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Generative AI and the Development of Critical Thinking among University Students

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Abstract
The rapid diffusion of generative artificial intelligence (GenAI) tools such as ChatGPT, Gemini, and Copilot into higher education has raised urgent questions about their influence on university students' critical thinking. This paper reviews and synthesizes recent empirical and theoretical literature to examine how GenAI shapes analytical reasoning, evaluation, and reflective judgment among students. Drawing on Bloom's revised taxonomy and the cognitive-offloading framework, the paper argues that GenAI's impact on critical thinking is neither uniformly positive nor uniformly negative but is contingent on how the technology is used, the learner's AI literacy and self-efficacy, and the pedagogical structures surrounding its use. Evidence indicates that structured, reflective engagement with GenAI can strengthen argumentation, evaluative reasoning, and higher-order cognitive skills, whereas passive, uncritical reliance is associated with metacognitive laziness, cognitive inertia, and diminished independent reasoning. The paper further discusses academic integrity concerns and offers pedagogical recommendations, including AI-literacy instruction, process-oriented assessment, and scaffolded prompt-based tasks, for cultivating critical thinking in an AI-saturated learning environment. The paper concludes that deliberate instructional design, rather than the technology itself, determines whether generative AI becomes a catalyst for or an obstacle to the development of critical thinking in higher education.

Keywords: generative artificial intelligence, critical thinking, higher education, cognitive offloading, AI literacy, academic integrity

1. Introduction

Generative artificial intelligence (GenAI) refers to machine learning systems, most notably large language models such as ChatGPT, that are capable of producing novel text, images, code, and other content by learning statistical patterns from vast datasets (Chan & Hu, 2023). Since the public release of ChatGPT in late 2022, GenAI tools have been adopted across higher education at a remarkable pace, supporting activities ranging from brainstorming and drafting to personalized tutoring and research

assistance (Marengo et al., 2024). This rapid uptake has intensified a long-standing debate in educational research: does technology extend human cognition, or does it substitute for it? The question is especially pressing for critical thinking, a competency widely regarded as the central outcome of a university education and a prerequisite for informed citizenship, professional judgment, and lifelong learning.

Critical thinking is commonly defined as the disciplined process of conceptualizing, analyzing, synthesizing, and evaluating information gathered from observation, experience, or reasoning as a guide to belief and action (Paul & Elder, 2007, as cited in University of Connecticut Center for Excellence in Teaching and Learning, n.d.). Because GenAI tools can perform many of the analytical and generative tasks that once required sustained human effort, educators and researchers have raised concerns that habitual reliance on these tools may erode the very cognitive processes that critical thinking depends upon (Ali et al., 2026). At the same time, other scholars argue that when GenAI is used deliberately and reflectively, it can scaffold argumentation, expose students to multiple perspectives, and free cognitive resources for higher-order analysis (Noroozi et al., 2025; Chatterjee, 2026).

This paper examines the relationship between generative AI and the development of critical thinking among university students. It synthesizes recent empirical studies, theoretical frameworks, and pedagogical literature to address three interrelated questions: (a) through what cognitive mechanisms does GenAI use influence critical thinking, (b) what conditions determine whether the influence is beneficial or detrimental, and (c) what pedagogical strategies can help universities harness GenAI to strengthen, rather than weaken, students' critical thinking. The paper proceeds by outlining the theoretical foundations of critical thinking and GenAI, reviewing the dual-sided empirical evidence, discussing academic integrity implications, and offering recommendations for practice and future research.

Fig. 1. University students using Generative AI as a learning assistant

2. Theoretical Background

2.1 Defining Critical Thinking and Higher-Order Thinking

Critical thinking is most often situated within Bloom's taxonomy of educational objectives, later revised by Anderson and Krathwohl, which distinguishes lower-order thinking skills, such as remembering, understanding, and applying, from higher-order thinking skills, namely analyzing, evaluating, and creating (University of Illinois Chicago Center for the Advancement of Teaching Excellence, n.d.; Rahmawati, 2021). Critical thinking is generally associated with the analysis and evaluation levels of the taxonomy, in which learners break information into its constituent parts, judge its validity against criteria, and form reasoned conclusions (EBSCO Research Starters, n.d.). Although the taxonomy is often depicted as a hierarchy, several scholars note that the underlying cognitive processes are recursive rather than strictly sequential, with learners moving fluidly between levels as they engage with complex material (Cambridge English, 2022; Rahmawati, 2021).

