



Review Article

Integrating critical thinking and artificial intelligence in higher education: A bibliometric and systematic review of skills and strategies

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ABSTRACT

This study examines the academic landscape on integrating artificial intelligence and critical thinking in higher education, revealing conceptualizations, competencies required by students, challenges and recommended learning strategies. The study employs a bibliometric analysis approach combined with a systematic literature review as a qualitative approach. A total of 640 documents were retrieved from the Scopus database using the query: ("critical thinking" AND ("artificial intelligence" OR AI) AND ("higher education" OR university OR college)), accessed on July 10, 2025. The dataset was limited to 2023–2025, reflecting the period following the widespread adoption of ChatGPT and similar generative AI tools in academic contexts. From this, 290 documents were selected for bibliometric analysis, and 23 were in-depth synthesized based on established inclusion criteria. The findings reveal a growing consolidation of research on AI and critical thinking, driven by a small group of highly influential authors and concentrated in prominent interdisciplinary journals. Five thematic clusters were identified: pedagogical innovation, psychological dimensions, academic ethics, systemic integration, and AI-related literacies. Emerging research directions include personalized learning, digital literacy, engineering education, and ethical AI applications. Critical thinking is conceptualized as a purposeful, evaluative, and self-regulated process that must be preserved despite increasing reliance on AI tools. Key challenges include uncritical dependence on AI, digital literacy disparities, lack of system transparency, and institutional limitations. The study highlights the need for inclusive and adaptive instructional frameworks that integrate AI in ways that support critical thinking in diverse higher education settings.

1. Introduction

The rapid advancement of artificial intelligence (AI) is bringing significant changes to higher education. It reshapes how instructors design and delivers instruction, what students are expected to learn, and how they engage in the learning process (Farooq et al., 2024). Technologies such as adaptive learning platforms, automated feedback systems, and generative models like ChatGPT offer opportunities for more personalized, scalable, and accessible education (Nikolopoulou, 2024). However, while these technologies promise pedagogical benefits, they

pose serious challenges related to students' cognitive development, ethical reasoning, and academic integrity (Francis et al., 2025). The increasing reliance on AI tools raises concerns about diminished reflective engagement, bias in algorithmic outputs, and the erosion of independent thought. Furthermore, integrating AI in higher education must be approached with critical attention to digital inequality, data privacy, and the potential for reinforcing systemic disparities (Bobula, 2024; Boratkar & Sambhe, 2024).

Critical thinking remains a foundational competency in higher education, enabling students to make reasoned decisions, solve complex

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problems, and evaluate diverse forms of information (Paul & Elder, 2019). Ennis (2018) defines critical thinking as a logical and reflective process to decide what to believe or do, emphasizing deliberation and rational judgment. Paul and Elder (2019) conceptualize it as purposeful and self-regulatory thinking, guided by intellectual standards such as clarity, relevance, and consistency. Facione (2011) elaborates on this by identifying six core skills: interpretation, analysis, inference, evaluation, explanation, and self-regulation. These dimensions collectively support learners in processing arguments, assessing evidence, and articulating justifications. Complementary perspectives highlight the need for distinguishing valid information (Tathahira, 2020), engaging in reflective reasoning (Sachdeva & Eggen, 2021), and applying systematic logic and scientific principles (Lau, 2011). These critical thinking skills are relevant and indispensable in AI-mediated learning environments, where students frequently interact with algorithmically generated outputs. Without intentional instructional design, the efficiency of AI tools may foster surface-level engagement and undermine the development of deep, analytical reasoning (Sarwanti et al., 2024; Walter, 2024).

Despite the growing integration of AI in academic settings, there remains a lack of conceptual and empirical clarity regarding its impact on the cultivation of critical thinking. While AI tools may assist in higher-order thinking, they also risk reducing the mental effort required for rigorous analysis, particularly when used without pedagogical scaffolding (Gonsalves, 2024; Panit, 2024). This dual function poses a critical dilemma for higher education: to what extent can AI be leveraged to enhance rather than erode students' capacity for independent and reflective thought (Gonsalves, 2024). There is a pressing need to examine how critical thinking is defined across AI-related educational literature, to identify the specific challenges AI presents to cognitive development, and to explore instructional strategies that address these challenges without compromising intellectual rigor. Ensuring that AI integration aligns with the fundamental goals of higher education requires a careful synthesis of theoretical and practical insights.

