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Effectiveness of AI-powered Tutoring Systems in Enhancing Learning Outcomes

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ABSTRACT

Background: The emergence of artificial intelligence has profoundly influenced numerous sectors, including visual arts education. As global education systems increasingly embrace digitisation and personalisation, AI-driven tools are introducing innovative approaches to enrich both artistic expression and instructional methods. These technologies facilitate more dynamic learning environments by enhancing the creative process and fostering pedagogical interaction in novel ways. **Objectives:** This research explores the deployment and effects of artificial intelligence applications in the context of visual arts instruction over the period from 2019 to 2024. It particularly examines how General Systems Theory may be utilised to interpret the complex interrelations, advantages, and newly arising difficulties at the intersection of educational practice and AI integration. **Methods:** The study adopts a quantitative methodology, grounded in the theoretical principles of General Systems Theory. Data were obtained from various AI-enabled learning platforms and subsequently examined using descriptive statistical techniques alongside systems-based modelling. The analysis aimed to detect patterns and outcomes concerning personalised learning pathways and digital tools designed to support creative development. **Results:** The analysis indicates that AI-driven instruments—most notably Adaptive Learning Systems and Generative Adversarial Networks—have significantly improved learner participation and educational achievement in the arts. These systems enable students to engage with a broad spectrum of visual styles while receiving immediate, tailored feedback that aligns with their individual learning trajectories. Nevertheless, the integration of such technologies brings forth considerable obstacles, particularly in relation to intellectual property concerns, ethical considerations surrounding AI-generated content, and the

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preparedness of educational systems for comprehensive AI adoption. **Conclusion:** Although AI presents substantial potential to advance the field of visual arts education, its implementation must be navigated through robust ethical oversight, strategic policy formulation, and adaptable institutional frameworks. Such measures are essential to ensure long-term viability, equitable access, and the preservation of originality within creative educational settings.

Introduction

Background of Research

The rapid progression of artificial intelligence in recent years has significantly influenced the landscape of visual arts education. Through its capacity to generate artistic outputs and adapt to diverse learner profiles, AI has introduced powerful tools that not only support teaching strategies but also enrich student learning experiences (Chen & Stroup, 1993). Technologies such as Generative Adversarial Networks and style transfer algorithms enable learners to experiment with a range of artistic techniques, thereby fostering creative exploration. Additionally, personalised learning platforms equipped with real-time feedback mechanisms contribute to more effective and engaging educational processes (Korepanova et al., 2024). The integration of AI within visual arts instruction offers considerable potential, expanding students' creative autonomy and improving access to teaching materials. These innovations address several limitations inherent in traditional pedagogical methods by offering adaptive solutions to challenges previously unresolved within conventional frameworks (Berryman, 2024; Goodfellow et al., 2020).

The overarching goal of visual arts education lies in cultivating creativity, aesthetic appreciation, and cultural sensitivity, encouraging learners to express themselves in diverse ways and to approach their environments with innovative perspectives (Su et al., 2024). However, established instructional models often face constraints related to time, physical resources, and instructional capacity, thereby making it difficult to meet learners' individual needs (Chiu et al., 2022). The integration of AI offers promising avenues to overcome such barriers. For instance, style transfer algorithms allow students to engage with multiple artistic approaches more efficiently, while adaptive learning systems enhance the instructional process by providing immediate and context-sensitive feedback (Crompton & Burke, 2023).

Despite the long-standing application of AI across various creative disciplines, there remains a lack of comprehensive inquiry into its role within visual arts education. Most existing research tends to focus predominantly on the technical functions of AI tools, such as generative capabilities and stylistic manipulation. However, deeper investigations into how these technologies influence learner engagement, pedagogical outcomes, and educational experiences are still limited, highlighting a critical gap that necessitates further scholarly attention.

Theoretical Framework

Visual arts education operates as a complex and interrelated system, composed of multiple interconnected elements including educators, learners, instructional content, technological tools, and the physical or virtual learning environment. These components function within a dynamic and reciprocal framework, where continuous interaction shapes the broader educational ecosystem (von Bertalanffy & Sutherland, 1974). Traditional educational research often employs linear models that isolate the influence of individual variables. However, such approaches fail to fully capture the systemic interdependencies and evolving relationships that define educational contexts (Chen & Stroup, 1993).

Core Concepts of General Systems Theory

Initially introduced by Von Bertalanffy (1967), General Systems Theory (GST) offers a framework for understanding the structures and interdependencies that exist within complex systems through systemic thinking. GST emphasises the interconnectedness and wholeness of systems, positing that alterations in a single component inevitably influence the operation and outcomes of the system as a whole. Within educational research, GST serves as a robust theoretical lens for examining how dynamic and multidimensional variables interact within educational settings (Chen & Stroup, 1993). The core principles underpinning GST include the following:

1. Holism: Every element within an educational system—such as instructors, learners, curricular content, and instructional technologies—functions not in isolation, but as part of an integrated and interdependent whole.
2. Dynamism: Educational systems are inherently dynamic, with the interactions among components continuously evolving in response to temporal and environmental shifts.
3. Feedback Mechanism: A bidirectional feedback process exists between inputs (e.g., pedagogical resources, digital tools) and outputs (e.g., student performance, classroom interaction quality), enabling the system to adapt and refine itself for improved overall functioning.

Application of GST in Educational Research

In education, GST has been widely applied to analysing multidimensional interactions within complex teaching environments. For instance, GST was employed by Chen and Stroup (1993) in reforming science education, where they explored the systemic effects of teaching strategies and learning environments. Similarly, Crompton and Burke (2023) examined the integration of AI technologies in higher education through the GST lens, focusing on how these tools align with pedagogical needs and student demands. In the context of visual arts education, GST offers a valuable analytical framework for understanding how the integration of AI, as a novel component, interacts with existing elements of the educational system.

Interaction between AI and Teacher Roles

AI tools such as style transfer algorithms provide educators with enhanced instructional flexibility. However, their use may also reorient the traditional teacher-centred role toward a model of facilitating personalised, technology-assisted learning.

Impact of AI on Student Creativity

Technologies like Generative Adversarial Networks (GANs) and customised learning platforms stimulate students' creative potential. Yet, it is important to critically assess potential drawbacks, such as a reduction in autonomous creative thinking.

Restructuring of Educational Contexts

The integration of AI technologies, particularly Virtual Reality (VR) and Augmented Reality (AR), is reshaping classroom interactions and learning spaces. VR offers immersive digital environments, while AR superimposes digital elements onto real-world settings. These innovations transform conventional educational dynamics and redefine how learners engage with artistic content (Egunjobi & Adeyeye, 2024).