In the context of higher education, critical thinking is treated not merely as a discrete skill but as a disposition, a habitual inclination toward reflective skepticism, open-mindedness, and evidence-based reasoning that learners apply across disciplines (Dumitru et al., 2026). This dispositional view is important for understanding generative AI's influence, because GenAI use may affect not only students' momentary performance on analytical tasks but also their long-term orientation toward inquiry and intellectual independence.

2.2 Generative AI in Higher Education

Generative AI models rely on deep learning architectures, particularly transformer-based neural networks, trained on large corpora of text and other data to produce coherent, contextually relevant outputs (Yusuf et al., 2024, as cited in Bhatt et al., 2025). In higher education, these systems have been adopted for personalized tutoring, automated feedback, academic writing support, literature synthesis,and administrative tasks such as grading (Marengo et al., 2024). Unlike earlier educational technologies that primarily delivered or

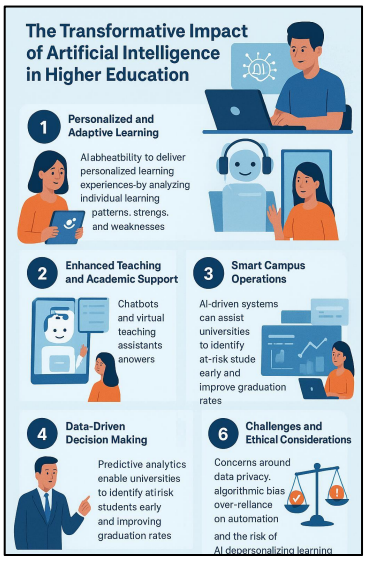

Fig. 2. Applications of Generative AI in Higher Education

organized

existing content, GenAI tools actively generate new content in response to user prompts, which fundamentally changes the nature of the student-technology relationship: the student is no longer simply a consumer of information but a co-author, editor, or evaluator of AI-generated material (Bhatt et al., 2025).

This shift carries significant implications for critical thinking, because it relocates the locus of cognitive effort. Where a traditional research task required students to search for, filter, and synthesize sources, a GenAI-supported task allows students to obtain a synthesized answer directly, shifting the primary cognitive burden from generation to verification and judgment (Ali et al., 2026). Whether this shift enhances or diminishes critical thinking depends on whether students actually exercise that verification and judgment, or accept AI output uncritically.

2.3 Cognitive Offloading and Metacognitive Laziness

The cognitive-offloading framework, originally developed by Risko and Gilbert, provides a useful lens for understanding GenAI's cognitive effects. Cognitive offloading refers to the use of external tools to reduce the mental effort required for a task, and it can be either adaptive, freeing resources for higher-level thinking, or maladaptive, leading to skill atrophy and dependency (Bordas, 2026, as cited in Fan et al., 2026). Recent scholarship has extended this framework to describe "metacognitive laziness," the tendency of learners to delegate planning, monitoring, and self-evaluation to AI systems rather than exercising these functions themselves (Fan et al., 2025, as cited in Dizon et al., 2026). Because metacognition, the capacity to monitor and regulate one's own thinking, is closely intertwined with critical thinking, chronic metacognitive offloading is theorized to weaken the very processes that critical thinking requires (Bordas, 2026). Whether such offloading occurs, however, appears to depend heavily on individual differences such as prior domain knowledge, motivation, and AI literacy, a theme that recurs throughout the empirical literature reviewed below.