Several recent reviews have examined the influence of artificial intelligence on higher education, particularly its impact on students' critical thinking skills. Melisa et al. (2025) employed a systematic literature review, while Raitskaya and Tikhonova (2025) adopted a scoping review, both demonstrating that generative tools such as ChatGPT facilitate idea generation, argument construction, and metacognitive awareness. Nevertheless, these tools can impede sustained reflection when educators fail to provide adequate guidance. Using a narrative review, Papanephytous and Nicolaou (2025) underscored the significance of contextual reasoning and ethical decision-making in AI-supported scientific learning. Similarly, Deroncele-Acosta et al. (2025) conducted a systematic literature review and identified critical thinking as a transversal competency shaped by AI, particularly within sustainability-focused curricula. Although these studies contribute valuable insights, they remain constrained by narrow temporal scopes—some limiting their coverage to 2023–2024 or omitting timeframes entirely—and by methodological designs that separate quantitative mapping of research patterns from qualitative synthesis of pedagogical practices. Consequently, the existing body of research does not yet provide a comprehensive, methodologically integrated understanding of how AI influences the definition, development, and support of critical thinking in higher education.

To address these gaps, the present study adopts a dual methodological framework that combines bibliometric mapping and systematic literature review. By focusing on Scopus-indexed publications from 2023 to 2025—the formative period following the public release of ChatGPT in late 2022—this research captures the earliest patterns of scholarly engagement with generative AI in higher education (Michalon & Camacho-Zuñiga, 2023). The study offers a novel contribution by integrating multidisciplinary perspectives from education, computer science, and social sciences, enabling a broad yet coherent analysis of the topic. Bibliometric mapping identifies publication trends, influential authors, key journals, institutions, thematic clusters, and emerging

research themes. At the same time, the systematic review examines conceptualizations of critical thinking, core competencies, pedagogical challenges, and instructional strategies relevant to AI-enhanced learning environments. This integrated approach addresses the limitations of single-method reviews by offering a macro-level mapping of research developments and a micro-level synthesis of strategies to foster critical thinking in AI-enhanced learning environments in higher education.

Guided by this approach, the study aims to map the academic landscape at the intersection of artificial intelligence and critical thinking, and to generate evidence-based insights that can inform curriculum design and pedagogical practices. To guide the analysis, the study addresses the following research questions:

1. What are the characteristics of the publication landscape and thematic trends in studies on AI and critical thinking in higher education from 2023 to 2025?
2. What conceptualizations of critical thinking and associated student skills are emphasized in the existing literature?
3. What challenges are identified in promoting critical thinking in AI-integrated higher education?
4. What instructional strategies are recommended to foster critical thinking in AI-supported learning environments?

2. Materials and methods

2.1. Study design

This study adopted a dual-method approach, combining bibliometric analysis and systematic literature review to examine the integration of artificial intelligence and critical thinking in higher education. The bibliometric component aimed to map the research landscape, while the systematic review sought to synthesize key challenges, conceptual frameworks, student competencies, and instructional strategies. The Scopus database was selected as the sole data source due to its extensive indexing of peer-reviewed and high-impact academic literature across multiple disciplines, ensuring both breadth and scholarly rigor. This approach allows for quantitative insight into publication patterns and qualitative interpretation of research themes.

2.2. Search strategy

The search was conducted on July 10, 2025, using the search query: ("critical thinking" AND ("artificial intelligence" OR AI) AND ("higher education" OR university OR college)). This initial search yielded 640 documents. To ensure relevance to the period after the public release of ChatGPT and the growing integration of AI in educational contexts, the search was restricted to publications from 2023 to 2025 (Michalon & Camacho-Zuñiga, 2023; Mirón-Mérida & García-García, 2024). Additional filters were applied to retain only journal articles, excluding conference proceedings, book chapters, and other non-peer-reviewed literature. Although certain conference proceedings—particularly in computer science education—undergo rigorous selection processes, many do not follow a standardized peer-review protocol, resulting in inconsistent methodological rigor and limited long-term citability. To ensure the reliability and comparability of the analyzed literature, such sources were excluded from the dataset. The results were further limited to documents in the final publication stage, resulting in 290 articles for bibliometric analysis. This filtering strategy was intended to focus the analysis on peer-reviewed journal sources, which are generally considered to offer higher methodological rigor and relevance for scholarly discourse. By excluding proceedings and other document types, this study presents a more straightforward overview of relevant publication trends and sources that may serve as potential outlets for researchers submitting empirical work on this topic.