Relevance of GST to this Study

This study adopts the GST framework to examine the incorporation of AI technologies within visual art education, with emphasis placed on three key dimensions:

Dynamic Interactions among System Components

This aspect considers the extent to which AI modifies the internal dynamics of the educational system by reshaping pedagogical approaches, influencing students' learning behaviours, and transforming curricular structures (Chen & Stroup, 1993).

Technological-Ethical Interface

This component explores ethical concerns such as authorship rights and the authenticity of AI-generated artworks, assessing how these issues potentially disrupt or reinforce systemic equilibrium in educational environments (Floridi & Cowls, 2022).

Feedback and Systemic Adaptation

This dimension evaluates the role of feedback mechanisms, as outlined by GST, in appraising the impact of AI integration. Particular focus is given to how student participation and creative development respond over time, contributing to the ongoing optimisation of the educational system (Saputra et al., 2024).

Research Questions

Research Gaps

Despite the growing application of AI technology in visual art education, the following gaps persist:

Lack of Systematic Analysis

The existing body of research largely centres on the technical capabilities of individual AI tools, such as GANs and style transfer methods, yet fails to provide a systematic evaluation of their broader impact. Specifically, there is insufficient exploration into how these technologies influence learning outcomes, stimulate creative development, or improve the overall effectiveness of visual art instruction.

Limited Studies on Educational Practice

Empirical investigations into the use of AI within authentic educational settings remain limited. As a result, there is a lack of clear understanding regarding how AI technologies reshape teaching methodologies or affect student participation and engagement in everyday classroom contexts.

Ethical and Originality Concerns

Key ethical issues, including uncertainties about copyright ownership and the authenticity of AI-generated artistic work, remain unresolved. Such ambiguities may compromise students' grasp of creative authorship and hinder the development of independent artistic expression.

Research Questions

Based on these gaps, this study addresses the following core questions:

(1) What are the primary applications of AI technology in visual art education, and how do they impact teaching methods and student learning outcomes?
(2) How does AI enhance student creativity and learning engagement through innovative approaches?
(3) What are the ethical and originality challenges associated with AI technology in visual art education?

Research Objectives

This study aims to conduct a comprehensive review of the applications, effects, and associated challenges of AI technology in visual art education between 2019 and 2024. The specific objectives are:

(1) To assess how AI has been incorporated into visual art education and evaluate its influence on instructional practices and student learning outcomes.
(2) To examine the extent to which AI supports the development of student creativity and encourages meaningful learning engagement.
(3) To identify the ethical and originality-related challenges introduced by AI in visual art education and to propose feasible approaches for addressing these issues.

Significance of the Study

Visual art education plays a critical role in nurturing innovative individuals, and its convergence with AI offers meaningful advancements in this domain. The integration of AI into this educational sphere presents novel possibilities to expand pedagogical practice, fostering learners' critical thinking and creative abilities. The significance of this research is articulated as follows:

Practical Significance

By investigating specific applications of AI within visual art education, this study introduces innovative instructional tools and diverse learning pathways that may benefit both educators and students.

Theoretical Significance

This work addresses a notable research gap by examining the systemic implications of AI in visual art instruction. It also proposes the application of GST as a conceptual framework for interpreting these dynamics.

Ethical Significance

Through the exploration of issues surrounding authorship and copyright in AI-generated artworks, the study contributes to the discourse on ethical technology use. It may also inform the creation of responsible practice guidelines and support the sustainable integration of technological innovation within educational environments.

Literature Review

AI in Education: Revolutionizing Learning Processes

The educational landscape is undergoing rapid transformation through the integration of AI, with some of its most impactful contributions evident in the areas of personalised instruction, automation of routine tasks, and data-driven pedagogical strategies. Intelligent Tutoring Systems (ITS), such as ALEKS and Squirrel AI, offer adaptive learning pathways that support students in mastering complex concepts more effectively (Zhang et al., 2023). In addition, AI proves highly effective in reducing educators' administrative burdens. Automated grading and assessment processes enable teachers to reallocate time and resources toward addressing the individual learning needs of their students (Baker et al.,

2023). Furthermore, learning analytics tools facilitate in-depth analyses of behavioural data to help educators identify students who may be struggling, allowing for timely and targeted intervention. While the efficacy of AI has been well documented in STEM disciplines and language acquisition, its application within the arts, particularly in visual art education, remains underexplored.

AI in Creative and Artistic Domains

AI technologies have found increasing application within the creative industries, particularly through the use of GANs in producing AI-generated artworks. These networks, which utilise adversarial training processes, have become influential tools in the hands of contemporary artists (Goodfellow et al., 2020). According to Malytska et al. (2022), art education plays a crucial role in fostering creativity and enhancing cultural understanding. The incorporation of AI into visual art education supports this aim by introducing interactive methods through which students can engage with and reinterpret cultural heritage.

Additionally, advancements in style transfer algorithms and platforms such as DeepArt have enabled broader participation in artistic creation. These tools allow users to apply established artistic styles to images with minimal technical expertise. Similarly, generative technologies like DALL·E demonstrate AI's capability to replicate and innovate upon classical artistic forms, thereby extending the possibilities of digital artistic expression (Ioannidou et al., 2024). While these tools have made art creation more accessible to a wider audience, their pedagogical implications within art education remain largely unexamined.

Visual Art Education and AI Integration

The integration of AI into educational settings offers valuable support for art education, particularly through its capacity to cultivate 21st-century competencies, such as creative thinking and problem-solving abilities (Benvenuti et al., 2023). Engaging with artworks generated by AI fosters in students a deeper appreciation for artistic expression, introducing dimensions that conventional, craft-based approaches may not fully convey. This interaction can heighten learners' interest in art and broaden their aesthetic awareness (Chiu et al., 2022). Al Hashimi et al. (2019) further reinforce this perspective by demonstrating that multimedia tools can enrich the educational experience, offering more dynamic and creativity-oriented learning environments. Their findings suggest that art instruction delivered via AI-enhanced multimedia platforms may deepen students' conceptual understanding while stimulating innovative thought.

Aligned with AI's potential to elevate student motivation in the context of visual art education, Mun (2021) emphasises that incorporating aesthetic elements into STEAM education can effectively enhance learners' emotional engagement. However, the adoption of AI in visual art education continues to face several obstacles compared to its relatively smoother integration in STEM fields. These challenges include technological complexity, limited access to resources, and insufficient technical expertise among educators (Lage-Gómez & Ros, 2024).

