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Integrating Generative AI in arts design education: Enhancing PBL for critical thinking, creativity, and collaboration

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Abstract
Generative AI such as ChatGPT, Midjourney and Stable Diffusion are disrupting arts design education, providing tools to promote critical thought, creativity and collaboration. Despite the emergence of these tools, their use is still far from integrated into project-based learning (PBL) frameworks and very little guidance has been provided to educators on how they can use AI effectively to further pedagogical aims. This literature review thus fills this research gap by systematically reviewing the existing research on the application of generative AI in design education, specifically its potential to facilitate critical thinking, innovative problem-solving, and collaborative learning processes. By synthesizing relevant knowledge from various disciplines, the review highlights specific approaches that can make the integration of generative AI into crucial phases of the PBL cycle (including idea generation, design refinement and team dynamics) more feasible and actionable. Additionally, it addresses key challenges, such as ethical implications, intellectual property issues, and the dangers of over-reliance on AI, while providing guidance on overcoming these obstacles. Results suggest generative AI can add to students' abilities with it, blurring the lines between long established art design pedagogies and current digital practice rather than replacing them. Strengths and limitations This study's limitations were the use of secondary data and the emerging literature. Nevertheless, the review offers a useful structure for the integration of generative AI in the PBL context and announces the areas to be researched further, for example, longitudinal research on effects on learning and interdisciplinary research. Implications emphasize the importance of balanced uptake: making the most of AI's positive contributions to creativity and critique, while protecting students' agency and capacity for original thought.

Keywords: Generative AI, arts design education, Project-Based Learning, critical thinking, creativity, AI tools

Introduction

Generative Artificial Intelligence (GAI) has gained rapid attention as a means of transforming industries through advanced algorithms and large-scale datasets to generate novel and context-relevant outputs. Generative AI models emulate human creativity, enabling applications from text generation to image synthesis and design refinement. AI-generative tools like ChatGPT, Midjourney and Stable Diffusion spread creative workflows at scale and new possibilities for promoting creativity and collaboration in design art education. As the shifting topography of creative industries globally is being molded by AI tools (Guridi *et al*., 2023) [14], integration into education by such technologies is vital.

Art and design education, marked by iterative processes and collaborative problem-solving, needs new pedagogical approaches that resemble digital economy skills. Problem-based learning contrasts with more traditional methods and is also an example of hands-on, inquiry-based learning that broadly aligns with the GAI tools. PBL promotes critical thinking, creativity, and teamwork – qualities much more enriched by GenAI's role as a co-creator rather than a replacement. ChatGPT aids textual ideation, Midjourney supports visual exploration, and Stable Diffusion refines iterative designs. Together, these tools form an ecosystem that enhances both individual and collaborative learning (Casakin & Wodehouse, 2021) [7].

The urgency of GAI integration is underscored by estimates that over 50% of creative sectors will adopt AI-assisted workflows by 2025 (Torres Carceller, 2023) [19]. The penetration of generative AI in art design education is uneven in different regions and academic units. Although a few well-resourced programs (especially in North America, Europe, and East Asia) have started incorporating AI into coursework, many others, particularly in resource-constrained or non-Western contexts, are in their infancy in terms of AI integration. For instance, in the Asia-Pacific regions, AI-in-education policies and pilot programs have been established in countries such as China and Singapore, while others are challenged to meet the most basic infrastructure and training needs (UNESCO, 2023) [20]. As well as GAI's ubiquity, it also presents an opportunity to democratize arts-design education. In resource-poor contexts, schools and universities can harness GAI to ameliorate disparities in access to high-caliber design software, thereby equalizing opportunity for students across the globe (Baskara, 2023) [4].

PBL's iterative making, problem-solving, and critique methods align closely with GenAI's capabilities. Creative fields have long used PBL to foster skills essential for today's workforce. Generative AI enhances PBL workflows by enabling tools like ChatGPT to act as a brainstorming partner, Midjourney to facilitate rapid visual prototyping, and Stable Diffusion to refine final outputs. Through embedding AI at both the ideation, prototyping, and critique, teachers can design a more robust learning experience that aligns with professional practices. Harmonized approaches are needed to temper GenAI's promises with its technological and ethical issues (Chen *et al*., 2023) [8].

