaptive learning platforms, learning analytics, and, more recently, generative AI tools capable of producing text, images, and design variations. In creative and art education, these technologies are increasingly explored not merely as productivity tools but as cognitive and creative supports that can extend learners' ideational capacities (Su & Mokmin, 2024).

Correspondingly, recent studies suggested that AI can play a valuable role in creative learning by lowering technical barriers and enabling rapid exploration of ideas (Harry & Sayudin, 2023). In visual art, design, and digital media education, generative AI systems have been shown to support brainstorming, visual prototyping, and stylistic experimentation by offering diverse prompts and variations that stimulate divergent thinking (Liang et al., 2026). Such affordances are particularly relevant to CG education, where students often struggle to move beyond initial ideas or habitual visual solutions.

Empirical evidence further indicated that AI-supported creative environments may enhance student engagement, motivation, and creative confidence when learners retain authorship and

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decision-making control (Mishra et al., 2024). By providing immediate feedback and alternative perspectives, AI tools can encourage iterative experimentation and reflective evaluation, both of which are central to creative development. Nonetheless, scholars also cautioned that uncritical or tool-driven adoption of AI may lead to superficial creativity, overreliance on automated outputs, or diminished reflective depth if pedagogical goals are not clearly articulated (Chen et al., 2020).

From a pedagogical perspective, AI in education can be understood as an intelligent support system that augments human learning processes rather than replacing them (Luckin et al., 2016). This perspective aligned with the view that AI should function as a cognitive scaffold within creative learning environments. Subsequently, research highlighted that AI should be framed as a creative partner or cognitive scaffold, supporting learners' exploration while preserving human agency and critical judgment (Harry & Sayudin, 2023; Su & Mokmin, 2024). These findings underscore the importance of structured teaching models that integrate AI use with creativity-oriented learning objectives, particularly in skill-intensive domains such as computer graphics.

Theoretical Foundations for AI-Supported Creative Teaching

The design of the AI-supported teaching module in this study is grounded in contemporary theories of creativity and learning that conceptualize creativity as a dynamic, developable process rather than a fixed individual trait (Beghetto & Kaufman, 2014). From a socio-cognitive perspective, creativity emerges through interactions among individual cognition, domain-specific knowledge, motivation, tools, and the surrounding learning environment (Mishra et al., 2024). This view determined the critical role of instructional design in shaping conditions that enable or constrain creative performance.

Creativity theories emphasize several core processes relevant to CG education, including divergent thinking, iterative experimentation, evaluative judgment, and reflective practice (Beghetto, 2023). Instructional environments that support these processes typically incorporate open-ended tasks, formative feedback, and opportunities for reflection, allowing learners to test ideas, learn from failure, and refine creative outcomes over time (OECD, 2023). In this context, technological tools function as mediating artifacts that can either enhance or inhibit creative cognition depending on how they are used.

Instructional design frameworks aligned with constructivist and learner-centered principles further informed AI-supported creative teaching. Such frameworks advocate aligning learning objectives, activities, and assessment with the stages of the creative process, emphasizing active knowledge construction and metacognitive awareness (Creswell & Poth, 2023). When AI tools are integrated into these frameworks, they can provide timely prompts, feedback, and representational support that scaffold creative thinking without dictating outcomes (Harry & Sayudin, 2023).

Importantly, recent scholarship stressed the ethical and pedagogical implications of AI integration in creative education. Maintaining learner agency, transparency of AI processes, and critical reflection on AI-generated outputs are essential to responsible AI-supported pedagogy (Chen et al., 2020). These theoretical considerations inform the present study's

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approach to AI integration, positioning AI as a supportive pedagogical resource embedded within a structured creative teaching module rather than as an autonomous creative authority. Note that this study draws on contemporary creativity theory, which views creativity as a dynamic interaction among cognitive processes, domain knowledge, motivation, and sociocultural context (Beghetto, 2023; Mishra et al., 2024). Instructional design models aligned with constructivist and learner-centered principles emphasize scaffolding, reflection, and iterative learning in the development of creativity.

