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International Journal of Graphic Design (IJGD)
Volume 03 No. 01 May 2025
E-ISSN: 2987-9434; P-ISSN : 2988-0343, Page 01-18
DOI: https://doi.org/10.11054/yy0jcw48
Available online at: https://journal.stekom.ac.id/index.php/ijgd

Integrating Generative AI and ChatGPT in Design Education: Impacts on Critical Thinking Development

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Abstract. *The integration of generative artificial intelligence (AI), and more particularly ChatGPT, into design education has brought about opportunities and challenges in developing critical thinking among students. As the design discipline increasingly intersects with emerging technologies, educators must take into account the implications of AI-powered tools on cultivating essential cognitive skills. The aim of this study is to investigate the implications of generative AI and ChatGPT on the critical thinking of design students in educational contexts. A mixed-methods approach was employed, combining quantitative data from pre- and post-intervention surveys with qualitative data from reflective diaries and focus group discussions. The subjects of the study were students majoring in visual communication design who utilized ChatGPT and generative AI tools throughout the semester. The findings attest to the improvement in critical thinking capability in problem definition, conceptualization, and self-reflection. In addition, the study affirmatively confirms that use of AI guided by others—additive to formal learning structures—may enable students' autonomy and creative thinking without reducing their creativity. These results suggest that generative AI, as an adjunct incorporated curricularly in strategic ways, could act as a pedagogical catalyst for advancing students' ability to think higher-order. This present study is part of the new debate concerning AI education in two essential ways: first, by means of a model of efficient application of generative AI by morals-based models. Research in the future will have to consider long-term effects and cross-disciplinary usage to further pedagogical strategies.*

Keywords *ChatGPT, Critical Thinking, Creative Pedagogy, Design Education, Generative AI*

INTRODUCTION

The revolutionary leap in Artificial Intelligence (AI) technology over the past decade has induced dramatic transformation in numerous fields, including design education. Generative AI and ChatGPT are among the most significant breakthroughs, as they are able to generate text, images, and other forms of creative content on their own (Bengesi et al., 2024). Its use in design education has been gradually increasing, as the profession increasingly requires graduates who are not only creative but also sensitive to digital technologies (Cropley, 2020; Mian et al., 2020). Design schools worldwide have begun integrating generative AI into their curricula, employing it as a visual aid, idea generator, and creative simulator, as per (Fleischmann, 2024).

In addition, ChatGPT has specifically been employed as a learning companion, offering ease of access to information and assisting students in the process of idea exploration (Xiao & Zhi, 2023). However, the ease of use of this technology has created doubts regarding AI dependence, which might hinder the learning of critical thinking—a necessary competence in design learning (Ruiz-Rojas et al., 2024; Zhai et al., 2024). Whereas others have looked into the

Published: May, 2025
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use of AI in education (Chen et al., 2020; Ouyang et al., 2022), the impact of ChatGPT and generative AI on creating the critical thinking ability of design students has scarcely been investigated. Studies today are more likely to emphasize the technical aspects of AI application or merely measure the improvement in learning efficacy, but not on the long-term impacts on cognitive skills such as critical thinking (Zhai et al., 2024).

This gap is the primary concern of this research to determine the precise effect of integrating generative AI and ChatGPT on developing critical thinking skills among design students. The aim of this research is to explore in detail the effect of the integration of generative AI and ChatGPT in design education on the development of students' critical thinking skills. Guided by a qualitative research approach, the present research seeks to generate a comprehensive overview of the possibilities as well as challenges that go into using AI technology for upgrading design education quality. Research introduces a new viewpoint towards enjoying the reality that AI technology is not just an idea-generating tool, but just as much a trigger of analytical thinking as well. The outcomes of this study should be employed as a basis for the development of adaptive design curricula and as a reference point for institutions in designing AI integration that enhances technological convenience as well as ensuring the enhancement of critical thinking.