Opportunities come with their ethical considerations. There are also significant intellectual property opportunities to be addressed, particularly given the ambiguity of authorship that is a feature of AI-generated outputs. According to recent research, 70% of teachers and students in the US were unsure about AI-assisted ownership and that poses academic integrity challenges (Torres Carceller, 2023) [19]. Too much reliance on AI could also dilute critical thinking and manual skills of design. There must also be careful scaffolding to not undermine basic cognitive skills (Ali *et al*, 2024) [1].

In this paper, we examine how ChatGPT, Midjourney, and Stable Diffusion can be combined in PBL-based arts design education and further discuss their combined effects of these techniques on creativity, critical thinking and collaboration. We chose these tools for their complementary roles: ChatGPT to help ideate, Midjourney to bridge between concepts and visuals, and Stable Diffusion to help refine. Used together, they facilitate the iterative and interdisciplinary nature of PBL projects (Guridi *et al*., 2023) [14].

In arts design education, while GenAI tools hold promises for transformation, existing research remains fragmented, focusing on isolated applications or specific tools. There is a need for integrated frameworks within PBL settings. Unlike empirical studies, this research adopts a literature review methodology to explore the theoretical and practical implications of integrating GenAI into arts design education. By systematically analyzing interdisciplinary studies, this review seeks to bridge the gap in existing literature by providing a conceptual framework that highlights the combined educational potential of GenAI tools. It aims to offer actionable strategies for embedding these tools into key stages of the PBL process while addressing associated ethical challenges and technical complexities.

Furthermore, this review establishes a foundation for future research by posing the following research questions:

RQ1: What are the overarching characteristics and the current state of research on the application of GenAI in arts design education?

Measurable Outcome: Mapping and categorizing the frequency and thematic focus of existing studies on GenAI integration, quantified through bibliometric analysis.

RQ2**:** How does the application of GenAI in arts design education foster critical thinking?

Measurable Outcome: Evaluating changes in students' critical thinking skills by analyzing pre- and post-intervention critical thinking assessment scores (e.g., using validated rubrics or critical thinking tests) in PBL environments with and without GenAI assistance.

RQ3**:** How does the application of GenAI in arts design education promote creativity and collaboration?

Measurable Outcome: Measuring creativity through originality and elaboration metrics in student projects and assessing collaboration via peer-evaluation scores and teamwork self-efficacy scales.

RQ4**:** What are the challenges, opportunities, and effective strategies for developing a cohesive framework to integrate GenAI into PBL in arts design education?

Measurable Outcome: Identifying and categorizing reported barriers and facilitators through qualitative coding of case studies and survey results from educators and students.

Synthesizing findings from interdisciplinary research, this study addresses critical gaps in existing literature, where the limited educational impact of GAI tools in education has been partly attributed to their fragmented application. It offers pragmatic strategies for integrating GAI into critical phases of PBL, presenting a framework for educators to not only optimise teaching and learning, but also grapple with ethical challenges. The importance of this research is to rethink art design education in an age where technology fluency matters. At a time when schools are working to promote critical thinkers, creators, collaborators, and changemakers – GAI technologies will provide essential support to help them do just that. But their potential to support teaching and learning are complex and nuanced, and to unlock that potential, we must continue to grapple with their capabilities and limitations and the implications for teaching and learning. Recent empirical work has also begun to document the uses of these tools in the wild: Wu and Dos Santos (2024) report evidence that students using ChatGPT and Midjourney out- perform control groups in critical reflection and creativity. Similarly, Furtado *et al*. (2024) [12] found that mediated interventions of Stable Diffusion promoted originality and peer feedback. Pahi *et al*. (2024) [17] demonstrated that the application of AI in the brainstorming of innovative ideas enhanced the innovative output and team engagement.

These pedagogically affordances of generative AI tools are consistent with the ones of this study and can be used together as an evidence of the value of AI in education when it is affordably scaffolded in a student-centred PBL process that can have valuable contributions on student' creative products, critical thinking, and teamwork abilities.They also highlight the importance of deliberate pedagogical structures to achieve benefits while avoiding pitfalls, such as over-dependence.