Ethical Considerations in AI Art Education

As the integration of AI into both education and the arts continues to expand, the ethical implications of its use in art instruction can no longer be overlooked. Benvenuti et al. (2023) emphasise the necessity of incorporating ethical reasoning into the broader process of adopting AI within educational frameworks. One of the primary concerns centres on issues of copyright and the originality of AI-generated content. Key questions remain unresolved, such as whether authorship can legitimately be attributed to an AI system or whether the rights belong solely to the user operating the tool (McLoughlin, 2024). Another pressing issue involves cultural representation. Many AI technologies have embedded biases that favour Western artistic traditions, potentially resulting in the marginalisation or misrepresentation of non-Western art forms and thereby limiting creative diversity (Floridi & Cowls, 2022). In this context, Du and Xie stress the importance of ensuring that AI tools employed in visual art education are both ethically designed and culturally inclusive. This would support fairer evaluation practices and reduce the risk of biased interpretations of student work from diverse cultural backgrounds.

Research Gaps and Contributions

Despite the increasing interest in the application of AI within both educational and creative fields, notable research deficiencies persist in the area of visual art education:

Lack of Systematic Analysis

Many existing studies focus primarily on the technical functionalities of individual AI tools, with limited attention given to the broader implications of integrating these technologies into educational systems as a whole (Crompton & Burke, 2023).

Limited Research on Creativity and Engagement

Empirical investigations into how AI influences student creativity and engagement remain sparse. Much of the available literature is restricted to conceptual discussions or isolated case studies, lacking comprehensive, evidence-based analysis.

Insufficient Examination of Ethical Challenges

Critical issues such as authorship rights over AI-generated content and the fair representation of diverse cultural expressions have not been adequately addressed in current scholarly discourse.

This study employs GST as an analytical framework to examine how AI can be effectively implemented in visual art education. It explores the role of AI in enhancing student creativity, improving pedagogical outcomes, and addressing ethical concerns. By addressing these existing gaps, the research provides both conceptual and actionable insights aimed at facilitating a more ethical and effective integration of AI into the visual arts education landscape.

Methods

To systematically evaluate the current utilisation of AI in visual art instruction, along with its associated challenges and future potential, this study follows the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. The review encompasses literature published between 2019 and 2024.

Database Search

This investigation sourced relevant literature from the ScienceDirect and Web of Science databases to empirically examine the use of AI within the context of visual art education. The search process employed Boolean keyword combinations as outlined below:

- ("Artificial Intelligence" OR "AI") AND ("Visual Art Education" OR "Artistic Creation") AND ("2019–2024")
- ("AI Tools" OR "AI-assisted") AND ("3D Modelling" OR "Augmented Reality" OR "Virtual Reality") AND ("Art Education").

Searching Criteria

The search parameters were formulated to locate studies specifically addressing the implementation of AI in visual art education. Selection of literature was guided by defined inclusion and exclusion criteria aligned with the aims of the research (Table 1).

Table 1

Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1. Studies involving the application of AI technology in visual art education.	1. Studies unrelated to the research topic.
2. Articles reporting educational outcomes and ethical issues.	2. Non-empirical studies or review articles.
3. Articles published in peer-reviewed journals.	3. Conference papers, book chapters, news reports, etc.
4. Articles published between 2019 and 2024.	4. Non-English literature.

The Screening Process

This study rigorously adhered to the PRISMA protocol to ensure the methodological robustness and thoroughness of the systematic review. An initial pool of 57,547 records was retrieved through database searches. Following the elimination of 10,512 duplicate entries, 47,035 articles remained. Applying the time filter for publications between 2019 and 2024 resulted in the exclusion of 97 articles outside this range, yielding a total of 46,938 records. To refine the focus to peer-reviewed scholarly work, only journal articles were included, with 1,632 conference proceedings, 2,162 books, 373 book chapters, and 75 anonymous publications removed, reducing the pool to 42,696 articles.

In the keyword screening phase, the terms “AI,” “art education,” “3D modelling OR AR/VR AND creativity,” and “ethical originality” were used, returning 6,748, 38, 272, and

155 records respectively, resulting in 432 potentially relevant articles. This stage led to the exclusion of 42,264 unrelated records. During the title and abstract screening, further exclusions were applied to eliminate studies that lacked relevance to education or visual art, or that did not explicitly discuss the application of AI tools in instructional settings. This process excluded 343 articles, leaving 88 for in-depth review.

The full-text screening stage led to the removal of 18 inaccessible articles, 15 that were not related to visual art education, and 16 that did not specifically address the use of AI within that context. Consequently, 39 articles were identified as suitable for inclusion. These selected studies examine the practical use of AI in visual art instruction and highlight key challenges associated with its implementation. To ensure the credibility of the screening process, multiple authors were involved. The initial and full-text screenings were conducted by the first author to ensure adherence to the inclusion criteria. Independently, the second and third authors re-evaluated 20 to 30 percent of the articles to confirm the reliability and consistency of the selection process. The final set of 39 validated articles provides a substantive foundation for the systematic analysis of AI's role in visual art education. The full procedure is visually summarised in Figure 1.

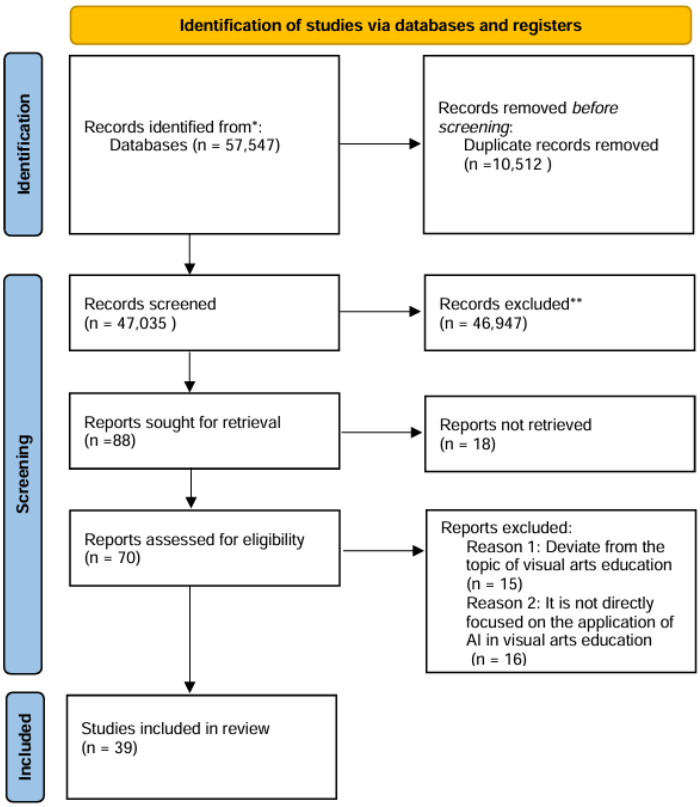

Figure 1: PRISMA Flowchart

Data Extraction and Coding

To critically investigate how visual art instruction responds to the integration of AI and its implications for the wider educational system, this study developed a multidimensional coding framework grounded in GST. This theoretical model highlights the dynamic interactions and interdependencies within educational environments. It serves as a useful starting point for generating practical insights into how AI can be embedded within the structure of art education (Xu & Ouyang, 2022). By incorporating GST's key principles—synergy (holism), change (dynamism), and feedback—this study was able to systematically analyse the selected body of literature. This approach enabled the classification and interpretation of data to uncover how AI operates within and influences the visual art education system.