LITERATURE REVIEW

A. Generative AI in Design Education

The evolution of Generative Artificial Intelligence (AI) technology in the last decade has brought profound transformation in every field, including design education. AI generating refers to a technology that can produce new content-including text, images, audio, and video-based on the data and patterns already learned (Bandi et al., 2023). Some of the most notable applications of generative AI include Large Language Models (LLMs) like ChatGPT that are able to generate natural language with a high level of relevance and context (Bhattacharya et al., 2024). The technology holds great potential for augmenting both effectiveness and innovation in teaching and learning practices in the field of design. Artificial Intelligence's potential to produce numerous content possibilities makes students' brainstorming sessions more speedy and vibrant.

In design education, generative AI has been applied in automating visual prototype design, speeding up idea generation, and reproducing intricate design results (Gao et al., 2024). Design schools worldwide have begun adopting this technology in their curriculum, according to (AlNajdi, 2022). The application of AI is not only intended to enhance students' efficiency but also to prepare graduates with the capacity to keep pace with technological advancement in the creative industries (Chaka, 2023). Exposure to generative AI enables students to develop their

technical competency and enhance their visual thinking through rapid exposure to global design references. The incorporation of this technology is perceived as able to satisfy the growing needs of an industry, which is more and more oriented towards a synthesis of creativity and technological knowledge (Yunianto & Wahyudi, 2024).

However, its incorporation in design education also raises pedagogical concerns that must be addressed. (Sharma et al., 2023) point out that without regulations, AI application can enable passive learning tendencies where students depend only on outputs generated by machines without initiating the process of examination critically. Too much dependence on AI can de-motivate students to investigate concepts independently, thereby undermining the intellectual processes design education must encourage. Hence, it is crucial that teachers ensure that the incorporation of AI into the curriculum is not only made in a convenient way but also preserves the focus on the development of critical thinking and creativity. The appropriate methodology of teaching will enable AI to serve as a support system rather than a substitution mechanism for students' cognitive functions.

B. The Use of ChatGPT as an Instructional Tool in Design

ChatGPT, as a text-based form of generative artificial intelligence, has been utilized extensively in design education due to its potential for offering immediate and contextually pertinent responses. Students utilize ChatGPT for a variety of activities, such as concept generation, development of narrative design, and exploration of varied innovative strategies (Kartal, 2024). ChatGPT is also a virtual teaching assistant, facilitating one-on-one and adaptive learning processes that are location-free and time-free (Lin, 2024). Through its interactive properties, students are able to expand their worldviews and accelerate the brainstorming process of their design project. Having ChatGPT also leads to higher student confidence in trying out different creative strategies that they would not have tried before (Prihatmoko & Setiyadi, 2024).

Still, a number of studies have illustrated the danger of over-reliance on ChatGPT that can impinge on the acquisition of critical thinking capacity. Students are likely to accept AI- generated answers without critical assessment and scrutiny (Hooda et al., 2022; Shoufan, 2023). According to a study by (Suriano et al., 2025), such reliance can erode metacognitive skills like reflective and analytical thinking that play a vital role in design education. As such, the integration of ChatGPT should be complemented with pedagogical strategies that promote learners' active engagement in thinking and critically assessing what they are being told. Active learning and critical digital pedagogy are some of the effective strategies that can be employed in ensuring that ChatGPT is utilized as a support tool rather than a replacement for students' critical thinking capacities.

C. Critical Thinking Theory in the Context of Design Education

Critical thinking is a fundamental skill relevant in design education as it allows students to make judgments, evaluate, and logically solve problems. (Silva Pacheco & Iturra Herrera, 2021) describe critical thinking as a process of thinking characterized by the capacity to analyze, assess, and reach conclusions in a logical and rational way. In design, this capability is crucial when students must respond to complex problems, analyze innovative solutions, and consider the aesthetic, social, and ethical value of their work (Weng et al., 2022). Without strong critical thinking capabilities, students will necessarily produce work that is technical but not context- and impact-sensitive. Therefore, becoming critically thinking designers is one of the measures of success of the design educational program.

