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Enhancing Critical Thinking with Gen AI: A Literature Review

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Abstract

The emergence of generative artificial intelligence (Gen AI) has sparked transformative changes across educational landscapes, with critical thinking emerging as a central skill enhanced by these technologies. This literature review explores the adoption and application of Gen AI tools, such as ChatGPT and AI-enhanced systems, in fostering critical thinking skills within higher education. Synthesizing recent research, the review examines the role of AI in collaborative learning, academic writing, and innovative pedagogical approaches, highlighting its ability to support soft skills development, enhance peer-based learning frameworks, and redefine assessment practices. Using a thematic analysis approach, this study categorizes findings into critical areas, including the role of Gen AI in developing cognitive skills, its collaborative potential, and its integration into future-ready educational frameworks. While these tools offer unprecedented opportunities for creativity, accessibility, and engagement, they also present challenges, including bias, ethical considerations, and reliance on AI-generated outputs. The review concludes by outlining future research directions, emphasizing the need for stakeholder-driven frameworks to fully leverage Gen AI's potential while safeguarding its responsible use in educational contexts. This study underscores the transformative potential of Gen AI in nurturing 21st-century critical thinking skills and calls for continued interdisciplinary inquiry to navigate its complex implications.

Keywords: *21st-Century Skills, AI-Driven Pedagogy, AI in Education, Critical Thinking Skills, Generative Artificial Intelligence (Gen AI), Human-AI Collaboration*

Introduction

Gen AI represents a transformative technology that is reshaping critical thinking and educational practices across diverse fields. Recent research highlights its ability to support creative exploration, foster collaboration, and enable new learning opportunities. For instance, studies demonstrate how tools like ChatGPT provide accessible resources for lesson planning and critical thinking development in teacher education, leveling educational disparities while emphasizing the importance of addressing inherent biases [1]. Moreover, Gen AI has been shown to inspire creativity, iterative problem-solving, and digital literacy among younger learners, equipping them with essential skills for an AI-driven future [2].

In higher education, the integration of generative AI into pedagogy and assessments has sparked significant debate. Educators advocate for adapting learning approaches to emphasize higher-order thinking and authentic application, transforming AI from a perceived threat to a critical thinking enabler [3]. Similarly, STEAM methodologies leveraging Gen AI have underscored its potential to

transcend traditional disciplinary boundaries, fostering a nuanced perspective on its societal and ethical implications [4].

Recent research explores the impact of generative AI tools on critical thinking skills in education. Studies indicate that these tools can enhance collaboration and critical thinking among university students, with 64% of respondents believing they significantly improve critical thinking ability [5]. AI can complement learning processes when used ethically, emphasizing the importance of developing critical thinking skills to effectively use AI and distinguish accurate information [6]. AI-based instruction has shown positive effects on students' trust, self-confidence, and open-mindedness, contributing to improved critical thinking skills [7]. However, the most significant improvements occur at lower levels of Bloom's taxonomy, with concerns about reliability, accuracy, and ethical implications in higher education [8]. While generative AI tools show promise for enhancing critical thinking, more comprehensive research is needed to understand their long-term impact and maximize potential benefits [5]. This literature review synthesizes current research on generative AI's role in enhancing critical thinking, providing a comprehensive understanding of its applications, challenges, and transformative potential in education and beyond.

Material and Methods

This study employed a systematic literature review approach to explore the impact of Gen AI tools on critical thinking skills in higher education. To ensure a comprehensive and rigorous selection of sources, the researcher utilized Elicit AI, an advanced research assistant designed for academic literature exploration. The Scopus database was chosen for its broad and authoritative coverage of peer-reviewed journal articles. The search process began by using the study title, Enhancing Critical Thinking with Gen AI: A Literature Review, as the query phrase in Elicit AI. This approach ensured that the articles retrieved were aligned with the study's focus and thematic relevance. From the initial pool of results, the AI-assisted tool identified and ranked the articles based on relevance, quality, and citation impact. Eight papers were selected as the most relevant for inclusion in the review. These papers were assessed for their contributions to understanding the relationship between generative AI and critical thinking, spanning themes such as AI-enhanced learning, collaborative potential, ethical considerations, and pedagogical implications. Each paper underwent detailed thematic analysis to synthesize insights into the current and potential roles of Gen AI in fostering critical thinking within academic and professional contexts. This method ensured a focused and data-driven review process, leveraging cutting-edge AI technology to identify high-quality research and provide a robust foundation for the study's conclusions.

Results

Table 1 shows the bibliometric analysis of the eight selected articles highlighting key trends in the research landscape on generative AI and critical thinking. The articles span publication years from 2022 to 2024, with the majority (50%) published in 2023, reflecting a recent surge of interest in the topic. Collectively, these studies have garnered 115 citations, with an average of 14.38 citations per article. The most-cited article, Leveraging ChatGPT for Enhancing Critical Thinking Skills by Guo et al. [9], has received 29 citations, demonstrating its influence in the field. Conversely, two of the 2024

publications—Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education and Generative AI-Enhanced Academic Writing: A Stakeholder-Centric Approach for the Design and Development of CHAT4ISP-AI—have not yet been cited, likely due to their recent release.