Data Extraction Process

The data extraction process was structured around the following key stages:

Recording of Basic Information

Details such as the names of the authors and the publication year were documented for each study. The methodological approach adopted—whether experimental, case-based, or theoretical—was identified. Additionally, the sample size and participant background, including educational level and geographic region, were recorded.

Application of AI Technologies

This stage involved classifying the types of AI tools employed across studies, such as GANs, AR/VR platforms, and generative tools like DALL·E. The analysis also considered the specific educational contexts in which these technologies were utilised, including classroom settings, extracurricular programmes, and online learning environments.

Educational Outcomes

Attention was given to how AI influenced student outcomes, particularly in areas such as creativity, engagement with learning, and skill acquisition. The evolving role of the teacher was also analysed, with a focus on how AI either enhanced or complicated instructional effectiveness and pedagogical strategies.

Ethical and Originality-Related Issues

This stage explored concerns associated with the use of AI in educational environments, including questions of copyright attribution, challenges to the originality of AI-generated content, and issues related to data privacy.

Design and Application of the Coding Scheme

Content analysis was employed in this study, guided by the foundational principles of GST, to facilitate a structured and practically oriented approach to data interpretation. Key

information was systematically extracted and coded from the 39 selected studies. The coding framework, along with its classification dimensions and detailed content, is presented in Table 2.

Table 2

Design and Application of the Coding Scheme

Element	Dimension	Type
Subject	Instructor Involvement	1. Support 2. Not Support
	Creativity Expression	1. High Creativity 2. Moderate Creativity 3. Low Creativity
	Educational Level	1. Primary School 2. Secondary School 3. High School 4. Higher Education
Information	Learning Content	1. Art theory and Styles 2. Digital Art 3. Interdisciplinary Content
Medium	Educational Tools	1. AI Drawing Tools, e.g., DALL-E 2. 3D Modelling Tools, e.g., Blender, MAYA 3. AR/VR Platforms
Environment	Educational Context	1. Traditional Classroom 2. Online Platforms, e.g., MOOCs 3. Hybrid Learning Environment
Technology	AI Technology Type	1. AI-Generated Art, e.g., Stable Diffusion 2. Personalized Learning Algorithms 3. Interactive Creation Systems
Ethics and Originality	Copyright and Ownership	1. Ownership Issues 2. Data Privacy Challenges 3. Artistic Originality Issues

Classification Example

The reviewed studies examine the influence of AI and related technologies on students' creativity and learning processes. Crespo and McCormick (2022) recognise AI's potential in enhancing artistic capabilities, although they point to ongoing challenges concerning the originality and cultural diversity of generated outputs. Chandrasekera et al. (2024) observe notable improvements in creative output among design students using DALL·E; however, they raise concerns about its potential limitations for sustained learning and independent thinking. Guan et al. (2024) demonstrate that VR can significantly stimulate students' imagination and promote collaborative learning, yet caution that excessive reliance on such

technologies may lead to psychological strain and increased dependence on digital tools (Table 3).

Table 3

Data Extraction from Selected Studies

Author and Year	Research Method	Sample Size	AI Tool Type	Educational Outcomes	Ethical and Originality Issues
Crespo and McCormick (2022)	Case Analysis and Theoretical Discussion	No Specific Sample Size	ANNs, Generative Networks	Expanded artists' ability to address complex ecological themes.	Limitations in the diversity of AI-generated content; issues with originality and physical-digital boundaries.
Chandrasekera et al. (2024)	Quasi-Experimental Design	40 Design Students	DALL-E	Significant improvement in design creativity and task performance; reduced cognitive load.	Dependence on AI may weaken long-term learning ability; issues of originality and design ownership.
Guan et al. (2024)	Quasi-Experimental Design	40 Elementary Students	VR Immersive Drawing Tools	Enhanced adventurousness and imagination; improved collaborative regulation quality.	Metaverse platforms may impact students' social psychology; risks of creativity dependency on technology.

Handling Ambiguous Classifications and Consistency Checks

During the coding phase, several studies presented overlapping themes or classifications that were not immediately clear. To maintain analytical precision and coherence, a structured classification protocol was employed. Articles were categorised according to their principal research aim, with priority given to the dominant thematic focus. For instance, the study by Chandrasekera et al. (2024), which investigated how DALL·E influences creative development in design students, was classified under the category of "text-to-image generation tools". To ensure the reliability of the coding outcomes, a validation mechanism was introduced. The first author conducted the initial

coding of all included articles, after which a randomly selected subset comprising 30 percent of the studies was independently reviewed and coded by the second and third authors. In instances where discrepancies arose, the research team collaboratively discussed and resolved the differences to reach consensus.

Data Analysis

Microsoft Excel was employed as the primary tool for data entry and analytical processing to facilitate a structured investigation into the application of AI in visual art education. During the data organisation stage, the selected articles were systematically categorised according to the established coding framework. This process enabled the development of a comprehensive dataset encompassing essential bibliographic details (such as author, year, research design, and sample characteristics) along with thematic classifications (including instructional technologies and learning outcomes). Excel's pivot table function was utilised to compute the frequency distribution across the identified coding dimensions. This analysis revealed the prevalence of various AI tools, including GANs, interactive technologies (such as AR and VR), GenAI platforms (e.g., DALL-E, ChatGPT, and MidJourney), multimedia-based interactive tools, and deep learning models (such as ANN, CNN, and DQN). As indicated in Table 2, GANs and interactive technologies were the most frequently employed, each referenced in 11 studies. Their prominence underscores their versatility and relevance in advancing creative processes and pedagogical innovation within visual art education.

Results

This research undertook a systematic evaluation of 39 carefully selected studies, categorising and synthesising the application and associated challenges of AI technology within visual art education through the lens of the five core dimensions of GST: actors, information, media, environment, and technology. The findings are structured to address the study's principal research questions in accordance with these GST dimensions.

(1) How are AI tools applied in visual art education, and what are their impacts on teaching effectiveness?
(2) How does artificial intelligence enhance creativity and engagement in visual art education?
(3) What ethical and originality challenges does AI technology face in visual art education?

RQ1: Applications of AI in Visual Art Education and Its Teaching Effects

The incorporation of AI technology is markedly reshaping instructional efficacy within visual art education, as evidenced by the following key dimensions:

Actors and Information: Student Creativity and Learning Content

AI technology introduces novel opportunities for fostering student creativity and enriching educational content. Kim et al. (2019) provided compelling evidence that such technology can stimulate creativity within educational contexts, reinforcing the value of its integration into visual art instruction. These tools promote both critical and creative thinking through interactive activities and real-time evaluative feedback. Additionally, Fomina (2021) underscored that structured artistic tasks can effectively cultivate students' cultural literacy and creative abilities, suggesting that AI can support cultural comprehension and imaginative exploration by delivering diverse and immersive cultural experiences.