2.3. Selection process

The selection process for the bibliometric analysis was confined to publications from 2023 to 2025, restricted to peer-reviewed journal articles to ensure methodological rigor, and further limited to documents in the final publication stage. This process yielded 290 records for analysis. In parallel, the selection process for the systematic review followed the PRISMA guidelines [Moher et al. \(2016\)](#) through four phases: identification, screening, eligibility, and inclusion, as presented in [Fig. 1](#). Initially, 560 documents published between 2023 and 2025 were identified. Filtering by document type (articles only) reduced the pool to 330, and further limiting to the final publication stage yielded 290 documents. Applying a language filter (English only) resulted in 276 articles, from which only open-access publications were retained to ensure full-text availability, narrowing the dataset to 132 articles. Keyword filtering was then applied to include only documents explicitly listing “critical thinking”, producing 26 articles. A final full-text review was conducted to exclude review articles, leading to the inclusion of 22 empirical studies in the systematic analysis. This decision was made through an internal consensus process among the three review authors, with two supporting the exclusion of review articles to maintain focus on original empirical research, while one recommended their inclusion.

2.4. Data analysis

The bibliometric analysis was conducted using Biblioshiny R and VOSviewer software. These tools enabled the comprehensive extraction and visualization of metadata, including citation networks, keyword co-occurrences, author affiliations, and thematic clusters. This analysis offers insights into the publication landscape, including impactful authors, relevant journal sources, relevant institutions, emerging themes, and potential directions for future research. Meanwhile, the systematic literature review employed a deductive thematic analysis approach, as outlined by [Nowell et al. \(2017\)](#), to identify and categorize themes aligned with the research questions. Three research team members independently reviewed the 22 included articles and conducted thematic coding manually, without using specialized qualitative software such as NVivo. Minor discrepancies in coding terminology were resolved through discussion and consensus. The thematic synthesis was

organized into three categories: (1) conceptualizations of critical thinking and associated student competencies in the AI era, (2) challenges in developing critical thinking in AI-enhanced environments, and (3) proposed instructional strategies to foster critical thinking alongside AI integration.

3. Results

The findings of this study comprise two primary aspects: (1) an overview of the publication landscape on critical thinking in the era of AI in higher education and (2) a synthesis of research on the integration of AI in the development of critical thinking skills in higher education. The publication landscape analysis includes the identification of influential authors, key journal sources, leading institutional affiliations, dominant research themes, and emerging topics that hold potential for future exploration. Meanwhile, the synthesis of research findings presents an overview of the conceptualization of critical thinking, the competencies required by students, the challenges, and strategies for developing critical thinking skills in the AI era. These findings provide a broad analytical perspective, offering critical insights into the research theme.

3.1. Publication landscape and thematic trends in research on AI and critical thinking in higher education (2023–2025)

[Table 1](#) shows the top 10 most cited authors based on total citation counts recorded in Scopus as of 2025. Walter Y is the most influential author, with 201 citations for a single publication in the International Journal of Educational Technology in Higher Education. Mohamed A.M. follows this with 174 citations, and Essel H.B. with 103 citations in Computers and Education: Artificial Intelligence. Other highly cited contributors include Darwin (84 citations), Banihashem S.K. (73 citations), Maheshwari G. (72 citations), and Essien A. (63 citations), whose works have appeared in high-impact journals such as Cogent Education, Education and Information Technologies, and Studies in Higher Education. Additional entries in the top ten include Jia X-H, Chan C.K.Y., and Shahzad M.F., each with over 40 citations. Several journal sources associated with these influential authors also appear among the ten most relevant publication venues in this field, as presented in [Table 2](#). This