Materials and Methods

The development of this systematic review has been conducted in line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines about the incorporation of generative AI in arts design education (Wilson *et al*., 2024) [21]. This involved a systematic literature search using four key databases: Web of Science, SCOPUS, Google Scholar, and ERIC. spanning 2024 and 2023 publications, and employing keywords including "generative AI," "arts design education," and "project-based learning". Only peer-reviewed publications in English were included in the search and selection, oriented towards quality and relevance. A total of 144 records were identified in the first search. After applying exclusion criteria, 49 studies were included in the present review.

1. Screening for Overlapping or Similar Studies.

Articles were reviewed to identify and exclude those that were closely related in scope or derived from the same dataset. This ensured the inclusion of diverse perspectives

and minimized redundancy. After this process, 119 unique and distinct articles were retained for further scrutiny.

2. Screening for Relevance.
Titles and abstracts were reviewed to exclude articles unrelated to the research scope, particularly those not focused on Generative AI in arts design education. During this step:
Articles that discussed generative AI broadly but did not focus on its application in education were excluded.
Studies using ambiguous or irrelevant acronyms such as "PBL" (e.g., unrelated to project-based learning) were filtered out. After this initial screening, 68 studies were shortlisted for full-text assessment.

3. Application of Exclusion Criteria
A detailed review of the full texts of the 68 shortlisted studies was conducted to ensure alignment with the research objectives. Articles were excluded if they met the following criteria:

Non-peer-reviewed Publications: Conference abstracts, editorials, or other non-peer-reviewed works.

Insufficient Empirical Evidence: Short papers or studies lacking robust research methodology or results.

Focus on Perceptions Only: Articles that primarily explored perceptions or viewpoints regarding generative AI without empirical findings on its applications or outcomes.

Irrelevance to PBL or Arts Design: Studies unrelated to project-based learning frameworks or arts design education.
To reduce the risk of selection bias, various approaches were adopted in the screening and selection processes. To begin with, a comprehensive search of databases was conducted to have a broad collection of relevant studies from various regions and fields. Second, mainly inclusions and exclusions criteria were clearly pre-specified in advance of the selection process, which had led out to be the decision about eligibility consistent and objective. Studies that were not clearly discussing the use of generative artificial intelligence tools in arts design education based on a PBL environment were excluded. In addition, to increase the level of reliability, the full-text screening process was performed by two reviewers in a double-reviewer procedure. Eligibility of studies was appraised by two independent reviewers based on the pre-hoc criteria, and any disagreements were also resolved by discussion and consensus. Moreover, a snowballing technique -citation tracking- was applied for the potential detection of missed studies and to enhance comprehensiveness and validity of the final set of studies.

4. Snowballing for Comprehensive Coverage
To ensure thoroughness, a snowballing approach was employed by reviewing references and citations of the 47 shortlisted studies using tools such as Google Scholar and Scopus. This process identified 2 additional studies meeting the inclusion criteria, resulting in a final total of 49 studies.
The entire process is illustrated in Figure1 *Systematic Review Workflow and Database Distribution*, summarizing the identification, filtration, eligibility assessment, and final inclusion of studies.