Table 1. Papers' Identification

Code	Title	Authors	Journal Name	Year
P1	Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education	Ruiz-Rojas et al. [5]	Sustainability	2024
P2	No worries with ChatGPT: building bridges between artificial intelligence and education with critical thinking soft skills.	Rusandi et al. [6]	Journal of public health	2023
P3	Playing with AI to Investigate Human-Computer Interaction Technology and Improving Critical Thinking Skills to Pursue 21st Century Age	Muthmainnah et al. [7]	Education Research International	2022
P4	The influence of AI text generators on critical thinking skills in UK business schools	Essien et al. [8]	Studies in Higher Education	2024
P5	Generative AI-Enhanced Academic Writing: A Stakeholder-Centric Approach for the Design and Development of CHAT4ISP-AI	Taiye et al. [10]	ACM Symposium on Applied Computing	2024
P6	Innovation to Improve Critical Thinking Skills in the Generation Z using Peeragogy as a Learning Approach and Artificial Intelligence (AI) as a Tool	Baskoro et al. [11]	Jurnal Teknik Industri	2023
P7	Future research recommendations for transforming higher education with generative AI	Chiu [12]	Computers and Education: Artificial Intelligence	2024
P8	Leveraging ChatGPT for Enhancing Critical Thinking Skills	Guo et al. [9]	Journal of Chemical Education	2023

The articles are published across diverse and reputable journals, including the Journal of Public Health, Computers and Education: Artificial Intelligence, and the Journal of Chemical Education. This diversity highlights the interdisciplinary appeal of generative AI in education, encompassing fields such as public health, industrial engineering, and chemical education. Several articles focus on the transformative role of AI in enhancing critical thinking, with an emphasis on innovative pedagogical strategies and the integration of tools like ChatGPT. Others explore the ethical and practical challenges of AI in education, calling for robust regulatory frameworks to guide its implementation.

Authorship trends reveal a collaborative research effort, with most articles authored by 3 to 6 researchers. The global scope of the research is evident in the varied institutional affiliations of the authors, reflecting widespread interest in the educational applications of generative AI. Despite the significant contributions of these studies, there is a clear citation disparity, suggesting a mix of well-established research and emerging work. This bibliometric review underscores the dynamic and interdisciplinary nature of the field, offering a solid foundation for future exploration into the transformative potential of generative AI in education.

Table 2 shows the main findings of the selected papers. AI has a strong potential to enhance critical thinking in higher education, but its impact varies based on implementation. Future efforts should focus on ethical considerations, structured AI integration, and fostering AI literacy to prepare students for an AI-driven future.

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Table 2. Papers' Main Findings

Code	Abstract summary	Main findings
P1	Generative AI tools show potential for enhancing critical thinking and collaboration in higher education, but more research is needed on their long-term impact and ethical considerations.	• Generative AI tools are widely known and used by university students, with a majority reporting improved critical thinking abilities through their use. • While the impact on collaborative work is not as significant, students are motivated to use these tools for collaborative purposes, suggesting potential for improvement in this area. • The study highlights the need for ongoing training and technical support to ensure the effective and ethical use of generative AI tools in higher education.
P2	Integrating teaching methods to develop critical thinking skills can help students and researchers use AI like ChatGPT effectively and ethically.	• Integrating specific teaching methods can help develop better critical thinking skills and a deeper understanding of the contexts in which AI is used. • Developing critical thinking skills among students and researchers is important to effectively use AI and distinguish accurate information from hoaxes and misinformation. • The collaboration between AI and humans in learning and research will yield significant benefits, but only if critical thinking skills and academic integrity remain top priorities.
P3	AI-based instruction can help improve critical thinking skills in non-native English students.	• AI-based instruction has a positive impact on students' critical thinking abilities. • AI-based instruction promotes students' trust, self-confidence, open-mindedness, and maturity in English, which helps them improve their critical thinking skills. • Critical thinking skills are the foundation for 21st-century skills, and AI-based instruction helps students learn these skills.
P4	AI text generators like ChatGPT can improve lower-level critical thinking skills in business students, but raise concerns about reliability, accuracy, and ethics.	• The use of AI text generators like ChatGPT had the greatest impact on the lower-order thinking skills in Bloom's taxonomy, such as remembering and understanding, rather than the higher-order skills like analyzing and evaluating. • The study identified concerns about the reliability, accuracy, and potential ethical implications of using AI text generators in higher education. • The study provides insights into the complex relationship between AI technologies and critical thinking skills, with implications for pedagogy, policy, and practice in higher education.
P5	This study examines the use of Generative AI chatbots to improve students' academic writing and critical thinking skills.	• The study examines the impact of Generative AI (GenAI) chatbots on improving students' academic writing and critical thinking skills. • The study aims to develop comprehensive AI literacy and robust regulatory frameworks to ensure the ethical and practical implementation of GenAI chatbots in education. • The study promotes a collaborative, stakeholder-centric approach to integrating GenAI into education, with the goal of preparing students for an AI-driven future.
P6	Using a model combining the 7E learning cycle, peeragogy, and AI can improve critical thinking skills in Generation Z.	• Using AI, particularly in the back-end learning process to verify and validate understanding, was effective in improving critical thinking skills for Generation Z students. • Uncontrolled use of AI in the front-end learning process can reduce learners' ability to explore a topic creatively and critically.
P7	The paper recommends future research directions to transform higher education with generative AI, including developing AI literacy and competency measures, and innovative pedagogies and assessments.	• Future higher education should be transformed to train students to be future-ready for employment in a society powered by generative AI. • New learning outcomes are needed, including skills in using and teaching with generative AI, as well as AI literacy, with an emphasis on interdisciplinarity and hands-on learning.

