Enhancing Critical Thinking in the Age of Artificial Intelligence: A Wide Overview

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Abstract: Nowadays, the increased access to information and artificial intelligence (AI) required us to become better critical thinkers. In addition, the access to generative AI simplified our work with information and sources of information, while requiring. This article dive into the topic of critical thinking and the use of generative AI, synthesizing findings from the last three years and offering an evidence-based background and recommendations to practitioners for effective and ethical integrated generative AI that nurtures rather than diminishes the cognitive rigor supported by critical thinking.

Keywords: critical thinking; artificial intelligence; generative AI; generative artificial intelligence; GenAI

1. Introduction

Critical thinking (CT) and artificial intelligence (AI) are increasingly intertwined in today's digital landscape, where AI tools like generative models influence many aspects of our lives (e.g., ChatGPT, Google Gemini, Microsoft Copilot). As AI tools become more sophisticated, they can generate content, solve complex problems, and offer recommendations that shape decisions in fields ranging from healthcare to entertainment. However, the true power of AI lies in its ability to augment human potential, which requires individuals to employ CT skills (Mei & Weber, 2025).

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Being able to assess AI outputs with a discerning eye—questioning the accuracy, biases, and ethical implications of what is produced—is essential for navigating a world where automation is becoming more pervasive. Thus, CT is defined as the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action (Paul & Elder, 2019). On the other hand, AI is broadly defined as the capability of a device to perform functions typically associated with human intelligence (Russell & Norvig, 2021). Generative artificial intelligence (GenAI) refers to deep-learning models capable of creating high-quality text, images, and other content based on the data they were trained on (Goodfellow, 2014).

The aim of this study is to synthesize research findings from the past three years (2022-2025) concerning the relationship between CT and GenAI. Findings provide an evidence-based foundation for developing recommendations to guide practitioners in an effective and ethical integration of GenAI into their professional practice, ensuring that its use actively supports the development of CT.

2. General Organization of the Paper

The increasing integration of AI into various facets of daily life, including academic and professional settings, requires an in-depth examination of its relationship with CT skills (Suriano et al., 2025).

This concern is important due to the increased use of GenAI, capable of performing intellectually demanding tasks and the transformations in research methodologies (O'Dea, 2024). While AI tools can augment efficiency in areas such as research and decision-making, there are significant concerns that over-reliance on these technologies could diminish essential cognitive abilities, such as CT, problem-solving, and analytical reasoning (Zhai et al., 2024; Gerlich, 2025). Studies have identified a negative correlation between frequent AI tool usage and CT scores, with cognitive offloading — the tendency to delegate mental effort to AI — being a primary driver of this decline (Jackson, 2025). This phenomenon is particularly pronounced among younger individuals, who show higher dependence on AI tools and correspondingly lower CT scores. Furthermore, research highlights ethical concerns, such as AI hallucination, algorithmic bias, plagiarism, privacy issues, and a lack of transparency, which contribute to users' over-reliance on AI and can impede the cultivation of CT skills (Zhai et al., 2024). Therefore, understanding the

complex interplay between AI usage and CT, especially how AI might inadvertently weaken these human cognitive functions, is crucial for educators, policymakers, and technology designers to foster a balanced approach to AI adoption that supports rather than undermines intellectual autonomy (Koos & Wachsmann, 2023).

Several systematic reviews and meta-analyses published between 2022 and 2025 examine the impact of CT over GenAI, particularly language models like ChatGPT. One comprehensive meta-analysis caught our attention by synthesizing data from 51 studies published between 2022 and 2025 (Wang & Fan 2025). The meta-analysis concluded that ChatGPT had a moderate positive effect (a g-value of 0.457) on higher-order thinking, particularly when used in STEM courses and when functioning as an "intelligent tutor". Authors suggested that ChatGPT can scaffold complex tasks, prompt reflection, and offer alternative perspectives to students. It was found to be especially useful in guiding students through structured frameworks, such as Bloom's Taxonomy, to encourage them to analyze, evaluate, and create. However, the study also provided important nuances regarding ChatGPT's impact on higher-order thinking. The authors cautioned that the sample sizes for improvements in higher-order thinking were small enough to warrant further follow-up studies. They also noted that while ChatGPT excels at helping students organize, summarize, and clarify information due to its training on existing knowledge and patterns, it is less effective at inspiring true originality or deep synthesis without human guidance. Over-reliance on AI for creative or analytical tasks could risk "flattening" student thinking unless carefully scaffolded. The study's recommendations for effectively cultivating students' higher-order thinking using ChatGPT include providing appropriate learning scaffolds or educational frameworks, encouraging its broad use across various grade levels and course types, and actively integrating it into different learning modes, especially problem-based learning. Additionally, continuous use of ChatGPT for 4–8 weeks was recommended for more stable effects. The research suggested that ChatGPT should be flexibly integrated into teaching as an intelligent tutor, learning partner, and educational tool. Thus, while AI tools significantly improve learning performance and student perception, their effect on higher-order thinking such as CT is moderate and context-dependent.