3. The Dual Impact of Generative AI on Critical Thinking

3.1 Evidence for Enhancement of Critical Thinking

A growing body of empirical work suggests that generative AI can, under the right conditions, strengthen students' critical thinking. In a quasi-experimental study,

university students who participated in structured workshops incorporating GenAI tools into critical-thinking activities showed statistically significant gains in applying, analyzing, and evaluating skills relative to a comparison group receiving traditional instruction, even as students' subjective perceptions of GenAI's value also increased (as reported in ResearchGate summaries of GenAI intervention studies, 2025). Similarly, research on GenAI-supported argumentation has found that AI-generated feedback can prompt students to more thoroughly articulate claims, supporting evidence, and counterarguments, an effect attributed to the real-time, iterative feedback loop that GenAI provides (Noroozi et al., 2025).

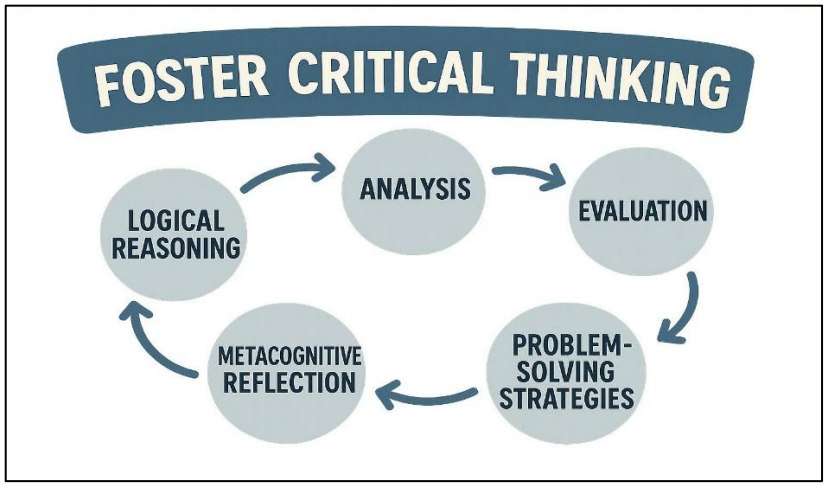

Fig. 3. Foster Critical Thinking Process in Higher Education

Other studies frame GenAI as a partner in "human-AI supported collaboration," contrasted with "passive AI-directed use." Using a cognitive-presence framework across university students, researchers found that students who treated ChatGPT as a dialogic collaborator, questioning its output, cross-checking claims, and revising their own reasoning in response, exhibited deeper engagement with the exploration and integration phases of critical thinking than students who accepted AI responses at face value (MDPI Education Sciences study, 2025). This distinction between collaborative and passive use recurs across the literature and suggests that the mode of engagement, rather than mere exposure to the tool, is the decisive factor in whether GenAI supports critical thinking.

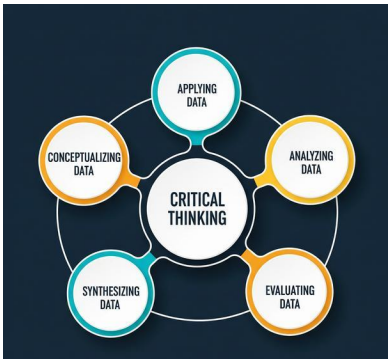

Fig. 4. Critical Thinking Process in Higher Education

GenAI has also been credited with lowering barriers to higher-order engagement for students who might otherwise struggle with foundational tasks. Because GenAI can quickly clarify complex concepts, summarize dense material, or generate alternative explanations, it may free cognitive capacity that can then be redirected toward analysis and evaluation rather than being consumed by basic comprehension (Bhatt et al., 2025). For students with lower prior achievement, this scaffolding effect has been associated with greater appreciation of GenAI's explanatory value, although higher-achieving students in the same studies expressed more caution about the technology's broader effects on independent skill development (Wong et al., 2025).