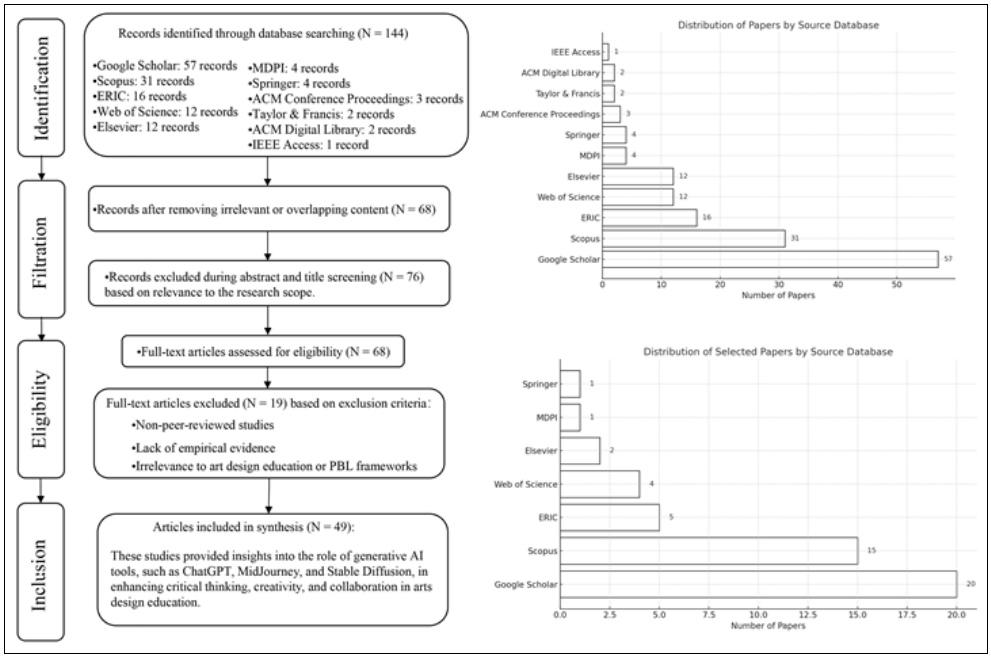

Fig 1: Systematic Review Workflow and Database Distribution

5. Research Methods and Coding Framework
This study adopts a systematic review methodology aligned with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The review aims to comprehensively analyze the integration of generative AI tools in arts design education within Project-Based Learning (PBL) frameworks, emphasizing critical thinking, creativity, and collaboration.

The research questions (RQs) guiding the study were developed to address the gap in literature and ensure the systematic organization of findings. These questions and their corresponding
coding categories are summarized in Table 1: Research Questions (RQs) and Coding Framework for the Integration of Generative AI in Arts Design Education.

Table 1: Research Questions (RQs) and Coding Framework for the Integration of Generative AI in Arts Design Education

RQ	Coding	Categories
1	Research Objects	Educational Levels: Higher education, vocational education, arts design education Tasks: Design challenges, creative projects, problem-solving, creative generation, collaborative learning Generative AI Tools: ChatGPT, Midjourney, Stable Diffusion, and other generative tools
2	Learning Support	Learning Support: Interactive learning, cognitive generation, problem-solving, critical thinking enhancement, creative generation Feedback: Timeliness, informativeness, interactivity, emotional connection, usefulness Evaluation: Adaptive assessment, authentic assessment, process evaluation
3	Challenges of AI	AI Limitations: Limited creativity, inability to produce originality Ethical Issues: Privacy concerns, data security, academic misconduct with AI use Capability Challenges: Dependence on AI tools limiting skills development
4	AI Integration and Methods	Integration of Generative AI: AI tools combined with PBL frameworks for creative tasks and design activities in classrooms Methodological Reliability: Ensuring scientific and transparent literature analysis

Results and Discussion

1. **RQ1:** What are the overarching characteristics and the current state of research on the application of GenAI in arts design education?

Table 2: Statistics on Key Characteristics and Trends in the Application of GenAI in Arts Design Education