Melisa et al. (2025) conducted a systematic review to investigate the impact of AI, specifically ChatGPT, on CT skills in higher education. The study synthesized findings from 19 studies published between 2023 and 2024, sourced from Scopus and Education Resources Information Center (ERIC). Their findings indicate that ChatGPT can enhance students' CT abilities. It facilitates quick access to diverse

perspectives, assists in information analysis, and supports the construction of arguments. This can be particularly beneficial for improving lower-level cognitive skills within Bloom's taxonomy, such as remembering and understanding. However, the systematic review also highlights potential drawbacks. Over-reliance on AI tools like ChatGPT can hinder students' motivation for self-reflection and critical evaluation. This raises concerns about academic integrity and the necessity to verify AI-generated content. Easy access to AI tools might undermine the development of essential analytical skills as students may become overly dependent on the technology. Moreover, some results suggest a significant negative correlation between frequent AI tools usage and CT abilities, mediated by increased cognitive offloading (Gerlich, 2025). The study by Melisa et al. (2025) suggests that AI tools can reduce the perceived effort required for CT tasks among knowledge workers. Younger participants exhibited a higher dependence on AI tools and scored lower on CT tests compared to older participants. This indicates a potential cognitive cost associated with over-reliance on AI (Gerlich, 2025). In order to maximize the educational benefits of ChatGPT and foster CT, researchers suggest that educators must guide students on its responsible use. This includes encouraging students to apply critical judgment and verify information accuracy. A comprehensive approach is important for fostering CT and other transferable skills in higher education. Pedagogical adaptability and integrity are crucial in the era of ChatGPT to balance AI's capabilities with the development of independent critical thought. Thus, teachers play an important role in designing activities that require critical evaluation of AI-generated content.

Another systematic review investigated the influence of GenAI on the CT skills of undergraduate students (Premkumar et al., 2024). The review identified 30 studies published between 2022 and 2024, sourced from Elsevier, Emerald Insight, IEEE Explore, Taylor & Francis Online, Digital Scholarship, Sage Publication, Springer Open, and Wiley Online. Results highlight a recognized gap between the acknowledged importance of CT skills for success in the job market and the actual proficiency levels among university students. Moreover, about half (56%) of the selected papers for this systematic review suggested benefits of GenAI for undergraduate CT. AI tools can also ease students' cognitive load, which can be beneficial in certain contexts. However, these benefits were often accompanied by limitations in study design that prevented broad generalization.

The systematic review of Lin et al. (2025), investigates the relationship between AI technologies and development of CT. The search engine used was Web of Science

Core Collection and Scopus, with no time range for holistic view. The final review included 21 articles classified as follow:

- 13 studies where AI is found a facilitator for CT - AI tools such as chatbots, clinical decision-making systems, learning assistance platforms, and game-based applications were shown to promote reflection, analytical reasoning, problem-solving, and creativity. By automating repetitive tasks, AI tools allow learners to focus on complex cognitive processes;

- 7 studies where AI is found as a barrier to CT - overreliance on AI outputs, uncritical acceptance of generated content, and exposure to biased or inaccurate information were found to hinder CT. In some cases, students showed reduced reflection, weakened decision-making, or diminished creativity when AI use replaced independent inquiry;

- 4 studies where CT is found to enable effective AI use - strong CT skills, including digital literacy, analytical reasoning, and creative thinking, improved learners' ability to engage critically with AI tools. This reciprocal relationship highlights that CT not only benefits from AI but also enhances the quality of AI-supported learning. Overall, the review underscores that the relationship between AI and CT is bidirectional and context-dependent. AI has the potential to foster CT if used thoughtfully, but misuse or over-dependence may undermine essential reasoning skills. Moreover, developing CT equips learners and educators to use AI more responsibly and effectively.

3. Proposed Good Practices for Practitioners

Based on the synthesized evidence found in reviews and meta-analyses that were analyzed in the above articles published in the last three years, several practices emerge to foster CT when working with AI:

➢ Structured Prompting with Bloom's Taxonomy

Educators can design and model prompts that explicitly align with Bloom's Taxonomy (e.g., "Analyze how…," "Evaluate the strengths and weaknesses of…," "Propose a new solution for…").

Students then use GenAI as an intelligent tutor to work through these prompts in stages:

- Clarify & Summarize → ask to explain or outline key concepts.

- Analyze & Compare → use GenAI to break down problems, compare alternatives, or highlight assumptions.

- Evaluate & Justify → critique AI's responses, questioning reasoning or evidence.

- Create & Extend → go beyond AI's suggestions by adding their own synthesis, examples, or alternative perspectives.

➢ **Critical Evaluation Journals of AI Outputs**

Educators can design assignments where students use GenAI to generate initial responses to a prompt, but the core task is for students to critically evaluate, verify, and refine the AI's output.

Steps:

- Generate → Students use GenAI to answer a question, summarize a concept, or draft an argument.

- Evaluate → Students fact-check claims, compare AI's response with course readings or information sources, and identify limitations, biases, or inaccuracies.

- Reflect → Students write a short journal entry explaining how their own reasoning diverges from, critiques, or improves GenAI's output.

- Refine → Students revise the AI's response into a final submission, clearly indicating their contributions versus AI support.