3.2 Evidence for Diminished Critical Thinking

A parallel body of research documents troubling associations between GenAI use and weakened critical thinking. Survey-based studies of GenAI users report that increased reliance on the tools is associated with self-reported reductions in cognitive effort, alongside a corresponding decline in confidence to complete analytical tasks independently (Lee et al., 2025). Large-scale survey research among Chinese university students similarly found that AI dependence significantly increases "cognitive inertia," a systematic avoidance of in-depth processing when facing complex or open-ended tasks, which in turn reduces students' innovation capability (Zhou et al., 2026).

Longitudinal and moderated-mediation studies point to a specific mechanism: cognitive fatigue. One study among university students found that heavy AI dependence increased cognitive fatigue, which subsequently reduced critical thinking, although information literacy partially buffered this negative pathway (Xu et al., 2025). Complementary work on metacognitive laziness has shown that the fluency and apparent authority of AI-generated output can create an "illusion of competence," encouraging learners to abandon the effortful, generative cognitive work that underlies durable learning and skilled reasoning (Fan et al., 2025; Education International, 2026).

Notably, several of these studies report a "performance paradox," in which students' short-term task performance improves with GenAI assistance even as their long-term, independent capacity for critical analysis is undermined (Education International, 2026).

A cross-national study examining metacognitive weakness and epistemic laziness as sequential mediators found that as GenAI use became a routine part of students' academic lives, weaker metacognitive regulation was associated with a heightened tendency toward epistemic laziness, defined as an unwillingness to independently seek, verify, or challenge information, which was in turn linked to lower critical-thinking dispositions (Yurt & Kuşci, 2026). These findings converge with pilot research in computational and data science courses, which found that students frequently accepted AI-generated responses without adequately scrutinizing their accuracy or appropriateness, suggesting that critical evaluation of AI output does not develop automatically simply through exposure to the technology (Lamberti et al., 2025).

3.3 Moderating Factors: AI Literacy and Self-Efficacy

The apparently contradictory findings reviewed above are substantially reconciled by research identifying AI literacy and self-efficacy as key moderating variables. Studies distinguishing between students with foundational AI literacy and those without have found that literate students engage in more rational, purposeful use of GenAI, treating it as a partner for deeper collaborative thinking, whereas students lacking such literacy tend toward uncritical over-reliance, with corresponding declines in information discernment, logical reasoning, and reflective questioning (Wu, 2025).

Self-efficacy, students' confidence in their own ability to use AI tools purposefully, has been similarly implicated. Research examining disciplinary differences in GenAI perceptions found that students with higher AI self-efficacy were more likely to view GenAI as a resource for critical thinking and creativity, while those with lower self-efficacy were more prone to passive acceptance of AI output, underscoring the value of targeted interventions that build students' confidence and competence in evaluating AI-generated content (Wong et al., 2025). Taken together, these moderating factors suggest that the critical variable is not whether students use GenAI, but how well-equipped they are to use it critically.

4. Academic Integrity and Ethical Considerations

Because critical thinking is cultivated through the effortful processes of research, argument construction, and revision, concerns about GenAI's effect on critical

thinking are closely intertwined with concerns about academic integrity. Survey data collected shortly after ChatGPT's release found that over one-third of surveyed university students had already used the tool for assessment writing, and a majority of those students believed such use constituted a form of cheating even as they continued to do so (Cassidy, as cited in Currie, 2023). More recent qualitative work across multiple national contexts has found persistent tension between the perceived productivity benefits of GenAI and fears that unsupervised use undermines the fairness and rigor of assessment (Farhi et al., 2024; Abdelghani et al., 2025).

Beyond individual instances of misuse, scholars warn of a subtler risk: even licit, permitted use of GenAI may still erode critical thinking and other academic skills if it substitutes for, rather than supports, students' own analytical work (Wong et al., 2025). This concern has prompted several institutions to move away from output-based assessment, which is highly susceptible to undetected AI generation, toward process-oriented assessment that requires students to document their reasoning, drafts, and decision points, thereby making the development of critical thinking itself a visible and gradable part of the assessment (Journal of Learning Development in Higher Education study, 2025).