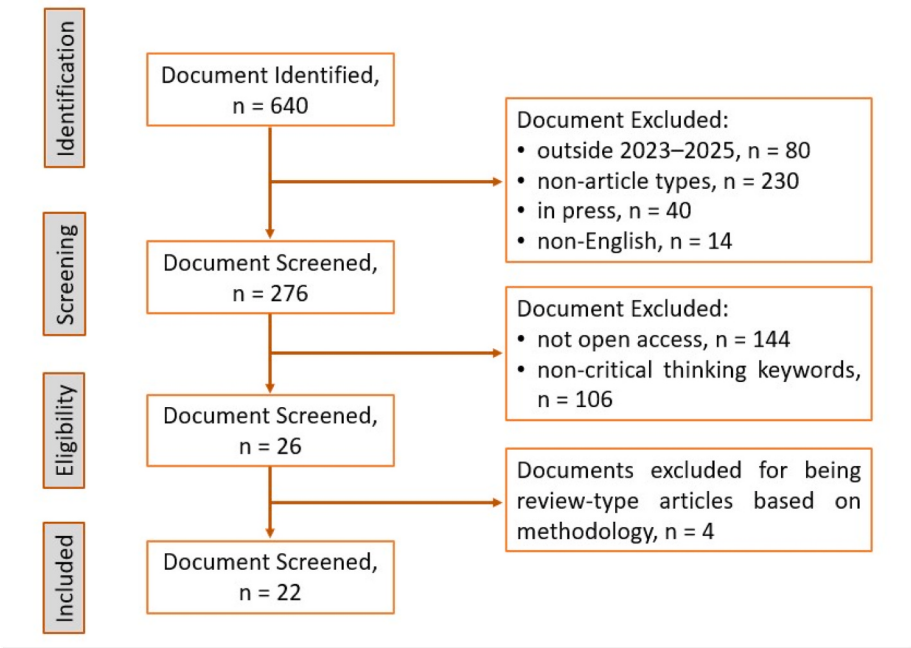


Fig. 1. Prisma flow chart.

Table 1
10 Teratas author berdampak berdasarkan database Scopus Tahun 2025

Author, Year	Source	DOI	TC
Walter Y (2024)	International Journal of Educational Technology in Higher Education	10.1186/s41239-024-00448-3	201
Mohamed A. M. (2024)	Education and Information Technologies	10.1007/s10639-023-11917-z	174
Essel et al., 2024	Computers and Education: Artificial Intelligence	10.1016/j.caeai.2023.100198	103
Darwin et al., 2024	Cogent Education	10.1080/2331186X.2023.2290342	84
Banihashem S. K., 2024	International Journal of Educational Technology in Higher Education	10.1186/s41239-024-00455-4	73
Maheshwari G., 2024	Education and Information Technologies	10.1007/s10639-023-12333-z	72
Essien A., 2024	Studies in Higher Education	10.1080/03075079.2024.2316881	63
Jia X-H, 2024	Systems	10.3390/systems12030074	57
Chan C.K.Y., 2024	Studies in Educational Evaluation	10.1016/j.stueduc.2024.101395	45
Shahzad M.F., 2024	International Journal of Educational Technology in Higher Education	10.1186/s41239-024-00478-x	43

Table 2
10 Teratas Sumber jurnal berdasarkan database Scopus Tahun 2025

Sources	Total Articles
Education and Information Technologies	15
Education Sciences	15
Environment and Social Psychology	8
Journal of Applied Learning and Teaching	8
Cogent Education	7
Frontiers in Education	7
Journal of Information Technology Education: Research	6
Electronic Journal of E-Learning	5
Advances in Physiology Education	4
Computers and Education: Artificial Intelligence	4

finding indicates a strong convergence between author impact and the prominence of specific journals within the discourse on AI and critical thinking in higher education.

Table 2 lists the top 10 journal sources publishing research on artificial intelligence and critical thinking in higher education from 2023 to 2025, based on data retrieved from Scopus. Education and Information Technologies and Education Sciences are the most prolific sources, each contributing 15 publications. These journals are primary outlets for disseminating research at the intersection of digital innovation and pedagogical development. Environment and Social Psychology and the Journal of Applied Learning and Teaching follow with eight articles, indicating growing interdisciplinary interest in the subject. Other significant sources include Cogent Education and Frontiers in Education with seven articles each, and the Journal of Information Technology Education: Research with six. Electronic Journal of E-Learning, Advances in Physiology Education, and Computers and Education: Artificial Intelligence round out the list with four to five articles each. The presence of these journals focusing on education and the domain of teaching and technology demonstrates that these topics are relevant across various educational contexts, from general pedagogy to specialized areas such as digital learning and subject-based instruction. Furthermore, the top 10 relevant affiliations of the corresponding authors in this field are presented in Table 3.

Table 3 presents the top 10 institutional affiliations of corresponding authors contributing to research on artificial intelligence and critical thinking in higher education during the 2023–2025. King Saud University ranks first with 13 publications, indicating its central role in

Table 3
10 Teratas institusi afiliasi author relevan berdasarkan database Scopus Tahun 2025.

Affiliation	Total Articles
King Saud University	13
Imam Abdulrahman Bin Faisal University	10
European University Cyprus	9
Kwame Nkrumah University of Science and Technology	9
Mindanao State University-Sulu	8
Shanghai University of Traditional Chinese Medicine	8
Technical University of Liberec	8
Universitas Negeri Yogyakarta	8
Edith Cowan University	7
Hong Kong Metropolitan University	7

advancing discourse in this domain. Imam Abdulrahman Bin Faisal University follows this with 10 publications, European University Cyprus and Kwame Nkrumah University of Science and Technology with nine each. A cluster of institutions, including Mindanao State University-Sulu, Shanghai University of Traditional Chinese Medicine, Technical University of Liberec, and Universitas Negeri Yogyakarta, contributed eight articles respectively. Edith Cowan University and Hong Kong Metropolitan University round out the list with seven articles each. The geographic diversity of these institutions—from the Middle East and Southeast Asia to Europe and Africa—reflects the global relevance and collaborative potential of AI and critical thinking research in higher education. Further analysis using keyword linkage networks is presented in Figs. 2 and 3.