Besides, social constructivist theory, advanced by (Wong et al., 2021), emphasizes that learning is optimally attained through discussion and socialization. Translating this in technology-based learning, for instance, using ChatGPT, the students must be guided to utilize the technology as a stimulus in their thought process and not as a band-aid solution. The interaction between students and AI technology needs to continue to involve reflection, discussion, and collaborative assessment of ideas in order to foster deep understanding. This is in harmony with the view that technology should support active learning approaches instead of substituting students' mental work. The application of ChatGPT therefore needs to be applied wisely in learning spaces that focus on students' mental engagement.

(Burke & Larmar, 2021) focus on the need to incorporate technology in learning through pedagogical strategies founded on dialogue and reflection. Utilization of ChatGPT should go beyond answering questions at the speed of light; it has to require learners to reflect and critique the information offered critically. This can be enhanced through methods like classroom discussions, peer assessment, or critical thinking problem-solving exercises. In the process, students are not only taught to receive but to produce ideas that exhibit and demonstrate reflective and analytic thinking. Curriculum development must thus attempt to balance the use of technology with the development of students' critical thinking.

D. Empirical Studies on the Impact of AI on Critical Thinking

An increasing amount of studies has explored the use of Artificial Intelligence (AI) in education, especially concerning the improvement of learning process efficiency. In their systematic review, (Wagner et al., 2022) discovered that most AI-related research continues to concentrate on technical elements, including data management and information retrieval. Regrettably, the number of studies investigating the effect of AI on the enhancement of higher-

order cognitive skills, including critical thinking, remains limited. This reveals a gap in the literature, which tends to emphasize AI's role as an administrative aid rather than as a catalyst for advancing students' intellectual capabilities. Yet, critical thinking is an essential competency in education, especially in fields like design, where deep evaluative thinking is a fundamental requirement.

(Guo & Lee, 2023) highlight that while AI can enhance information accessibility, it does not automatically contribute to the development of critical thinking skills. Without the support of appropriate pedagogical strategies, the use of AI may in fact encourage passive learning patterns, wherein students rely solely on machine-generated responses. Likewise, (Liu et al., 2023) claim the instrumental integration of AI frequently neglects the reflective and evaluative aspects of the educational journey. Without adequate educational support, students may forfeit important chances to enhance their skills in analyzing, synthesizing, and critically assessing concepts. Hence, it is crucial for educational organizations to develop strategies for integrating AI that proactively encourage students' intellectual participation.

Integrating AI with educational techniques such as problem-solving, peer review, and discussive critique fully incorporates the use of these technologies while lessening the chance of overdependence on them, as explained in (Zhai et al., 2024). The integration of AI is helpful when it is meant to assist, and care is taken to ensure students' critical thinking skills are developed as well. However, there is still a vast gap in research focusing on the influence of generative AI and ChatGPT on critical thinking skills within the scope of design education. The majority of the available literature still emphasizes the functionality and the ease of use of AI/AI technologies. This is what motivates the present study: to provide a constructive understanding of how generative AI can be used decisively to enhance the design students' critical thinking abilities.

METHODS

A. Research Proposal

This research introduces a model for the strategic integration of Generative AI, focusing on ChatGPT, into the educational instruction framework of design courses. The incorporation is perceived not only as a form of technological assistance, but also as a constantly engaging partner throughout the learning journey for students. This blend uses Critical Digital Pedagogy (CDP) to make students actively assess, think about, and reflect on the AI's produced results and products. In a more technical field, the integration of ChatGPT aims at four main strategies: brainstorming sessions, discussion, reflection journaling, and project-based learning activities.

In employing this approach, students should learn not only the technical support but also develop higher critical, creative, and reflection thinking abilities. The model's intention is to minimize the technology dependency risk with a push on making students ideators and not just information buyers. Apart from its practical application benefit, the research creates an emulational CDP framework model of integrating AI that may be followed by other companies. Therefore, the study provides a tangible answer to bridge digital transformation and enhance reflective teaching principles.