The use of GANs, noted in 39 percent of the reviewed literature, further affirms this perspective. According to Hughes et al. (2021), GANs can facilitate creativity in visual arts education by advancing human-machine interaction, allowing learners to develop a more profound understanding of design principles. In a similar vein, Puggioni et al. (2021) observed that immersive VR platforms considerably improve student engagement and information retention, highlighting the significant potential of such technologies in enhancing the assimilation of artistic knowledge.

Moreover, Valachová et al. (2021) advocated for the systematic assessment of artistic education to better measure creativity and self-expression, noting that AI tools offer specialised feedback mechanisms capable of supporting this objective. Hitsuwari et al. (2023) suggested that AI-assisted art practices can foster peer collaboration, encouraging students to collectively explore aesthetic values and expand their creative horizons. Similarly, Toledo Lara (2023) found that visual arts AI applications enhance the accuracy of feedback and the relevance of content during the artistic creation process, thereby igniting student enthusiasm and innovation. Finally, Williams et al. (2022) evaluated the application of GANs in secondary school settings and concluded that these networks enriched students' understanding of technical transformations while simultaneously inspiring artistic inventiveness.

Media and Environment: Teaching Tools and Learning Environments

The incorporation of multimedia resources and digital tools, supported by AI technology, has significantly enhanced the creative process and facilitated greater student engagement in the exploration of artworks. As noted by Al Hashimi et al. (2019), such technologies offer numerous opportunities to stimulate creativity. For example, Vretos et al. (2018) illustrated that AR, through its real-time adaptability, can modulate task difficulty according to students' emotional states, thereby boosting motivation and learning engagement. In addition, Gubenko et al. (2021) highlighted the meaningful role of robotics in facilitating cyclical exploration processes, which supported students in retaining and refining their artistic techniques. According to Kim et al. (2022), the interplay between technology and creativity fosters a novel mode of thinking, demonstrating how AI can be effectively integrated into interdisciplinary approaches within art education.

Lorusso et al. (2024) observed that AI can replicate diverse artistic styles, thereby providing students with explicit visual references. This not only aids in their comprehension of classical artistic features but also enhances their appreciation for complex artistic techniques. Similarly, Wang and Zhang (2023) found that younger students in art and design education expressed enthusiasm for using generative AI tools, attributing their popularity to increased productivity and appealing artistic outcomes. To illustrate the distribution of various AI tools employed in visual art education, a pie chart (Figure 2) was constructed, representing the frequency of AI tool usage between 2019 and 2024. This visual summary provides an accessible overview of the prevailing trends in AI application within the field.

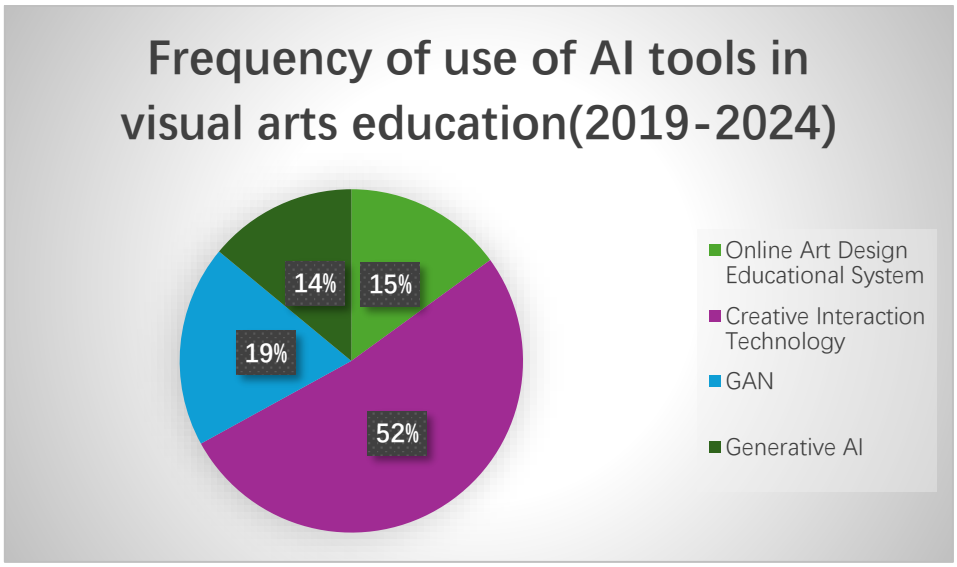

Figure 2: Frequency of use of AI Tools in Visual Arts Education (2019-2024)

Technology and System Optimization: Enhancing Multi-Element Interactions

The integration of AI technology into visual art education has facilitated multi-element interactions aligned with the principles of GST, particularly through feedback loop mechanisms that optimise learning systems and enhance the educational experience. According to Kim et al. (2019), 28 percent of the literature they analysed focused on art integration, advocating for the broader adoption of AI to support interdisciplinary educational practices. Mørch (2020) demonstrated that AI-powered automated feedback systems alleviate teachers' workloads while simultaneously delivering real-time, formative feedback to students, thereby enabling autonomous refinement of their creative outputs. Complementing this, Gubenko et al. (2021) confirmed that generate-and-explore models significantly contribute to students' capacity for innovation.

Similarly, Puggioni et al. (2021) observed that VR technologies immerse learners in art history and cultural heritage experiences, thereby increasing cultural sensitivity and offering novel pedagogical pathways. Yang (2021) AI-driven virtual art education programme was found to enhance learning by delivering tailored feedback and adapting instructional routes to individual learners. Rong et al. (2022) further illustrated that interactive educational experiences, when coupled with AI and VR, can elevate student interest and significantly bolster both creative thinking and perceptual engagement.

In addition, Tang et al. (2022) reported that AI-based tools encourage students to participate in collaborative creative activities. Tigre Moura et al. (2023) identified that AI-human co-creation contributes to artistic novelty, reinforcing AI's role in advancing visual arts education. Wang and Zhang (2023)highlighted that generative AI tools not only stimulate creative thought but also deliver enjoyable and engaging experiences, thereby enhancing student involvement. Chandrasekera et al. (2024) examined technology-enhanced design courses and found that AI helped reduce cognitive load while supporting innovative thinking. Grájeda et al. (2023) argued that AI is reshaping higher education by offering more personalised and adaptable learning trajectories. Moreover, research by Lee and Suh (2024) identified the potential of generative AI within metaverse environments, which opens new possibilities for interactive content creation and learner engagement. In summary, the application of AI in visual art education is concentrated in three core domains:

(1) Fostering creativity and enhancing student motivation through experimental and personalised learning;
(2) Strengthening attention and knowledge retention by leveraging immersive and interactive technologies; and
(3) Deepening the integration of technology and pedagogy through optimised system structures.