Fig. 2 illustrates the keyword co-occurrence network generated using VOSviewer, based on 59 refined keywords with a minimum occurrence of four. The analysis reveals five thematic clusters that characterize current research trends on artificial intelligence and critical thinking in higher education. Cluster 1 (red) focuses on pedagogical integration, featuring critical thinking, generative AI, assessment, curriculum, and large language model, indicating attention to instructional design and evaluation. Cluster 2 (green) emphasizes psychological and learner attributes, including creativity, motivation, machine learning, and demographic variables. Cluster 3 (blue) highlights ethical concerns like academic integrity, plagiarism, and academic writing. Cluster 4 (yellow) reflects broader contexts with keywords like artificial intelligence, higher education, educational innovation, and digital competence. Finally, Cluster 5 (purple) centers on AI literacy, digital literacy, and students' perception, signaling a growing emphasis on preparing students for critical engagement with AI technologies. Meanwhile, the overlay visualization analysis related to the latest keywords is presented in Fig. 3.

Fig. 3 presents the overlay visualization of keyword co-occurrences, illustrating the temporal evolution of research themes on artificial intelligence and critical thinking in higher education. The color gradient reflects the average publication year of documents associated with each keyword, with yellow indicating the most recent topics. The most recent emerging keywords include curriculum, digital literacy, personalized learning, AI tools, engineering education, educational technology, digital competence, collaborative learning, procedures, EFL, and ethics. These findings suggest a growing scholarly interest in pedagogical strategies, technological adaptation, and ethical considerations within AI-enhanced learning contexts.

3.2. Conceptualizations of critical thinking and expected student competencies in the AI era

Table 4 presents the results of the synthesis of 22 documents that reveal students' conceptualization of critical thinking in their studies and state the skills students need to have in the era of AI integration.

The reviewed literature, as presented in Table 4, shows a diverse but convergent understanding of critical thinking, especially in integrating