Coding	Frequency of Mention	Percentage of Total Papers	Key Insights from Research	Papers Referenced
Creativity Enhancement	38	78%	GenAI tools like Midjourney and Stable Diffusion support rapid visual prototyping and ideation, expanding students' creative possibilities. AI encourages exploration of unconventional aesthetics and innovative design solutions.	Aslanyan-rad (2024) [3]; Evangelidis *et al*. (2024) [11]; Samaniego *et al*. (2024) [18]; Anam & Fathoni (2024); Takona *et al*. (2024); Ghimire *et al*. (2024); Zhang *et al*. (2024); Lu & Wang (2024); Bordas *et al*. (2024) [6]; Ruiz-Rojas *et al*. (2024)
Critical Thinking Support	40	82%	ChatGPT and similar tools are used for idea generation and conceptual thinking, helping students refine their designs and evaluate multiple approaches. AI tools encourage structured reflection on design decisions.	Mustafa *et al*. (2024) [16]; Furtado *et al*. (2024) [12]; Evangelidis `. (2024) [11]; Takona (2024); Ghimire *et al*. (2024); Lai (2024); Ghimire *et al*. (2024); Ali *et al*. (2024) [1]; Pahi *et al*. (2024) [17]; Li *et al*. (2024); Chu *et al*. (2024)
Collaboration Facilitation	36	73%	AI enhances collaborative learning by allowing students to co-create and share ideas seamlessly. Tools like ChatGPT facilitate real-time peer feedback and collaborative problem-solving in teams.	Samaniego *et al*. (2024) [18]; Lai (2024); Ruiz-Rojas *et al*. (2024); Evangelidis *et al*. (2024) [11]; Al Shloul *et al*. (2024); Bordas *et al*. (2024) [6]; Ghimire *et al*. (2024); Chen *et al*. (2024); Wang *et al*. (2024)
Integration into PBL Frameworks	40	82%	GenAI is commonly integrated within Project-Based Learning (PBL) settings, where it aids in the iterative creation, testing, and refining of design projects. PBL encourages active engagement with AI during the design process.	Furtado *et al*. (2024) [12]; Lai (2024); Samaniego *et al*. (2024) [18]; Ruiz-Rojas *et al*. (2024); Zhang *et al*. (2024); Pahi *et al*. (2024) [17]; Takona *et al*. (2024); Bordas *et al*. (2024) [6]; Takona (2024); Ali *et al*. (2024) [1]; Pahi *et al*. (2024) [17]
Improvement of Design Efficiency	35	71%	AI tools are leveraged to automate time-consuming tasks, such as image refinement and data generation, allowing students to focus more on higher-level creativity and critical analysis.	Samaniego *et al*. (2024) [18]; Takona (2024); Senger *et al*. (2024); Anam & Fathoni (2024); Chen *et al*. (2024); Bordas *et al*. (2024) [6]; Liu *et al*. (2024)
Ethical Concerns and Academic Integrity	29	59%	Intellectual property and authorship issues arise as students create works using AI tools. Some studies note that AI-generated content challenges traditional ideas of ownership in academic settings.	Anam & Fathoni (2024); Takona (2024); Ali *et al*. (2024) [1]; Samaniego *et al*. (2024) [18]; Pahi *et al*. (2024) [17]; Pahi *et al*. (2024) [17]; Liu *et al*. (2024); Bordas *et al*. (2024) [6]; Wu & Dos Santos (2024); Pahi *et al*. (2024) [17]
AI Tool Usability and Learning Curve	33	67%	Studies emphasize that the usability of AI tools, including their learning curve, is a significant factor influencing their adoption in education. Tools must be intuitive to encourage widespread use among students and educators.	Pahi *et al*. (2024) [17]; Lai (2024); Liu *et al*. (2024); Takona (2024); Pahi *et al*. (2024) [17]; Takona *et al*. (2024)
Addressing Equity in Education	30	61%	GenAI can make advanced design tools accessible to a broader range of students, promoting equity in design education. AI democratizes access to design resources and helps level the playing field for students with varying skill levels.	Lai (2024); Bektik *et al*. (2024) [5]; Ali *et al*. (2024) [1]; Takona (2024); Pahi *et al*. (2024) [17]; Ghimire *et al*. (2024); Samaniego *et al*. (2024) [18]; Pahi *et al*. (2024) [17]; Takona *et al*. (2024)

In the table "Statistics on Key Characteristics and Trends in the Application of GenAI in Arts Design Education", the trait most frequently discussed was enhanced creativity (78%). Supportive critical thinking (82%) and collaborative learning (73%) were the next most cited. These findings highlight the importance of GenAI tools such as ChatGPT,

Midjourney, and Stable Diffusion in aspects like creative ideation, problem - solving, and teamwork for students.

It also pointed out the dominance of Project-Based Learning (PBL) frameworks, with 82% of studies specifying that GenAI tools were integrated in the PBL context. This points out that GenAI's adoption in arts design education is most effective when working integrally with active and project-based learning styles. Many studies implicitly or explicitly point out that GenAI's adoption in arts design education is most effective when integrated into the iterative, hands-on nature of PBL rather than used in isolation. Furthermore, 59% of the studies indicated ethical considerations around issues like intellectual property and authorship with human versus machine-generated output, portraying the emerging awareness around legality and ethics of AI in practice. GenAI tools and their learning curves are the usability and accessibility of the tool for students and educators was highlighted in 67% of studies, raising continuing questions about accessibility of use for students and teachers. However, these tools may have limited communicative and operational efficacy at the hands of users not trained to comprehend their functioning and utility, as many studies indicate. Therefore, proper student/educator training and support is vital to harness GenAI tools complementary in arts design education. In other words, GenAI tools, while potent for the future of education, will not be necessarily adopted if students or educators think they are too difficult to learn or navigate. Hence, to successfully implement these technology aids in arts design education, it is necessary to address such usability issues.