By integrating AI tools into a structured pedagogical framework, educators can scaffold creative processes while preserving learner agency (Harry & Sayudin, 2023). This theoretical perspective informed the design of the AI-supported teaching module examined in this study.

Methodology

Research Design

A DBR methodology was employed to guide the development, implementation, and evaluation of the AI-supported teaching module (Anderson & Shattuck, 2022). DBR is well-suited to educational innovation research because it allows for the iterative refinement of interventions in authentic learning environments while generating theory-informed insights.

Participants and Research Context

Participants were 96 second-year undergraduate students enrolled in a CG course at a university in China. Among them, 40 were male, and 56 were female. All participants had prior experience with CG software. However, they had limited exposure to creativity-oriented learning tasks. Participation was voluntary, and informed consent was obtained from all students prior to data collection.

Instrument

Creativity was measured using a validated self-report creativity scale adapted for higher education contexts (Liang et al., 2026). The scale assessed three dimensions: creative thinking, originality, and creative engagement. Correspondingly, responses were recorded on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The reliability of the instrument was examined using Cronbach's alpha, indicating acceptable internal consistency. The scale was administered twice: before the intervention (pre-test) and after the teaching module (post-test).

Design of the AI-Supported Teaching Module

The AI-supported teaching module was structured around four stages of the creative process—ideation, exploration, refinement, and reflection—consistent with creativity-focused instructional design frameworks (Beghetto & Kaufman, 2014). AI tools were integrated to support each stage, functioning as cognitive scaffolds rather than autonomous creators (Harry & Sayudin, 2023). The AI-supported teaching module was designed to align with the creative

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process in CG production and was implemented over several instructional weeks. The module consisted of four interconnected phases:

Ideation Phase: Students engaged with AI tools capable of generating visual prompts and conceptual variations based on textual descriptions or thematic inputs. These tools were utilized to stimulate divergent thinking and expand the range of initial ideas.

Exploration Phase: AI-supported visual experimentation enabled students to explore different forms, compositions, and styles rapidly. This phase emphasized iterative trial-and-error learning and encouraged students to compare and evaluate multiple design alternatives.

Refinement Phase: Intelligent feedback mechanisms and analytical prompts helped students refine their chosen concepts. Rather than providing prescriptive solutions, AI tools offered suggestions and questions that prompted critical reflection and iterative improvement.

Reflection Phase: Students documented their creative decisions, challenges, and learned experiences in reflective journals. AI-assisted prompts were employed to support metacognitive reflection and articulation of creative intent.

Throughout the module, instructors played a central role in guiding AI use, facilitating discussions, and emphasizing the importance of human judgment and creativity.