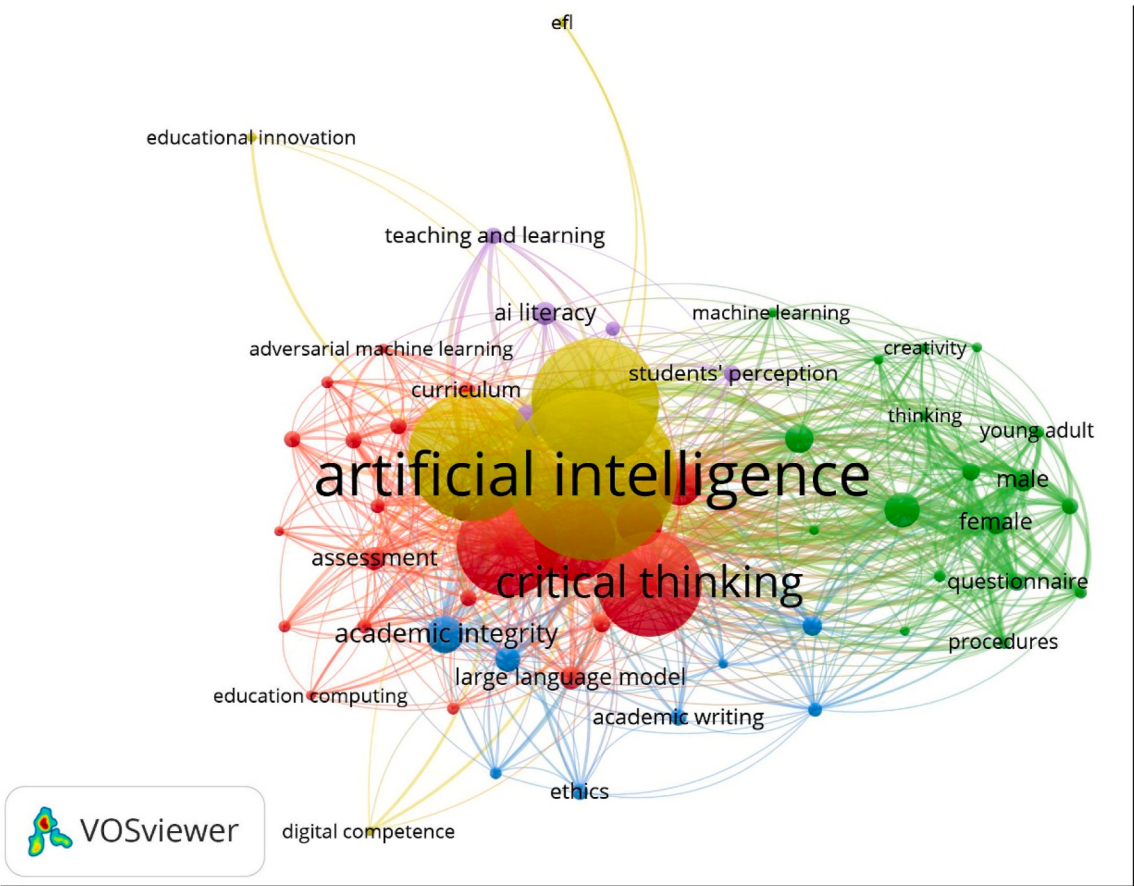


Fig. 2. Keyword Co-occurrence network based on network visualization.

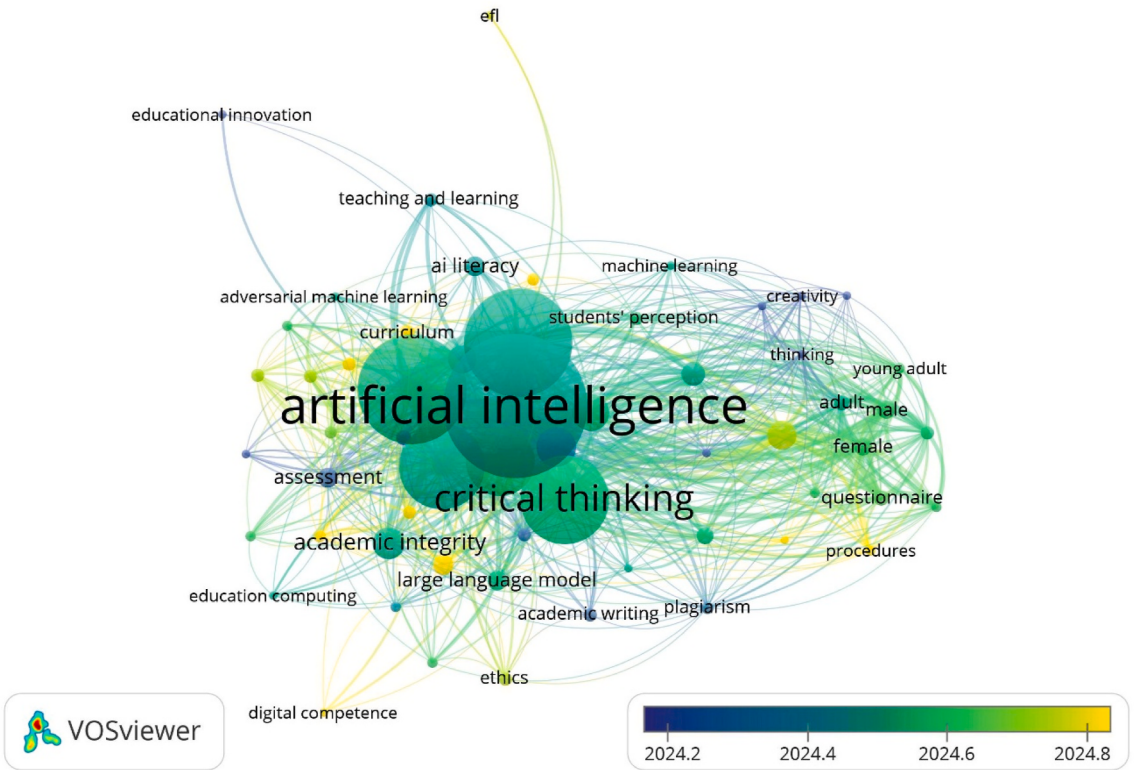


Fig. 3. Keyword Co-occurrence patterns based on overlay visualization.

Table 4

Summary of critical thinking conceptualizations and suggested student competencies in AI-Integrated higher education.