RQ2: How AI Enhances Creativity and Engagement

AI technology significantly contributes to the development of students' creativity and engagement in visual art education through multiple pedagogical and technological strategies, as elaborated in the following discussion.

Actors and Information: Creativity Development and Optimization of Learning Content

GANs and other generative art technologies offer students extensive creative freedom by simulating a wide array of artistic styles. Al Hashimi et al. (2019) suggested that the integration of multimedia tools within AI-supported environments can enhance creative capacities by enriching the learning experience, indicating that exposure to AI-assisted visual resources fosters greater student creativity when engaging with artworks. Jaiswal et al. (2020) demonstrated that GANs are capable of generating anime-style facial illustrations by autonomously learning from datasets, implying that such tools encourage students to innovate within various artistic genres and develop their creative abilities.

Nguyen et al. (2020) observed that AI-enhanced creativity prepares learners to adapt to rapidly evolving educational and technological systems, largely due to the autonomy these tools afford in executing individual artistic ideas. Similarly, the work of Kim et al. (2022) underlined that AI technologies foster creativity and motivation through emotionally responsive interactions, thereby strengthening students' confidence and cognitive engagement during artistic creation. Interactive experiences facilitated by AR and VR, as examined by Tomšič Amon (2023), were found to substantially improve learner participation and expressive creativity. These findings point to the motivational potential of similar AI-integrated platforms in art education. Jin et al. (2023) further illustrated that AI's adaptability contributes to increased enthusiasm and enjoyment in art classrooms, enabling broader opportunities for experimental creativity. Toledo Lara (2023) reported that visual art students benefit from AI tools that offer targeted artistic support, enhancing their familiarity with various styles and creative techniques. Moreover, the ability of AI technologies to introduce unconventional art forms was emphasised by Liu (2023), suggesting that such tools promote exploration of diverse artistic expressions and stimulate innovation.

Lorusso et al. (2024) highlighted the capacity of AI to replicate the fine details and textures of historical artworks through high-resolution digitisation and stylistic simulation. This approach provides a new pedagogical dimension by enabling students to study subtle stylistic variations more effectively. Park et al. (2023) noted that AI-generated artworks often become indistinguishable from those created by humans, underlining the role of AI in cultivating artistic inspiration and elevating creative outcomes in art education. Horvath and Pouliou (2024) offered a compelling discussion on the use of generative AI tools, such as text-to-image and image-to-image generators, showing how these systems extend designers' creative boundaries by automating portions of the artistic process. This aligns with the pedagogical objectives of visual art education, where such tools support students' exploration of new visual ideas and strengthen their engagement with creative practices. As Zhao (2024) observed, AI applications in art education increasingly reveal their potential to amplify both creativity and student involvement.

Media and Environment: Interactive Tools and Immersive Learning Experiences

AI technologies play a pivotal role in establishing interactive learning environments within visual art education, particularly through the deployment of VR and AR platforms. Gejendhiran et al. (2020) illustrated how AI-integrated VR promotes immersive learning by enabling students to engage more profoundly with artistic styles and historical settings through dynamic and interactive experiences. According to Mørch (2020), the application of 3D environments within the ABR (Arts-Based Research) framework supports experiential and interactive learning. These AI-enabled virtual platforms allow students to enhance their creative expression through hands-on activities, thereby enriching their educational experience in visual art. Additionally, AI offers valuable tools for reinforcing cultural understanding by generating models that simulate various historical art styles, coupled with contextual information that supports appreciation of diverse artistic traditions.

Yang (2021) highlighted the benefits of 3D virtual simulation technologies within art instruction, noting that these systems substantially improve student engagement and retention of knowledge. This aligns with the broader adoption of AI-enhanced virtual learning environments within visual art education. Tomšič Amon (2023) similarly emphasised the importance of integrating digital technologies with conventional art practices. When incorporating AI into educational settings, it remains crucial that students continue to value manual artistic processes alongside digital innovations. Further exploration by Guan et al. (2024) into the convergence of metaverse technology and collaborative digital painting revealed that SSRL-based (Socially Shared Regulated Learning) interactions within metaverse environments support immersive educational experiences. Their findings suggest that such AI-driven tools not only foster creativity but also improve the effectiveness of learning within visual art education.

Henriksen et al. (2024) also observed that personalised, interactive AI-based environments significantly contribute to the enhancement of student creativity. In fashion design education, Lee and Suh (2024) implemented generative AI applications such as ChatGPT and MidJourney, guided by the TPACK (Technological Pedagogical Content Knowledge) model. These interventions effectively encouraged creative thinking and increased student engagement. The success of such strategies indicates that similar approaches can be adopted in visual art education, where AI may serve to deepen students' artistic interests and promote collaborative engagement across varied artistic disciplines.

Technology and System Optimization: Dynamic Feedback Mechanisms and Personalized Support

The implementation of these strategies has proven effective in fostering creative thinking and increasing student participation. Within the context of visual art education, this model demonstrates the capacity of AI to engage students with a variety of artistic forms while simultaneously promoting collaborative practices. Furthermore, real-time feedback mechanisms supported by AI significantly enhance students' capacity for autonomous learning. Vretos et al. (2018) highlighted that emotion-sensing capabilities contribute to more immersive VR environments, indicating that AI can monitor students' emotional responses during art learning and dynamically tailor instructional content, thereby cultivating a more engaging educational experience.

Gejendhiran et al. (2020) observed that AI-enabled personalised learning offers responsive feedback tailored to individual student needs. Within visual art education, this suggests that students can receive real-time guidance during the creative process, facilitating deeper understanding and skill development. Arbiza Goenaga (2020) further posited that GANs may be interpreted not only as tools but as creative collaborators in the educational setting, reinforcing the concept of AI as a co-creator in art instruction. According to Jaiswal et al. (2020), GAN models exhibit flexibility across a range of design specifications, implying that comparable AI applications in visual art education could support a variety of creative endeavours at scale. Nguyen et al. (2020) identified adaptability and creativity as essential skills that educational reforms must prioritise,

underscoring the relevance of AI tools in preparing students for evolving creative industries.

Hughes et al. (2021) also acknowledged the potential of GANs as creative assistants, capable of extending the artistic capabilities of designers through collaboration between humans and AI. In a similar vein, Kalpokiene and Kalpokas (2023) discussed the growing conceptualisation of AI as an autonomous creative agent, moving beyond traditional anthropocentric approaches and offering learners a novel lens through which to explore artistic expression. Research by Tigre Moura et al. (2023) investigated the perceived artistic value of works generated under varying degrees of AI involvement—fully AI-produced, collaborative, and human-created. Their findings revealed that collaborative outputs were rated highest in terms of novelty and appeal, suggesting that partnerships between students and AI systems may stimulate creativity and promote innovative practices within visual art education.