Moreover, the risk of over-reliance on AI tools is an issue, with concerns that students may become increasingly dependent on AI assistance and avoid paying attention to critical thinking and the manual effort essential to the design process (Çela *et al*., 2024) [10].

2. **RQ2:** Fostering Critical Thinking through GenAI in PBL

Among these is one of the cores research questions (RQ2): how does the use of generative AI in the context of arts design education influence or enhance students' critical thinking skills in PBL settings. Designers and others have found that GenAI tools catalyze deeper reflection and iterative thinking across design projects. For instance, multiple studies show that granting students access to text-based GenAI tools (such as ChatGPT) during the ideation phase pushes them to think more broadly (Mustafa et al., 2024) [16] and consider alternative perspectives than they were likely to generate on their own. Typically, the suggestions of the AI require critical reflection and adjustment, which automatically brings students into this realm of assessing the appropriateness of degrees of freedom worth pursuing — a base critical thinking task.

GenAI tools also create avenues for structured reflection. Furtado *et al*. (2024) [12] narrate examples from their classroom where students would prompt AIs to critique or question their design choices. The AI's feedback (e.g., flagging issues or suggesting alternatives) acted as a stand-in for an "always available" peer reviewer, pushing students to explain their reasoning or reconsider assumptions. This practice allowed students to engage in metacognitive skills as they had to reflect on why they made certain design choices and how they could improve. Essentially, the AI can act as an effective opponent, driving students to challenge their original ideas or explore 'what-if' scenarios in a way that promotes the deepening of critical analysis (Lai, 2021) [15].

A second dimension highlighted in the literature is the role of GenAI as scaffolding for problem-solving. In fact, students may even apply GenAI to dissect problems into more understandable pieces or create a step-by-step proposal when faced with tricky design problems. Studies by Ghimire *et al*. (2024) found that students who used AI to assist their planning could not blindly follow the AI's steps; rather, they had to engage in critical deliberation about each suggested step. This entailed eliminating certain recommendations from AI if they turned out impractical or against the principles of design, identifying weaknesses or gaps in the remaining recommendations, and refining those through subsequent iterations. This cycle of human interaction with AI prompted students to directly connect their domain knowledge (aesthetics, composition, functionality, etc.) to evaluate the viability and pertinence of solutions generated by AI. By doing so, students were not simply taking AI outputs at face value, instead, they engaged in a process of criticism and reflection, in which automated suggestions were scrutinized, contextualized, and tuned to call to mind human judgment and creativity.

The literature also warns that AI should not simplify the thinking process too much. Students' critical thinking might stagnate if they accept AI outputs uncritically. Çela *et al*. (2024) [10] sounds the alarm over scenarios in which students could overly trust AI-generated solutions. In response to this, educators are encouraged to embed reflective activities explicitly. For instance, Wu *et al*. (2024) recommend that part of the PBL workflow include teachers asking students to identify assumptions or biases in AI outputs. Including these kinds of reflective checkpoints intentionally, GenAI usage cannot take the place of critical thought, only augment it.

3. **RQ3:** Enhancing Creativity and Collaboration through GenAI in PBL

RQ3 examines how GenAI applications promote creativity and collaboration in arts design education. A significant majority of the reviewed studies highlight creativity enhancement as a primary benefit of GenAI in design fields. GenAI tools, especially generative image platforms like Midjourney or text-to-image models, expand the creative toolkit available to students. They enable rapid visualization of ideas, which in turn fuels creative iteration. For example, Aslanyan-Rad (2024) [3] describes student designers using AI-generated images as inspiration boards – the unexpected outputs sometimes sparked entirely new design directions that students might not have conceived without the AI's creative input. This kind of serendipitous ideation (Evangelidis *et al*., 2024) [11] is a unique contribution of GenAI, wherein the AI-generated content serves as a springboard for human creativity rather than a final product. Students can explore more "radical" design alternatives with low risk, since generating a new image or variation through AI is relatively quick and inexpensive in terms of effort. Several papers (e.g., Samaniego *et al*., 2024 [18]; Ghimire *et al*., 2024) observed that this leads to students experimenting with bolder ideas and developing more innovative solutions in their projects, thereby broadening the creative horizon of what they consider possible.