B. Methodology

To maintain the validity and reproducibility of the study, the research is divided into five major phases. Step one of the research entails creating a design education instructional module with ChatGPT to frame an AI-infused intervention curriculum. The module positions AI as a facilitator of reflective thinking and not a technical tool by emphasizing the generation of ideas, critical discussion, and design critique. For facilitating the cognitive engagement of the students, the content also offers moral guidelines for AI usage. For the effective integration of ChatGPT, the intervention curriculum is enacted in a systematic fashion through eight sessions of the Digital Design Studio course.

In the second stage, participants are recruited and 30 fifth-semester University X Visual Communication Design students form the study population. Purposive sampling is used in the selection of participants with an emphasis on having students who have utilized ChatGPT for one or more semesters. As a common point, they also attended an introductory workshop on the ethical use of AI (Vakkuri et al., 2021). The data is gathered in stage three using semi-structured interviews, class observation, and student design assessment. These three approaches complement each other to give a general picture of how the critical thinking skills of students are developing (Cáceres et al., 2020; Shaw et al., 2020).

The fourth step is data analysis by thematic analysis to determine the trends of the critical thinking of the students. Coding of data, thematic grouping, and interpretation based on critical thinking dimensions are all part of the analytical process (Braun & Clarke, 2021). Triangulation of interviews, project analysis, and classroom observations strengthens data validity. NVivo software is also used to make qualitative data processing easier (Lemon & Hayes, 2020; Limna, 2023; Natow, 2020). The final step is evaluation, where the growth of students in analysis, evaluation, inference, and reflection is measured through the Faciano rubric. The results of the evaluation show that ChatGPT helps in preparing students with their critical thinking abilities (Guo & Lee, 2023).

C. Instruments and Data Information

This research employed some of the needed tools in order to facilitate massive data gathering and evaluation. The tools were constructed to determine the perceptions of the students as well as their critical thinking capacity throughout the process of learning along with ChatGPT. Some of the key tools used were semi-structured interviews, classroom activity observations, the Facione model critical thinking rubric, and grading students' design projects. Each instrument fulfilled a supporting function in collecting authentic, complete, and measurable information. The specification of the instruments and their roles is given below in Table 1.

Table 1. Research Instruments and Their Functions

Instrument	Function
Semi-Structured Interviews	To explore students' perception regarding their experiences and viewpoints in using ChatGPT.
Classroom Activity Observations	To document the interaction processes between students and ChatGPT, particularly during brainstorming and critical discussions.
Facione's Critical Thinking Rubric	To evaluate how well studens have developed their critical thinking abilities in the four primary areas of analysis, evaluation, inference, and reflection.
Student Design Project Analysis	To evaluate the quality of ideas, originality, and the level of critical reflection demonstrated in students' creative outputs.

Along with the main tools, this research is also accompanied by a number of other instruments and platforms in order to enable the process of data collection and analysis. The primary platform that is used here is ChatGPT (GPT-4 API), and it is used as a learning tool within the process of designing and analyzing design concepts. For aiding qualitative data processing tasks, NVivo is employed to enhance thematic coding in addition to data gathering collected with interviews, observation, and students' projects using its analysis capacity increased. Normal machinery like a computer or laptop is used by the students to work with ChatGPT and achieve design work. With this fusion of tools and equipment, the research hopes to gather precise and extensive data in exploring how AI incorporation influences the enhancement of critical thinking among design students.

D. Theoretical Framework Development

Theoretical foundations for this research are social constructivist theory and the Critical Digital Pedagogy (CDP) model. Social constructivism underscores that learning is best achieved through social interaction, conversation, and participatory knowledge building. In the use of ChatGPT, students are not only taught but are also asked to learn, converse, and analyze AI-produced results together with peers and educators. To the contrary, CDP holds the opinion that

educational digital technology should be reflective and critical and call for students to think critically and actually involve themselves in all phases of learning.

This research develops an AI integration model blending these two approaches with a focus on technical effectiveness as well as intellectual growth of the students. Students brainstorm and discuss with ChatGPT to critically assess AI-proposed ideas, apply them to design contexts, and think critically about their creative process. Through this, it is expected that critical thinking capabilities of the students, which include analyzing, evaluating, inferring, and reflecting, will be shaped. Aside from that, class discussion and peer review social interaction serve as critical contexts for argument evaluation, ideas expression, and defending design decisions.