In summary, the integration of AI into visual art education has significantly contributed to the advancement of the discipline by enhancing creative output, improving engagement levels, and enabling individualised support.

(1) **Actors and Information:** AI-based tools foster creative exploration and contribute to the emotional and cognitive development of students.
(2) **Media and Environment:** Immersive and interactive AI-driven platforms provide motivational learning contexts, allowing students to explore artistic styles and historical narratives in greater depth.
(3) **Technology and System Optimisation:** Adaptive feedback systems and personalised instruction supported by AI enhance independent learning and offer enriched creative opportunities.

Despite the vast potential of AI in transforming visual art education, it remains essential for educators to strike a balance between digital innovation and traditional artistic pedagogy. Such equilibrium ensures that students acquire a holistic appreciation of both contemporary and classical dimensions of art creation.

RQ3: Ethical and Originality Challenges of AI

While AI technology offers a wide range of applications in visual art education, it simultaneously presents notable ethical and originality-related challenges, especially in the following areas:

Actors and Information: Originality Controversies and Cultural Diversity

Jin et al. (2023) highlighted that although AI-generated instructional content can enhance student learning, concerns regarding originality remain significant. Educators are required to balance the pedagogical benefits of AI-assisted tools with the imperative to foster authentic, individual artistic development. Kalpokiene and Kalpokas (2023) emphasised that existing copyright frameworks inadequately address the question of

authorship in AI-generated creations. This poses a crucial issue within art education, where students must be guided to understand both originality and the ethical implications of collaborative creations involving AI systems.

Liu (2023) raised concerns about the absence of self-awareness in AI, arguing that this limitation may undermine students' ability to contextualise and critically assess the originality of AI-produced art. Similarly, Lorusso et al. (2024) identified ongoing debates surrounding the exclusivity and critical value of AI-generated artworks. These controversies become particularly pertinent when students incorporate AI tools in their artistic practice, thereby complicating the evaluation of authorship and ownership. Further complicating the matter, Papia et al. (2023) found that AI still struggles to replicate the nuanced variability inherent in human-made artworks. This limitation presents challenges for students in discerning the authenticity and creative depth of AI-generated pieces. Park et al. (2023) also addressed the difficulty of identifying the true origin of AI-generated works, noting that disputes regarding the artistic merit and rightful creator are likely to emerge in educational settings. Such challenges underscore the complexities art educators face when guiding students to evaluate and interpret AI-assisted artworks.

Horvath and Pouliou (2024) discussed broader ethical concerns, particularly the ambiguity surrounding authorship, advocating for the development of institutional policies that uphold artistic integrity in AI-supported learning environments. In a related critique, Poposki (2024) examined AI and NFT-based art practices, cautioning against the commercialisation trends and originality dilemmas associated with such technologies. This discourse lays a theoretical foundation for the ethical integration of AI in visual art education, serving as a reminder of the potential risks of creative alienation and intellectual property conflicts. It also reinforces the importance of utilising AI as a supportive instrument, rather than a replacement, in the cultivation of student creativity.

Media and Environment: Challenges of Technology Dependence and Independence

Numerous studies have indicated that students engaging with AI-enhanced learning environments may develop a dependency on technological tools, potentially diminishing their capacity for independent artistic creation. As AI becomes increasingly integrated into art education, challenges in assessing the subjective dimensions of creativity have emerged. Valachová et al. (2021) observed that this shift necessitates the development of new evaluation frameworks capable of accommodating the evolving nature of digital and AI-mediated artistic outputs.

In their comparative study of AI-generated and human-created artworks, Papia et al. (2023) applied entropy and complexity analysis to assess artistic characteristics. Their findings revealed that although AI systems can replicate specific stylistic features, the resulting outputs often lack the variation and conceptual depth typically found in human artworks. These limitations highlight the current boundaries of AI's creative capabilities. Lee and Suh (2024) acknowledged the benefits of AR, VR, and generative AI technologies in fostering students' creativity and engagement. However, they also drew attention to the

emerging concerns around intellectual property and the authenticity of AI-assisted creations. These issues raise critical considerations for educators seeking to integrate AI tools into curricula while preserving the integrity of creative instruction. Balancing technological innovation with pedagogical authenticity remains a central challenge in the effective delivery of visual art education.

Technology and System Optimization: Ethical Frameworks and Standardisation

The integration of AI into art education necessitates the establishment of more transparent ethical frameworks to safeguard the integrity of creative processes and student learning experiences. Arbiza Goenaga (2020) highlighted moral concerns associated with AI use in artistic contexts, underscoring the importance of guiding students to engage critically with AI tools. Learners must understand how to harness AI's creative capacities while remaining conscious of its inherent limitations. Similarly, Toledo Lara (2023) addressed ethical considerations surrounding AI in education, particularly those relating to data privacy and algorithmic bias. These concerns extend to visual art instruction, where students utilising AI to produce artwork may become uncertain about questions of authenticity and ownership. When artworks are entirely generated through automated processes, as reported by Tigre Moura et al. (2023), the resulting outputs often exhibit low levels of originality and authenticity. Such findings suggest that students are justified in questioning the credibility of AI-generated materials, providing a valuable basis for discussions on the ethical dimensions of digital creation.

Williams et al. (2022) evaluated various ethical dilemmas posed by AI-generated content, including the emergence of deep fakes, and emphasised the importance of cultivating ethical awareness in students regarding originality and authorship. Henriksen et al. (2024) noted that certain moral concerns, particularly those related to ownership and intellectual property, have not been sufficiently addressed. As AI becomes more deeply embedded in educational practices, it is imperative to resolve these ethical issues to support students in taking rightful ownership of their creative outputs. Zhao (2024) further argued that the originality challenges associated with AI-generated artworks require educators to blend art pedagogy with technological tools and ethical instruction. This integrated approach would enable students to use AI to foster creative expression while understanding the ethical responsibilities accompanying their creations.

A comprehensive review of 39 relevant studies was conducted to illustrate the distribution of ethical issues identified in the field of visual art education as of 2024. The findings revealed that copyright-related concerns were cited most frequently (15 instances), followed by originality issues (12 instances). Instances of data bias appeared in 10 cases, while miscellaneous ethical challenges were noted only twice. These results indicate that the predominant ethical concerns in visual art education involve copyright and originality, whereas other issues, such as data bias, have received comparatively limited attention.