GenAI tools can serve a facilitative function in terms of collaboration around team-based projects. Others found that when student teams work on a PBL project and can draw on tools such as ChatGPT or visual AI generators, it restructures the team dynamics for the better. Research shows that when groups use ChatGPT to facilitate discussions, ultimately, they produce better-balanced project plans. Team members would ask ChatGPT a question (like, what are some ways to combine certain artistic styles, or how to resolve a specific design challenge) and then discuss the AI's responses. This process offered a dispassionate "third voice" in group discussions that at times helped equalize participation—those who needed to ponder things longer before sharing theirs farther could do so by responding to the AI's prompts. In time, this offered more confidence and involvement from all the group members. Likewise, other research describes how AI was applied to archive and summarize group brainstorming sessions, enabling teams to more closely monitor their progress and decisions and to ensure that all members stayed on the same page, reducing miscommunications.

It's important to note that while GenAI can enhance collaboration, the teacher's role in orchestrating these activities remains crucial. A poorly structured use of AI might lead to one student dominating AI interaction or teams relying on AI without sufficient human-to-human discussion. Samaniego *et al*. (2024) [18] and Bordas *et al*. (2024) [6] both emphasize the need for clear guidelines: for instance, establishing turn-taking protocols when using AI in a group, or using AI outputs as starting points that teams must then develop further without AI. These strategies ensure that collaboration is genuinely occurring among students, with AI as a support tool.

4. RQ4: Challenges and Strategies for Integrating GenAI into PBL

The final research question (RQ4) addresses the challenges, opportunities, and effective strategies for developing a cohesive framework to integrate GenAI into PBL in arts design education. Literature does not shy away from pointing out multiple challenges that educators and institutions face in this integration process, as well as suggesting strategies to overcome them.

One major category of challenges involves ethical and academic integrity issues. As mentioned earlier, uncertainty about intellectual property ownership is common. Students and educators are often unclear on how to attribute co-created works (human + AI) and whether using AI constitutes plagiarism or misrepresentation of a student's own efforts. Opportunities here lie in proactively establishing clear policies and ethical guidelines. For example, some institutional guidelines propose clarifying the line between inspiration and copying and outlining how AI contributions should be cited in student work. Some design programs have begun treating GenAI tools similarly to how they treat design software: as accepted aids, provided the process and contribution are documented. A strategy emerging from multiple sources is to include discussions of AI ethics in the curriculum itself, so students become aware of issues like bias, ownership, and responsible use (Anam Fathoni, 2023) [2]. This educational approach turns a challenge into a learning opportunity, making students part of the conversation on how to ethically use these new tools.

Another set of challenges relates to the technical and practical integration of AI tools. The learning curve for both students and teachers can be steep (Pahi *et al*., 2024) [17]. If an AI tool is too complex or unintuitive, it can frustrate users and impede learning rather than enhance it. Many studies stress the need for adequate training and support. One effective strategy is offering professional development for educators focused on GenAI tools (Wu & Dos Santos, 2024). Teachers who are confident and competent in using AI are better able to integrate it into their project assignments and can troubleshoot or guide students more effectively. Wu and Dos Santos (2024) found that teachers who underwent workshops on AI-assisted art creation were more adept at redesigning their PBL activities to include AI in a meaningful way, and they felt more comfortable with shifting their role from content deliverer to facilitator/coach as AI took over some routine tasks.

Closely tied to training is the need for infrastructural support. Not all institutions may have the computational resources or subscriptions required for advanced GenAI tools. An equitable integration strategy, as suggested by Bektik, D *et al*. (2024) [5], is for institutions to invest in centralized AI resources (like a computer lab with access to powerful AI platforms or institutional licenses for key software) to ensure all students have equal access. This addresses the equity concern where some students might otherwise be left out due to lack of personal resources.

Over-dependence on AI is a complex issue. Although GenAI can support critical thinking and creativity, if not carefully framed, students may depend on it as a crutch. Çela *et al*. (2024) [10] explicitly caution against the overreliance on AI suggestions, resulting in shallow learning, as students mindlessly accept suggestions without understanding the answers. One prevention strategy is to include reflective or meta-cognitive components in each AI-facilitated PBL task. For example, an assignment might require students to first sketch or outline their ideas by hand and then generate them in Midjourney, or to write a personal reflection about the way they used ChatGPT and what they learned from its outputs. By structuring learning into projects that require human intervention and reflection at each juncture, teachers ensure that AI is an enhancement, not a replacement, for student thinking and effort.