This is a conceptual model which can provide scope for integration of ChatGPT to function as a driving force for building critical thinking and not just an automation mechanism. The conceptual model developed in this study is presented in Figure 1. It represents a structured framework that aligns generative AI with reflective learning processes and pedagogical intent. By emphasizing critical interaction rather than passive usage, the model offers practical guidance for educators aiming to foster higher-order thinking through AI-supported instruction.

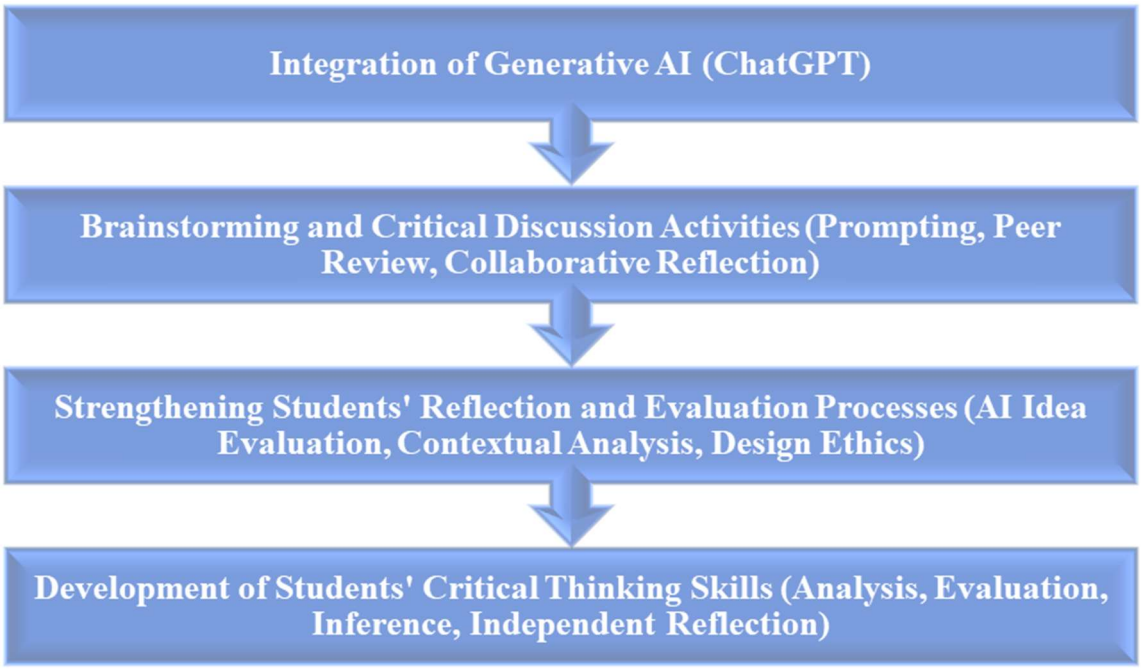

Figure 1. Research Framework for AI Integration in Design Education

This model shows that the integration of ChatGPT relates to learning activities of critical reflection, finally leading to students' improved critical thinking ability. The engagement of AI goes beyond offering answers; it is extended to where students can critically appraise, analyze, and generate ideas by themselves. Such interaction encourages learners to move from passive

receivers of information to active participants in constructing knowledge. This reinforces the importance of pedagogical frameworks that promote reflection and evaluation in the use of AI tools within design education.

E. Implementation of the Solution

The approach is implemented methodically in four phases so that ChatGPT can be effectively utilized for developing critical thinking among design students. The first phase entails workshops and socialization, where students and teachers undergo technical and ethical training on how to use ChatGPT. The materials for training include the creation of effective prompts, strict testing of AI-produced content, and digital ethics principles to guarantee academic integrity of AI application. The workshops entail simulations of ChatGPT applications in design situations, giving students hands-on knowledge. The training provides a background for students to use AI responsibly during their course of study.