➢ **Guided Critical Thinking Workshops with AI Support**

Educators can design short, structured workshops where students use GenAI tools to handle routine tasks (e.g., summarizing readings, outlining arguments), while class time focuses on higher-order critical thinking activities such as questioning assumptions, evaluating evidence, and applying concepts to real-world job-market scenarios.

Steps:

- AI Support for Lower Cognitive Load → Students use GenAI to generate summaries or organize key concepts.

- Instructor-Guided Discussion → In class, students critically examine the AI's outputs, identifying gaps, biases, or oversimplification.

- Application Task → Students apply refined insights to solve a practical, job-related problem (e.g., case study analysis, decision-making task).

- Reflection → Students reflect on how AI helped reduce cognitive load and where their own CT skills were required beyond AI's capabilities.

➢ **AI-Critique and Reflection Cycles**

Educators can implement structured classroom activities where students use AI tools to generate initial ideas or solutions, but the primary task is to critically interrogate, refine, and extend these outputs through guided reflection.

Steps:

- AI Generation (Facilitator role) → Students use an AI tool (e.g., chatbot, learning assistant, case-based system) to obtain a draft solution, explanation, or recommendation.

- Critical Evaluation (Barrier mitigation) → Students evaluate the AI's output for accuracy, bias, depth, and creativity, comparing it with course materials or independent sources.

- CT Application (Enabler role) → Students improve the AI output by adding their own reasoning, alternative perspectives, or creative extensions.

- Reflection Cycle → Students write a short reflection on how AI supported or limited their thinking, explicitly linking the experience to CT skills (analysis, evaluation, problem-solving).

4. Conclusion

Despite the potential benefits of using GenAI, researchers expressed caution against over-reliance on technology, suggesting it could diminish students' ability to think for themselves (Sardi et al., 2025). Another significant issue identified is the potential for GenAI to hinder CT and creativity if students become overly dependent on it (Wang et al., 2024). Another study also identified concerns related to the reliability, accuracy, and potential ethical implications of GenAI application in higher education (Essien et al., 2024). If students use the technology without criticaly thinking about each output, they may hand over critical cognitive work to the machine (Walter, 2024). Confidence in GenAI was found to be associated with less CT, while self-confidence correlated with more CT (Lee et al., 2025).

Goyal's (2025) recommendation for AI literacy programs highlight the need for a design that equip students with the knowledge and skills necessary to critically engage with AI technologies. Such programs must integrate socio-technical and ethical understanding, foster metacognitive reflection, and promote CT and creativity. Emphasis should be placed on developing students as discerning users who can evaluate AI outputs thoughtfully, communicate effectively with AI systems, and use them to support inquiry and self-regulated learning. Integrating these competencies into curricula will prepare students for better academic and professional environments shaped by AI.

Moreover, AI can both enhance and obstruct CT development, depending on how it is integrated into education. It calls for: careful guidance for students in AI use to avoid overreliance, embedding CT instruction into curricula to maximize AI's benefits, expanding research to younger learners and underrepresented regions and employing stronger theoretical frameworks and standardized CT assessments in future studies. This work represents the first systematic attempt to map the reciprocal relationship between AI technologies and CT skills, contributing to a deeper understanding of how digital tools can shape higher-order thinking in the era of AI (Lin et al., 2025). Moreover, Findings where AI can improve lower-level cognitive skills within Bloom's taxonomy are sustained by Essien et al. (2024) that conducted the study on UK postgraduate business school students, using Bloom's taxonomy, revealed that the most significant improvements with generative AI occurred at these lower levels of taxonomy.

Last but not least, educators' work can be detached such as: 1. The need for structured integration of AI. Incorporate AI tools within a guided learning framework that balances AI assistance with activities requiring independent evaluation and reflection. This mitigates over-reliance and promotes active cognitive engagement (Wang & Fan, 2025). 2. The existence of a critical evaluation framework would help in practice. Educators could apply CT frameworks that involve questioning AI outputs' accuracy, bias, and ethical implications. Using methods such as comparing AI outputs with authoritative reliable sources and repeated optimization, enhances CT (Stadler et al., 2024). 3. Promoting intellectual humility, would encourage awareness of AI's limitations and the illusion of knowledge. Fostering intellectual humility helps users question AI's answers and seek diverse perspectives rather than accepting outputs at face value (Prike et al., 2024). 4. Development of prompt skills would train AI users in effective prompt to interact with AI as a thinking partner, encouraging exploratory dialogues that challenge assumptions and stimulate deeper

reasoning (Federiakin et al., 2024). 5.The need for ethical awareness and transparency. Educating about ethical concerns related to AI generation, including data bias and plagiarism risks, emphasizing responsible AI use that safeguards academic integrity and fairness (Zhai et al., 2024). 6.A continuous reflection and feedback would make a difference in practice. Integrate reflective practices and feedback loops where users critically appraise AI-generated content and refine their thinking, supported by educators or peers (Goyal, 2025). Overall, research from the past three years points to a clear need for educators to adopt intentional strategies that harness the cognitive support of GenAI while simultaneously fostering students' strength rather than replace CT.

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