Author(s)	Research Method	Conceptualization of Critical Thinking	Suggested Student Competencies
Cook (2025)	Qualitative (narrative analysis)	The ability to challenge knowledge, interpret evidence, and generate creative and socially impactful solutions	Advanced information literacy; digital ethics and socio-cultural sensitivity; dialogic co-creation
Zhou et al. (2024)	Quantitative (survey, SEM)	The art of evaluating cognitive processes, involving analysis, reasoning, and affective dispositions	Self-regulation; critical evaluation of AI output; strategic use of AI for high-order thinking
Vieriu and Petrea (2025)	Mixed-methods (survey and interviews)	Not explicitly defined	Not specified
Qi et al. (2025)	Quantitative (survey)	The ability to identify assumptions, evaluate evidence, draw conclusions, and self-correct	Analytical and evaluative skills; self-directed learning; AI literacy
Kharis et al. (2024)	Mixed-methods (survey and interviews)	Not explicitly defined	AI literacy; academic ethics; cognitive skills; collaborative learning with AI
Ruiz-Rojas et al. (2024)	Mixed-methods (survey and thematic analysis)	The ability to analyze, evaluate, and synthesize information while questioning assumptions and identifying bias	Ethical AI use; bias awareness; creativity and analysis; effective communication; collaborative work
Fakour and Imani (2025)	Mixed-methods (MLP and interviews)	The capacity to analyze, evaluate, and synthesize information through dialogic learning	Not specified
Giray (2024)	Conceptual essay	The ability to critically evaluate AI content, recognize limitations, and maintain deep cognitive engagement	AI literacy; academic research skills; awareness of AI limitations; valuing the learning process
Liu and Tu (2024)	Quasi-experimental (pre-post test)	A purposeful, self-regulated judgment process involving analysis, evaluation, inference, and interpretation	Digital literacy; self-regulated learning; analysis, evaluation, inference, interpretation
Alam et al. (2023)	Opinion piece	The ability to independently evaluate AI-generated information and avoid superficial understanding	AI literacy; ethical AI use; critical information evaluation
Michalon and Camacho-Zuñiga (2023)	Action research	The capacity to evaluate reasoning, detect contradictions, and form judgments through reflective questioning	Prompt engineering; information verification; written communication; methodical reasoning

Table 4 (continued)

Author(s)	Research Method	Conceptualization of Critical Thinking	Suggested Student Competencies
Mirón-Mérida and García-García (2024)	Experimental (AI plagiarism detection tools)	Not explicitly defined	Not specified
Mahdi and Sahari (2024)	Quantitative (survey and SEM)	The ability to interpret, analyze, and evaluate texts for accurate decision-making in translation contexts	Not specified
Youssef et al. (2024)	Cross-sectional survey	A systematic approach to analyzing, evaluating, and synthesizing information using high-order cognitive skills	Information verification
Darwin et al. (2024)	Qualitative (case study)	A multidimensional skill involving contextual analysis, evidence evaluation, and methodological reasoning	Not specified
Šedlbauer et al. (2024)	Qualitative	A reflective process involving error detection, rethinking, and exploring alternatives	Formulating precise questions; AI response verification; AI as an object of academic inquiry
Van den Berg and Du Plessis (2023)	Qualitative (document analysis, exploratory case)	The capacity to evaluate AI-generated material and construct arguments through critical reflection	AI content critique; validation and argumentation; awareness of AI limitations and bias
Chaparro-Banegas et al. (2024)	Quasi-experimental (pre-post test)	Reflective thinking used to evaluate statements and reach justified conclusions	Asking questions; recognizing AI value; applying reasoning to real-world issues
Murtiningsih et al. (2024)	Qualitative	The ability to verify, reflect, and resist passive consumption of AI content	Critical digital literacy; academic honesty; collaboration and autonomy; technological adaptability
Xu and Jumaat (2024)	Mixed-methods (survey and focus group)	The ability to evaluate, analyze, and understand academic content when using AI tools	Information literacy; AI output verification; prompt engineering; ethical AI use
Tsopra et al. (2023)	Curriculum design (Kern's model)	Digital health critical thinking involving ethical and technical evaluation of AI-CDSS	Digital health literacy; ethical reasoning in clinical AI systems
Essel et al. (2024)	Mixed-methods (experiment and interview)	The ability to evaluate arguments through critical openness and reflective skepticism	Critical evaluation of AI output; reflective and metacognitive thinking

artificial intelligence in higher education. Some authors provide clear theoretical frameworks—adapted from scholars concerned with critical thinking theory such as [Facione's \(2011\)](#) purposeful and self-regulated judgment process ([Liu & Tu, 2024](#)), or [Lipman \(1988\)](#) skillful and responsible thinking guided by criteria and contextual sensitivity

(Michalon & Camacho-Zuñiga, 2023)—other authors emphasize the practical application of critical thinking in navigating AI-generated information (Alam et al., 2023; Van den Berg & Du Plessis, 2023). A common conceptual thread is that critical thinking involves evaluative reasoning, reflective skepticism, and the ability to analyze and interpret complex information in rapidly evolving digital environments (Chaparro-Banegas et al., 2024; Essel et al., 2024; Xu & Jumaat, 2024). Even studies without explicit theoretical grounding consistently highlight critical thinking as essential for ethical engagement with AI technologies, thoughtful decision-making, and intellectual autonomy (Darwin et al., 2024; Giray, 2024; Murtiningsih et al., 2024).