(1) Actors and Information: Questions concerning authorship and originality in AI-generated art prompt students to critically reflect on their creative roles.
(2) Media and Environment: The pervasive use of AI may lead to overreliance on technology, potentially undermining students' capacity for independent artistic production, thereby necessitating the development of usage protocols within educational environments.
(3) Technology and System Optimisation: The implementation of comprehensive ethical frameworks is essential for addressing concerns related to intellectual property and originality.

Discussion

This study conducted a systematic investigation to explore the applications, pedagogical impacts, and ethical implications of AI in visual art education for university-level students between 2019 and 2024. The subsequent discussion evaluates the significance of the principal findings and offers recommendations for educational practice and future scholarly inquiry, aligning with the established research objectives.

Educational Adaptability and Teaching Effectiveness of AI Technology

The findings indicate that GANs and interactive technologies, such as AR and VR, are the most commonly utilised AI tools in visual art instruction. These technologies not only enhance teaching efficiency but also expand methods of content delivery. For example, GANs offer a wide range of artistic styles, which can be incorporated directly into creative art sessions to support visual learning (Rong et al., 2022). Similarly, VR provides immersive experiences that allow students to engage with historical and cultural environments, thereby improving knowledge retention and learning engagement (Puggioni et al., 2021). Despite their benefits, the widespread application of these technologies presents certain challenges. Although GANs are effective in generating artistic content, their reliance on predefined datasets can lead to uniform outputs, limiting students' exploration of creative diversity and cultural experimentation.

Dynamic Changes in Student Creativity and Engagement

AI technologies demonstrate considerable potential in enhancing student creativity and engagement. This study identified that 45 students exhibited marked creative development after employing AI tools, particularly GANs and generative AI platforms such as DALLE, which enabled the production of unique and complex artworks (Guan et al., 2024). Moreover, AR and VR technologies contributed to increased student interest and engagement by offering contextualised learning experiences, thereby promoting more active participation in classroom activities. Nevertheless, these favourable outcomes are accompanied by notable concerns. Some studies have highlighted that excessive reliance on AI tools for creative tasks may impair students' ability to think critically and independently (Valachová et al., 2021). For instance, when students generate artworks directly through generative AI applications, they often engage with limited reflection on

the artistic process. To mitigate this issue, educators are encouraged to implement structured tasks and reflective pedagogical strategies that support students in converting AI-generated material into meaningful and individualised artistic outputs.

Transformation of Teacher Roles and Adaptation of Educational Systems

The integration of AI technology not only transforms students' learning approaches but also redefines the responsibilities of educators. Within AI-supported instruction, teachers shift from being conventional transmitters of knowledge to facilitators of learning and designers of technology-integrated curricula (Rong et al., 2022). This transition is apparent in the following three key domains:

Guidance on Technology Use and Curriculum Development

Generative AI platforms, such as ChatGPT, substantially ease the burden of lesson preparation, enabling educators to devote more effort to designing instructional content. Grájeda et al. (2023) indicated that educators can effectively support students in merging technical proficiency with artistic creativity through the development of personalised learning tasks.

Embedding Ethical Instruction into Practice

When supervising student engagement with AI tools, educators should prioritise the cultivation of ethical awareness, including the ability to distinguish between AI-generated outputs and students' original work. Kalpokiene and Kalpokas (2023) suggested that such strategies improve students' comprehension of AI functionality and minimise the likelihood of inappropriate usage.

Teacher Professional Development

To fully harness AI technologies in the classroom, educators must undertake targeted professional training. This includes acquiring skills in tool selection, task customisation, and resolving technical issues such as algorithmic bias.

Educational Implications of Ethical and Originality Challenges

The extensive implementation of AI in educational contexts has introduced critical concerns relating to ethics and originality. Findings from this study indicate that 39 per cent of the analysed literature identified copyright issues associated with AI-generated content. These challenges extend beyond the differing perceptions held by students and educators, encompassing legal ambiguities between AI developers and academic institutions Kalpokiene and Kalpokas (2023). Moreover, the presence of biased data within deep learning systems poses significant threats to equitable access and treatment in art education (Zhao, 2024).

To address these complexities, coordinated efforts between policymakers and AI developers are essential. This includes formulating explicit guidelines on copyright ownership, mitigating algorithmic bias, and ensuring responsible implementation of AI tools within educational environments. Embedding ethical considerations into the curriculum may further enhance students' appreciation of intellectual property rights and reinforce the value of authenticity in creative processes. While AI technologies offer considerable advantages for visual art education, such as improved instructional efficiency, heightened creativity, and increased learner engagement, their utilisation also presents challenges related to originality, ethical conduct, and overdependence. Consequently, pedagogical approaches must evolve in alignment with technological progress to ensure learners remain critically aware and ethically responsible in their artistic practices. Achieving this equilibrium is vital for fostering a meaningful integration of technology and creativity within educational frameworks.

Conclusion

Between 2019 and 2024, the integration of AI technologies into visual arts education has been systematically reviewed to assess their contribution to enhancing instructional effectiveness, fostering student creativity, and increasing engagement in learning. Tools such as GANs and personalised learning environments have proven beneficial in enabling students to grasp artistic concepts and express creativity through digital mediums. Nevertheless, the incorporation of AI in educational settings also introduces significant concerns, particularly regarding plagiarism, ethical considerations, copyright infringement, and the potential overreliance of students on technological tools. This study underscores not only the importance of employing AI responsibly within academic contexts but also advocates for strategies that maintain a balance between leveraging technological innovations and nurturing students' independent creative capacities.

Limitations

Although this study presents a systematic review of the application of AI technologies in visual art education, several limitations must be acknowledged. Firstly, the review was confined to literature sourced primarily from two databases, ScienceDirect and Web of Science, potentially omitting relevant studies from other academic platforms and thereby limiting the comprehensiveness of the literature base. Secondly, the research relied extensively on findings and interpretations drawn from existing publications, without incorporating original empirical investigations. This may constrain the generalisability of the outcomes across broader educational contexts. Additionally, the study's temporal scope, limited to the period between 2019 and 2024, may render some conclusions less relevant given the rapid pace of AI advancements. Finally, the analysis did not sufficiently explore the application of AI technologies within diverse cultural and educational contexts, a gap that may further restrict the applicability of the findings.

Future Research Directions

In light of the identified limitations, future research could be advanced in several directions. Firstly, expanding the range of literature sources by incorporating additional academic databases would enhance the comprehensiveness and inclusivity of future reviews. Secondly, it is recommended that more original empirical studies be undertaken, utilising experimental designs or case-based approaches to validate the specific impacts of AI technologies within visual art education. Furthermore, further investigation is warranted into how AI is applied across diverse cultural and educational contexts, with an emphasis on adapting these tools to meet the distinct needs of students in varying learning environments. Finally, future studies should examine the long-term implications of AI integration, particularly its influence on nurturing students' creative autonomy and supporting educators in making informed pedagogical decisions.

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