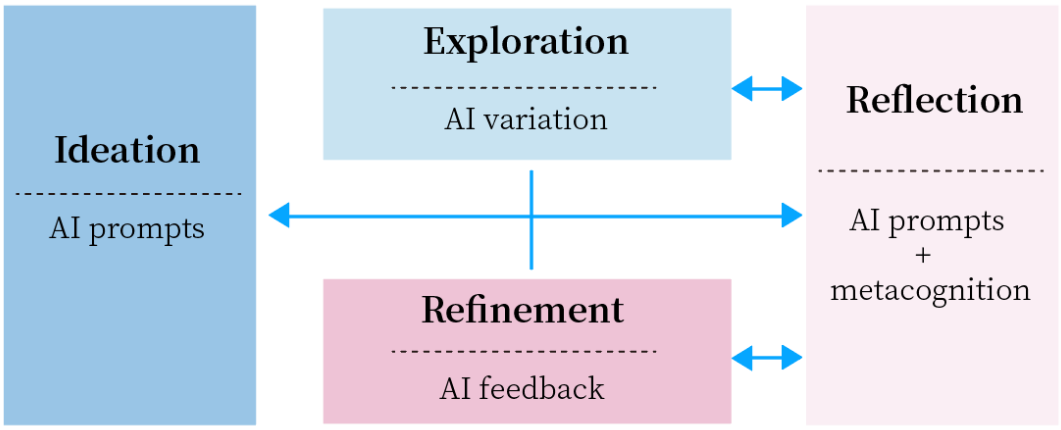

Figure 1: Process-Oriented AI-Supported Creative Teaching Model in CG Education

The proposed AI-supported teaching model is structured around four stages of the creative process: ideation, exploration, refinement, and reflection. AI is embedded across all stages as a cognitive scaffold, supporting students' creative thinking while preserving human agency. Instructor guidance and reflective practice are integrated throughout the process, forming a cyclical and iterative learning model.

Data Collection and Analysis

A mixed-method approach was adopted for this study. Consequently, quantitative data were collected using a validated self-report creativity scale commonly employed in higher education

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research (Liang et al., 2026). It included reflective journals, project artifacts, and instructor observations, which were analyzed using paired-sample statistical tests. In contrast, qualitative data were subjected to thematic analysis following established qualitative research procedures (Creswell & Poth, 2023).

Quantitative data were analyzed using descriptive statistics and paired-sample t-tests to examine changes in creativity scores, and through thematic analysis, involving open coding, category development, and theme identification. This triangulation of data sources enhanced the credibility and depth of the findings.

Quantitative Data Collection and Analysis

Quantitative data were collected using a validated self-report creativity scale, widely used in higher education research, to assess students' creative thinking, originality, and engagement (Liang et al., 2026). The scale was administered to participants at two points: prior to the implementation of the AI-supported teaching module (pre-test) and immediately after the completion of the module (post-test). This pre–post design enabled the examination of changes in students perceived creativity attributable to the instructional intervention.

Descriptive statistics, including means and standard deviations, were calculated to summarize overall trends in creativity scores. Paired-sample t-tests were then conducted to determine whether observed differences between pre-test and post-test scores were statistically significant. This analytical approach is appropriate for within-group comparisons in educational intervention studies and has been commonly employed in creativity and instructional research (Liang et al., 2026). Correspondingly, statistical significance was evaluated at the conventional alpha level of 0.05.

Qualitative Data Collection and Analysis

Qualitative data were collected from multiple sources to capture students' creative processes, perceptions of AI support, and reflective learning experiences. These data sources included students' reflective journals, final and intermediate project artifacts, and systematic instructor observation notes recorded throughout the instructional intervention. Reflective journals documented students' ideation strategies, decision-making processes, and perceived challenges and gains during the creative tasks. At the same time, project artifacts provided concrete evidence of the creative outcomes.

Qualitative data analysis followed established thematic analysis procedures (Creswell & Poth, 2023). The process involved several stages. First, all qualitative materials were read repeatedly to achieve data familiarization. Second, open coding was conducted to identify meaningful units related to creativity development, AI-supported learning, and student engagement. Third, related codes were grouped into broader categories, which were then refined into higher-level themes that captured recurring patterns across data sources. Throughout the analysis, constant comparison was employed to ensure consistency and to refine emerging interpretations.

Data Triangulation and Trustworthiness

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Triangulation across quantitative and qualitative data sources was employed to enhance the credibility and trustworthiness of the findings. Note that quantitative results demonstrate changes in students' self-reported creativity, while qualitative findings offered contextualized explanations for how and why these changes occurred within the AI-supported learning environment. By integrating multiple data sources, the study achieved a more nuanced and robust understanding of the pedagogical impact of the AI-supported teaching module, consistent with best practices in mixed-methods educational research (Creswell & Poth, 2023).

Results

Quantitative analysis revealed statistically significant improvements in students' self-reported creative thinking and originality following participation in the AI-supported teaching module. The results of the paired-sample t-test indicated a significant increase in students' creativity scores following the implementation of the AI-supported teaching module. The mean creativity score increased from M = 3.18 (SD = 0.46) in the pre-test to M = 3.85 (SD = 0.50) in the post-test. A paired-sample t-test confirmed that this difference was statistically significant, $t(95) = 9.27$, $p < .001$. The effect size was calculated as Cohen's $d = 0.76$, indicating a moderate to strong effect. These findings suggest that the AI-supported teaching module had a statistically significant and practically meaningful impact on students' perceived creativity.