The second component is completing an eight-week learning module as part of the Digital Design Studio course. The module includes brainstorming innovative ideas with ChatGPT, in-class discussions, peer feedback, and design exercises utilizing AI as inspiration. The students are asked to utilize AI not just on a technical level but also think very carefully about how their own minds are functioning. Such activities attempt to make sure that AI acts as a facilitator in the development of students' creative ideas, and not utilized as an automation tool without reflective thinking. Thus, the whole learning process attempts to stress students' critical thinking at every step of the learning activity all the time.

The third stage involves observation and monitoring, where lecturers monitor students' interaction with ChatGPT during the class periods. The observation focuses on the prompting process, evaluation of AI-generated responses, and students' engagement in critical discussions. Observational data serve as the primary source for analyzing the development of students' critical thinking skills. The fourth stage is the final evaluation, conducted using a critical thinking rubric based on Facione's model, which includes four dimensions: analysis, evaluation, inference, and reflection. The evaluation results indicate the extent to which the integration of ChatGPT contributes to enhancing the critical thinking skills of design students. The following formula (1) is used to calculate the index of critical thinking skill development.

$$CTI = \frac{(A+E+I+R)}{4} \quad (1)$$

Where:

CTI = Critical Thinking Index

A = Analysis Score

E = Evaluation Score

I = Inference Score

R = Reflection Score

The CTI scores obtained by students fall within a value range of 1 to 5, in accordance with the Likert scale used in the assessment rubric. A score of **CTI ≥ 4** is interpreted as an indicator that the student has demonstrated optimal development of critical thinking skills. This formula enables researchers to measure students' progress in an objective and standardized manner, while also facilitating the replication of the evaluation in similar studies. The indicators for the four dimensions are listed in Table 2.

Table 2. Indicators of Critical Thinking Development

Dimension	Indicator	Description
Analysis	In-depth identification of design problems	Students are able to deconstruct the components of a problem or challenge within the design process in detail.
Evaluation	Critical assessment of ChatGPT output	Students evaluate the accuracy, relevance, and quality of the solutions generated by the AI.
Inference	Drawing logical conclusions from AI results	Students are able to develop new ideas or creative solutions based on their exploration using ChatGPT.
Reflection	Reflecting on the thinking process and final outcome	Students reflect on the strengths, weaknesses, and implications of the ideas or designs they have produced.

Through this systematic implementation process, the study is expected to make a significant contribution to the development of an AI-based design learning model that continues to emphasize the enhancement of students' critical thinking skills. Such a model offers not only a framework for integrating ChatGPT pedagogically but also demonstrates how generative AI can support reflective learning. By prioritizing cognitive engagement rather than automation, the model addresses existing concerns about AI-induced passivity in educational settings. This contribution is particularly valuable as institutions worldwide seek adaptable strategies to align digital tools with human-centered learning outcomes.

RESULTS AND DISCUSSION

A. Testing Results and Analysis of ChatGPT Implementation in Design Education

The implementation of the ChatGPT-based learning module was carried out over an eight-week period in the Digital Design Studio course. In this study, a total of 30 students took part,

and data was gathered via observation, semi-structured interviews, and examination of student design projects. Observational results show that most of the students used ChatGPT for the most part during the brainstorming stage of the design process. Students' inquiry activities shifted from basic to more sophisticated ones with time. At the initial stages of usage, students accepted AI-provided results with fewer critical judgments.

But with peer review and class discussion feedback, the students started to show a willingness to critique and edit the AI-generated outputs depending on the design context they were working on. The change conforms to the findings of (Wang, 2020), who posits that student participation in tech-oriented learning processes has the potential to help counter passive learning behaviors. Students who initially worked mainly based on ChatGPT responses migrated to critically probing the generated ideas, taking into consideration the balance of such in line with the design brief as well as gauging aesthetic and ethical aspects of their deliverables. This is a demonstration that generative AI, where educated in concert with a contemplative pedagogy, is capable of filling the role of a critical thought facilitator and not just technically support (Ruiz-Rojas et al., 2024).