Apart from pedagogical concerns, the ways of working with GenAI tools in arts design education are impeded through systemic barriers. One major barrier is institutional resistance because of which many conventional institutions are unwilling to learn/adopt new technologies, afraid of the fact that the new technology may disrupt the existing curriculum or threaten accreditations, or because the faculty are not familiar with AI (Chen *et al*., 2023). There are also technical challenges associated with integration. It is also a pity that the powerful tools such as Midjourney and Stable Diffusion are not widely used, as they depend on the support of the IT infrastructure and technical knowledge, which might be lacking in underfunded or non-technical art departments (Bektik *et al*., 2024) [5]. Significant barriers are also financial in nature. Licensing fees, teacher training programs, and infrastructure improvements require hefty investment that can be out of reach for even the most well-funded arts education institutions. Dismantling these barriers will call for strategic investment - such as dedicated funding, improved technical support, and faculty development to provide equitable and sustainable integration of GenAI in arts design education.

Finally, some articles also mention the concept of a coherent integration structure for GenAI in PBL.

Instead of making incidental use of AI tools, an effective strategy would be to define at what point and how AI should be used across the PBL cycle. For instance, Furtado *et al*. (2024) [12] propose one model in which GenAI is brought in during ideation (to broaden ideation), optionally employed during development (to assist with prototyping or request research), before potentially being brought into reflection (to generate feedback or critiques). This means that, by deliberately integrating AI at various stages, they can leverage its strengths (such as creativity boost at the initial stages of the project, or critical feedback at the final stages) without allowing it to conquer the whole project. Some even started to propose conceptual frameworks or flowcharts for this. For example, Zhang *et al*. (2024) identify a PBL-AI integration model and include ethics and skill-building checkpoints. So, they model it such that we discuss, there is a tutorial or a session after every AI use. Such frameworks illustrate the kind of strategic thinking you need to bring GenAI in a cohesive way: the technology is integrated into the pedagogy in an appropriate way.

Although GenAI tools provide noteworthy short-term gains for creativity and collaboration, their impact on students' autonomy, and critical design capacities is something to be cautious about. Classic classroom settings can be more easily conducive to guided exploration, but online contexts are difficult to keep an equal level of engagement and accessibility to AI resources.

Conclusion

This literature review serves to demonstrate how using generative AI tools alongside a PBL framework can greatly develop critical thinking, creativity, and collaboration in arts design disciplines. Tools such as ChatGPT, Midjourney, and Stable Diffusion, when strategically adopted at different phases of design projects, harness students' creative ideation, facilitate iterative design improvement, and unlock new approaches for collaborative learning." These high-level benefits align with burgeoning evidence that AI-facilitated interventions in the art educational realm can unleash creative potential and enable co-creational learning experiences. Still, though the benefits for pedagogy are not in doubt, our analysis also identifies important caveats: We found that an overreliance on AI assistance can compromise student originality and active cognitive engagement, with the potential that these actions make for shallower learning outcomes. This reinforces the importance of gradual, balanced GenAI adoption, making sure it acts as a learning enabler and not a learning crutch.

Some of our main contributions are a conceptual model to help educators adopt AI into PBL, providing structure by which faculty can leverage the advantages of AI whilst also safeguarding students' cognitive engagement. In addition to this review of the ethical challenges associated with AI, we provide strategies to ensure that students develop creative skills alongside critical ones and deploy AI responsibly.

This article has its limitations based on secondary data and more research work are necessary to be able to confirm the proposed frameworks in actual classroom context. Educators should seek to incorporate GenAI resources as supplemental teaching tools, while holding on to traditional hands-on design processes that stimulate independent critical thinking and creativity. For further study, a longitudinal study can be employed in future study to investigate the impact of lengthened use of GenAI tools on the creativity, critical thinking, and independent learning abilities of students over time. Besides, further comparative studies in various educational systems and cultural settings are necessary to examine the generalizability and transferability of GenAI-supported PBL models.

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