Ethical debate also extends to questions of equity and access. Because the benefits of GenAI for critical thinking appear to depend on AI literacy and self-efficacy, which are themselves unevenly distributed across student populations, unstructured GenAI adoption risks widening existing achievement gaps rather than narrowing them (Education International, 2026). Institutions that fail to provide explicit AI-literacy instruction may inadvertently privilege students who already possess strong metacognitive skills and digital literacy, while leaving less-prepared students more vulnerable to uncritical dependence.

5. Pedagogical Strategies for Fostering Critical Thinking Alongside Generative AI

The literature reviewed above converges on a central implication: banning or ignoring generative AI is neither feasible nor pedagogically optimal, whereas structuring its use around explicit critical-thinking goals shows considerable promise. Several concrete strategies emerge from recent research.

5.1 Embedding AI Literacy and Prompt Engineering Instruction

AI literacy, encompassing an understanding of how generative models work, their limitations, and their societal implications, has been proposed as a foundational

competency for modern higher education, alongside prompt engineering, the skill of formulating precise, well-scaffolded queries that elicit useful and verifiable AI responses (Walter, 2024). Structured instruction in prompt engineering has been shown to foster critical thinking and reflective interaction by requiring students to specify their reasoning goals, anticipate ambiguity, and iteratively refine their queries, rather than accepting a single AI response as final (Informing Science Institute conference proceedings, 2025). Embedding such instruction directly into course curricula, rather than treating it as an optional add-on, helps ensure equitable access to the metacognitive benefits of thoughtful AI use.

5.2 Positioning AI as an Object of Critical Inquiry

Rather than treating GenAI purely as a productivity tool, several researchers recommend integrating it as an object of critical scrutiny within the curriculum itself. In this model, students are explicitly tasked with testing AI-generated responses against reliable sources, identifying inaccuracies or biases, and reflecting on the tool's reasoning limitations, transforming routine AI use into a structured exercise in evaluation and judgment (arXiv preprint on educational AI labs, 2025). This approach directly targets the verification and judgment functions that, per the discussion in Section 2.2, become the primary locus of cognitive effort once generative tools are introduced into a task.

5.3 Redesigning Assessment toward Process and Verification

Process-oriented assessment, which evaluates drafts, annotated reasoning, oral defenses, and reflective journals alongside or instead of final products, reduces the incentive for uncritical AI reliance while making students' developing critical-thinking processes directly visible to instructors (Journal of Learning Development in Higher Education study, 2025). Complementary strategies include redesigning exam questions to demand application, analysis, and evaluation of novel scenarios that GenAI cannot answer through simple retrieval, thereby shifting assessment emphasis away from easily replicable tasks and toward genuinely higher-order cognitive demands (Ensuring Academic Integrity in the Age of ChatGPT, 2024).

5.4 Cultivating a Verification Mindset and Human-AI Collaboration

Educators are encouraged to model and require what has been termed a "verification mindset," in which students are trained to treat AI output as a first draft or hypothesis to be tested, corrected, and integrated with their own knowledge, rather than as a finished, authoritative answer (Education International, 2026). Framing GenAI

explicitly as a collaborative partner, rather than a substitute author, has been associated with improved essay quality, sustained engagement, and more positive emotional responses to AI-assisted feedback, provided that students retain primary cognitive agency over the final product (Chan et al., 2025, as cited in discussions of GenAI-assisted writing in Hong Kong higher education).

6. Discussion

Synthesizing the evidence reviewed in this paper, three broad conclusions emerge. First, generative AI does not have a single, fixed effect on critical thinking; rather, its influence is conditional on the mode of engagement, ranging from collaborative, reflective use to passive, uncritical acceptance of AI output. Second, this conditionality is substantially explained by individual-level moderators, particularly AI literacy and self-efficacy, which determine whether students exercise the verification and judgment functions that GenAI use displaces from the generation stage of a task. Third, institutional and pedagogical design, including curriculum-embedded AI literacy instruction, assessment redesign, and explicit framing of AI as a partner rather than an author, appears capable of shifting the balance of these effects toward the beneficial end of the spectrum.