B. Interpretation of Interview, Observation, and Evaluation Data

According to the semi-structured interview findings, 80% of the students indicated that ChatGPT allowed them to test their ideas instantly. Nevertheless, 70% of them admitted a tendency to accept AI-produced results without analyzing their validity or accuracy at the onset. Following the intervention—consisting of class discussions and reflective journals—most students began to demonstrate a more critical stance toward AI outputs. Students noted that discussion sessions and peer reviews encouraged them to evaluate the ideas produced by AI more thoroughly. Table 3 presents a comparison of student activities before and after the intervention:

Table 3. Comparison of Student Activities Before and After the Intervention

Indicator	Before Intervention (Percentage)	After Intervention (Percentage)
Use of ChatGPT for brainstorming	90%	95%
Critical evaluation of AI output	30%	85%
Ability to reflect on thinking processes	25%	80%

Table 3 indicates a significant improvement in students' critical evaluation and reflective thinking following the implementation of reflective learning strategies. Figure 2 further illustrates the increase in critical evaluation and reflection among students. These findings suggest that targeted interventions, such as structured peer discussions and reflective journaling, can effectively shift students from passive acceptance of AI-generated content to active engagement.

This reinforces the potential of generative AI tools, like ChatGPT, to serve not merely as content providers but as catalysts for deeper cognitive engagement when integrated through thoughtful pedagogical design.

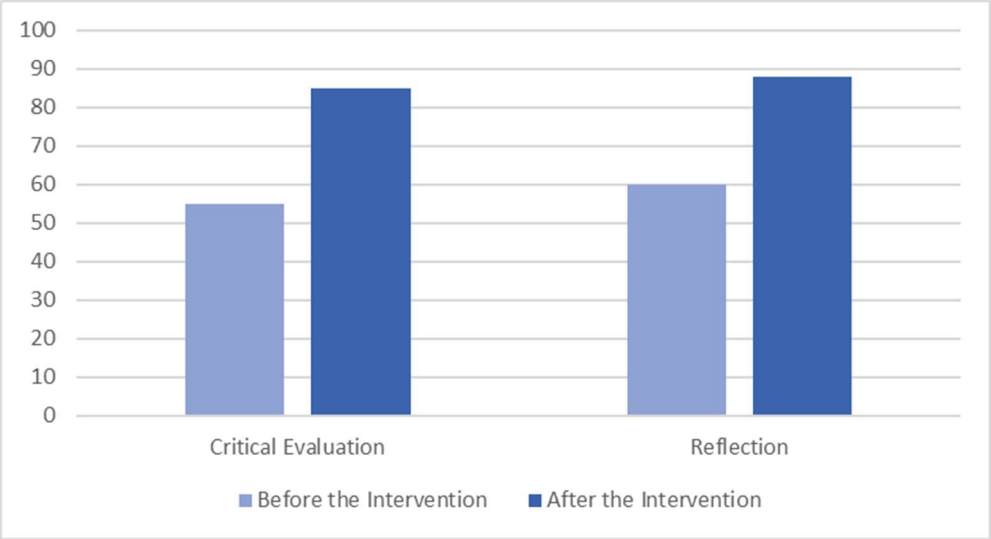

Figure 2. Demonstrates a significant improvement in critical evaluation and reflection following the intervention.

The final assessment, based on Facione's critical thinking rubric, yielded an average Critical Thinking Index (CTI) score of 4.1 on a 1–5 scale (Rauscher & Badenhorst, 2021). Improvements were observed across all four dimensions, with analysis and reflection showing the most substantial increases. Table 4 illustrates that the pedagogical approach combining the use of AI with critical discussions and reflective journals successfully enhanced all dimensions of students' critical thinking. These findings demonstrate the value of integrating generative AI with reflective pedagogical strategies to strengthen students' analytical, evaluative, and inferential reasoning. The significant gains across all measured dimensions indicate a strong alignment between the instructional design and the intended cognitive outcomes.