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Code	Abstract summary	Main findings
		• The study recommends future research directions on competencies for the future workforce, AI literacy assessment, new literacies, interdisciplinary teaching, innovative pedagogies, and new assessment methods.
P8	Using ChatGPT can enhance critical thinking skills in higher education, but challenges remain in training educators and ensuring reliable information sources.	• The use of ChatGPT in the study led to significant improvements in students' confidence to ask insightful questions, analyze information, and comprehend complex concepts. • Students reported that ChatGPT provided diverse perspectives and challenged their current ways of thinking. • Students expressed an increased utilization of ChatGPT to enhance their critical thinking skills and a willingness to recommend it to others.

Discussions

A. The Role of Generative AI in Developing Critical Thinking Skills

Generative AI tools are increasingly recognized as effective in fostering critical thinking skills among university students. The integration of AI-based instruction has been shown to improve students' confidence, open-mindedness, and ability to comprehend complex concepts [9]. These tools support foundational skills such as remembering and understanding, as well as higher-order thinking like analyzing and evaluating, though their impact is more pronounced on lower-order skills [8]. This underscores the importance of designing educational strategies that maximize the potential of AI for deeper cognitive engagement. Moreover, AI-enhanced instruction not only aids in critical thinking development but also contributes to the maturity and self-trust necessary for navigating academic and professional environments [11]. However, concerns over reliability, accuracy, and ethical implications highlight the need for critical evaluation and ethical considerations in AI's use in higher education [7],[12].

B. Collaborative Potential and Ethical Considerations in Generative AI Usage

While generative AI has positively impacted individual critical thinking abilities, its role in collaborative work remains underutilized [5]. Despite students' motivation to engage with these tools collaboratively, their potential to foster teamwork and peer learning needs further exploration [6]. Encouraging collaborative AI interactions could amplify the learning process by combining human creativity and machine efficiency [1],[4]. Furthermore, the ethical and responsible use of generative AI tools requires ongoing training and technical support to address issues of misinformation, hoaxes, and academic dishonesty [11],[12]. This aligns with the necessity of establishing robust AI literacy programs and regulatory frameworks to guide students and educators in using these tools responsibly, ensuring their integration aligns with academic integrity and societal values [3],[10].

C. Preparing for an AI-Driven Educational and Professional Future

The transformative impact of generative AI in education highlights the need for future-ready competencies and reimagined learning outcomes [12]. To equip students for an AI-driven world, educational institutions must emphasize interdisciplinarity, hands-on learning, and AI literacy [1],[3]. Generative AI's ability to simulate complex scenarios can prepare students for dynamic problem-solving, while new teaching methods can integrate critical thinking with AI usage in meaningful contexts [8],[9].

Additionally, balancing the back-end use of AI for validation and verification with front-end creativity is crucial to maintaining learners' ability to critically explore topics [7],[11]. The long-term success of AI integration will depend on developing innovative assessment methods, interdisciplinary teaching approaches, and a workforce skilled in leveraging AI for collaborative and analytical tasks [5],[10].

Conclusion

The emergence of generative artificial intelligence (Gen AI) has sparked transformative changes across educational landscapes, with critical thinking emerging as a central skill enhanced by these technologies. This literature review explores the adoption and application of Gen AI tools, such as ChatGPT and AI-enhanced systems, in fostering critical thinking skills within higher education. Synthesizing recent research, the review examines the role of AI in collaborative learning, academic writing, and innovative pedagogical approaches, highlighting its ability to support soft skills development, enhance peer-based learning frameworks, and redefine assessment practices. While these tools offer unprecedented opportunities for creativity, accessibility, and engagement, they also present challenges, including bias, ethical considerations, and reliance on AI-generated outputs. The review concludes by outlining future research directions, emphasizing the need for stakeholder-driven frameworks to fully leverage Gen AI's potential while safeguarding its responsible use in educational contexts. This study underscores the transformative potential of Gen AI in nurturing 21st-century critical thinking skills and calls for continued interdisciplinary inquiry to navigate its complex implications.

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