Table 1 : Pre-test and Post-test Comparison of Students' Creativity Scores (n = 96)

Measure	Pre-test (M ± SD)	Post-test (M ± SD)	t(df)	p-value	Cohen's d
Creativity	3.18 ± 0.46	3.85 ± 0.50	9.27 (95)	< .001	0.76

Note. M = Mean; SD = Standard Deviation. Statistical significance was set at $p < .05$.

The qualitative analysis revealed three major themes that explain the observed quantitative improvements. First, AI-supported ideation enhanced divergent thinking. Students reported that AI-generated prompts helped them overcome initial creative blocks and expand their range of ideas. One participant noted that "the AI suggestions pushed me to think beyond my usual design habits and explore more possibilities." Second, iterative experimentation was significantly increased. The ability to rapidly generate and compare multiple visual alternatives encouraged students to experiment more freely and reduced their fear of making mistakes. Several students reported feeling more confident when trying unconventional ideas because they could quickly visualize different outcomes. Third, reflective engagement was strengthened. Students demonstrated increased awareness of their creative processes and decision-making. Reflective journals indicated that AI-assisted prompts supported deeper metacognitive thinking. As one student reflected, "I became more conscious of why I chose certain ideas and how I improved them step by step." These qualitative findings provide rich contextual support for the statistically significant improvements observed in students' creativity scores.

Discussion

The findings demonstrate that an AI-supported teaching module can effectively foster creativity in CG education when grounded in sound pedagogical principles. Consistent with creativity

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theory, the results highlight the importance of supportive learning environments that integrate tools, guidance, and reflection. AI served as a cognitive scaffold, enhancing ideation and experimentation while preserving students' ownership of creative decisions.

From an instructional perspective, the structured integration of AI across different stages of the creative process was critical to the module's effectiveness. This approach contrasts with unstructured or tool-centric uses of AI and underscores educators' role in mediating technology use. The study contributes to ongoing debates about the role of AI in creative education by providing empirical evidence of its pedagogical value when thoughtfully designed.

Implications for Practice

This study offers several practical implications for CG and digital media educators. First, it demonstrates how AI tools can be aligned with creativity-oriented learning objectives through structured instructional design. Second, it highlights the importance of reflective practice in AI-supported creative learning. Third, the proposed teaching module provides a transferable framework that can be adapted to other creative disciplines.

Limitations and Future Research

Despite its contributions, the study has limitations. The research was conducted within a single institutional context and used a relatively small sample size. Creativity was primarily measured through self-report and qualitative data. Future studies could incorporate performance-based creativity assessments, longitudinal designs, and comparative studies across institutions to further validate and extend the findings.

Conclusion

This study developed and evaluated an AI-supported teaching module to foster creativity in undergraduate CG education. The results provide empirical evidence that AI, when integrated as a supportive pedagogical tool within a structured instructional framework, can enhance students' creative thinking, engagement, and reflective capacities. The proposed module advances AI-enhanced creative pedagogy and offers practical insights for digital media education amid rapid technological change.

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Ethics Statement: This study was conducted in accordance with ethical research standards. All procedures involving human participants were reviewed and approved by the [Universiti Pendidikan Sultan Idris], approval number [2026-1061-01]. Informed consent was obtained from all participants prior to data collection. Participation was voluntary, and respondents were assured of confidentiality and anonymity. The data collected were used solely for academic purposes.

Author Contribution Statement: All authors contributed significantly to the development of this manuscript. [Li Ziye] handled data collection, analysis, and interpretation of results. contributed to the literature review, drafting, and critical revision of the manuscript. [Balamuralithara Balakrishnan] was responsible for the conceptualization, methodology, and overall supervision of the study. All authors read and approved the final version of the manuscript prior to submission.

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