Table 4. Students' Critical Thinking Index (CTI) Scores Before and After the Intervention

Critical Thinking Dimension	Initial Score	Final Score	Improvement
Analysis	3.0	4.2	+1.2
Evaluation	2.9	4.0	+1.1
Inference	3.2	4.0	+0.8
Reflection	2.8	4.3	+1.5

C. The Study's Contribution, Implications, and Limitations

This study makes a significant contribution by addressing a gap in the literature, which has predominantly emphasized the technical efficiency of AI utilization (Enholm et al., 2022; Santoni

de Sio & Mecacci, 2021). It asserts that, through a pedagogical approach grounded in Critical Digital Pedagogy, AI technologies such as ChatGPT can serve as catalysts for the development of critical thinking skills (Yu, 2024). Conversely, the findings challenge the concerns raised in previous studies, such as (Wang, 2020), which highlight the risk of passive learning patterns due to overreliance on AI. It emerges from this work that such hazards can be minimized by creating effective learning interventions.

The findings of this study contribute meaningfully to the development of design students' critical thinking skills, but there were some limitations mentioned for future advancement of the study. First, the sampling was limited within one educational center with a relatively homogeneous group of participants, and caution needs to be exercised while interpreting the results if the findings need to be generalizable. Secondly, the two-month implementation schedule was not sufficient to evaluate how AI usage influenced students' development of critical thinking skills in the long run. Furthermore, external variables like differing learning styles and levels of ICT literacy among the learners were also not considered by this research study, which can also have varying impacts on outcomes.

The study paves the way for the creation of a curriculum more specifically aligned with digital technologies in design education. The reflective model of ChatGPT implementation outlined herein can be duplicated in other institutions through modification to suit local conditions and particular requirements. Moreover, the investigation of generative visual AI tools (e.g., DALL-E) in developing creativity and critical thinking is a fruitful avenue for future research, especially considering the growing complexity of demands within the design sector. For future research, it is suggested to carry out longitudinal investigations to examine the lasting effect of AI use on students' critical thinking. Moreover, comparative research in different institutions or cultural settings could contribute to the knowledge of the effectiveness of this reflective AI integration model.

CONCLUSION

It is the conclusion of this research that the incorporation of Generative AI, in this instance ChatGPT, has a beneficial influence on the development of design students' critical thinking. Taking a pedagogical stance situated in Critical Digital Pedagogy, students were invited to interact with ChatGPT not simply as a technological tool but also to become directly engaged in analysis, evaluation, inference, and reflection processes. The results exhibit considerable enhancement across all facets of critical thinking with a total mean Critical Thinking Index (CTI) score of 4.1 out of a 5-point scale. The findings confirm that AI usage, coupled with reflective learning strategies, can reduce the possibility of technological dependency (Dimitriadou &

Lanitis, 2023). Also, this research takes a significant role in filling the gap in the literature on how AI technology influences the design students' creative thinking dimensions. While other research has concentrated mainly on the technical success of AI implementation, this research is interested in its capacity to enhance critical thinking. The results highlight the imperatives of creating design curricula that are, on the one hand, attuned to digital technologies and, on the other hand, devoted to building the intellectual potentials of the students. The tactical incorporation of ChatGPT would thus be an effective approach to intensify the quality of design education amidst the digital age (Lazkani, 2024; Yu, 2024).

Subsequent research needs to consider longitudinal research to respond to the long-term effects of applying ChatGPT on how the critical thinking ability of students will be developed in the long term. Long-term research will give a clearer vision of the long-lasting impact of AI on the design learning experience. In addition, there must be cross-institutional and cross-cultural comparative analysis to validate AI model-based learning in different settings (Dahri et al., 2024). This is also vital in consideration of differences in students' characteristics, their digital literacy level, and institutional infrastructure readiness. Additional studies should also examine the application of generative visual AI models like DALL-E. Application of these visual AI tools can potentially unlock new paths to learning how they affect learners' creative and critical thinking skills throughout the design process. Subsequent studies will be expected to examine other extraneous variables—e.g., learners' learning styles or facilitator roles adopted by the teachers—to yield more holistic results (Costa et al., 2020; Rafiq et al., 2023). Finally, developing a curriculum framework from AI that embeds technical, ethical, and cognitive factors is important for improving the quality of design education in response to fast-moving digital change.

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