These conclusions suggest a reframing of the debate. Rather than asking whether generative AI helps or harms critical thinking, a more productive question is: under what instructional conditions does GenAI use strengthen critical thinking, and how can universities systematically create those conditions at scale? The recurring finding that structured, literacy-supported, verification-oriented use of GenAI is associated with gains in analysis and evaluation, while unstructured, low-literacy use is associated with cognitive inertia and metacognitive laziness, positions instructional design, not the technology itself, as the primary lever available to educators (Wu, 2025; Education International, 2026).

Table- 1: Illustrative educational contributions of Generative AI.

S. No.	Benefit	Educational Impact
1.	Personalized learning	Better understanding
2.	Instant feedback	Faster learning
3.	Brainstorming	Improved creativity
4.	Research support	Better literature review

5.	Coding assistance	Problem-solving skills
6.	Language support	Academic writing improvement

This reframing also carries implications for how universities conceptualize digital and AI literacy more broadly. If critical thinking in an AI-saturated environment increasingly depends on the capacity to interrogate, verify, and productively collaborate with AI-generated content, then AI literacy itself becomes a component of critical thinking, rather than a separate technical skill. This suggests that curricula historically organized around discipline-specific critical thinking exercises may need to be supplemented with cross-disciplinary modules on evaluating machine-generated information, source verification in an AI context, and reflective, metacognitive practices for AI-assisted work.

7. Limitations and Directions for Future Research

The literature synthesized in this paper is subject to several limitations that also point to productive avenues for future research. Much of the existing empirical work relies on self-reported measures of cognitive effort, confidence, and critical-thinking disposition, which may be subject to social-desirability bias or limited introspective accuracy; longitudinal studies employing validated, performance-based measures of critical thinking are needed to substantiate causal claims (Lee et al., 2025; Xu et al., 2025). Many studies also draw on samples from single institutions or countries, limiting generalizability across educational systems, disciplines, and levels of technological infrastructure (Xu et al., 2025; Yurt & Kuşci, 2026).

Additionally, because generative AI models and their capabilities are evolving rapidly, findings based on earlier iterations of these tools may not generalize to more advanced systems with different interaction modalities, such as voice-based assistants or agentic AI systems capable of multi-step reasoning on a student's behalf. Future research should examine how emerging agentic and multimodal AI tools reshape the cognitive-offloading dynamics described in this paper, and should prioritize experimental and longitudinal designs capable of isolating the causal contribution of AI literacy interventions, curricular design, and assessment structure to students' critical-thinking outcomes over time.

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Fig. 4. Future Classroom with AI

Table-2: Factors Influencing Critical Thinking

S. No.	Recommendation	Expected Outcome
1.	AI Literacy Training	Better AI use
2.	Faculty Development	Effective teaching
3.	AI Ethics Policy	Responsible use
4.	Oral Assessment	Independent thinking
5.	Project-Based Learning	Higher-order skills
6.	Reflective Journals	Improved metacognition

8. Conclusion

Generative AI has become an inseparable part of the contemporary university learning environment, and its influence on critical thinking is among the most consequential questions facing higher education today. This paper has shown that the relationship between GenAI use and critical thinking is neither straightforwardly positive nor straightforwardly negative, but is shaped by how students engage with these tools, how well-equipped they are through AI literacy and self-efficacy to use them judiciously, and how deliberately institutions design curricula and assessments around AI-assisted learning. Passive, uncritical reliance on generative AI is consistently associated with

markers of cognitive inertia, metacognitive laziness, and diminished independent reasoning, while structured, reflective, verification-oriented engagement is associated with gains in analysis, evaluation, and argumentative sophistication. For universities, the central task is therefore not to resist generative AI but to intentionally cultivate the literacies, pedagogies, and assessment practices that allow students to use these powerful tools as instruments of, rather than substitutes for, critical thought.

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