Across the studies, several recurring competencies emerge as necessary for maintaining and enhancing critical thinking in AI-supported learning contexts. Among these are advanced information and AI literacy, including the ability to verify, interpret, and assess the credibility of AI-generated content (Qi et al., 2025; Youssef et al., 2024; Zhou et al., 2024). Self-regulated learning is also emphasized, particularly the capacity to plan, monitor, and reflect on one’s cognitive processes when engaging with AI tools (Essel et al., 2024; Liu & Tu, 2024). Other competencies include prompt engineering, reflective communication, and digital health literacy—each of which supports students in becoming active, critical users of AI rather than passive recipients of automated output (Michalon & Camacho-Zuñiga, 2023; Tsopra et al., 2023; Xu & Jumaat, 2024). Several authors also stress ethical awareness, academic honesty, and collaborative adaptability as essential in preserving human-centered values in AI-mediated educational settings (Kharis et al., 2024; Murtiningsih et al., 2024; Ruiz-Rojas et al., 2024).

Furthermore, some studies highlight discipline-specific manifestations of critical thinking, such as clinical reasoning in digital health (Tsopra et al., 2023) or translation accuracy in language studies (Mahdi & Sahari, 2024), without always specifying the required skills. Others reveal implicit concerns about over-reliance on AI, suggesting the need for students to develop resilience against cognitive automation by nurturing deeper analytical habits and critical engagement with digital tools (Giray, 2024; Šedlbauer et al., 2024). The literature suggests that cultivating critical thinking in the AI era demands a fusion of evaluative reasoning, ethical discernment, and digital competence, underscoring the urgency of embedding these competencies into curricula across disciplines.

3.3. Challenges in fostering critical thinking in AI-integrated higher education

The results of the synthesis of 22 documents that identify the challenges in fostering critical thinking within AI-integrated higher education environments are presented in Table 5.

The studies reviewed in Table 5 consistently emphasize that overreliance on AI-generated content is a critical barrier to developing independent and reflective thinking among students. Many authors report that students tend to accept AI outputs without adequate evaluation, which diminishes cognitive engagement and reduces opportunities for deep reasoning and self-correction (Michalon & Camacho-Zuñiga, 2023; Xu & Jumaat, 2024; Zhou et al., 2024). Furthermore, several works highlight that AI responses often contain inaccuracies, fabricated references, or biased information, posing significant risks of misinformation and plagiarism if left unexamined (Alam et al., 2023; Essel et al., 2024; Mirón-Mérida & García-García, 2024). These concerns are compounded by the lack of transparency in AI systems, which frequently provide untraceable or unverifiable sources, making it difficult for students to assess the reliability of information (Van den Berg & Du Plessis, 2023; Giray, 2024). Additionally, disparities in students’ digital literacy and prompting capabilities contribute to uneven critical engagement with AI tools, with some students unable to distinguish between high- and low-quality content (Chaparro-Banegas et al., 2024; Qi et al., 2025).

Psychological and structural challenges also surface in multiple studies. Anxiety regarding AI usage negatively correlates with students’

Table 5
Summary of challenges in fostering critical thinking in AI-Integrated higher education.

Author(s)	Conceptualized Challenges
Cook (2025)	Political hegemony and utilitarian curricula suppress critical pedagogy; time and financial constraints limit student engagement in critical discourse.
Zhou et al. (2024)	Overreliance on generative AI reduces cognitive reflection; AI hallucinations impair learning accuracy and critical evaluation.
Vieriu and Petrea (2025)	Excessive AI dependency undermines independent thinking, reduces interpersonal learning, and increases academic dishonesty.
Qi et al. (2025)	Low cognitive skills lead to uncritical AI use; digital skill gaps widen inequalities in critical thinking development.
Kharis et al. (2024)	AI tools may discourage autonomous reasoning and creative exploration, threatening students’ critical development and academic integrity.
Ruiz-Rojas et al. (2024)	Ethical concerns such as algorithmic bias and data privacy challenge fair and transparent learning environments.
Fakour and Imani (2025)	AI lacks contextual sensitivity and emotional nuance; overreliance on AI weakens motivation and judgment; AI responses may appear plausible yet be incorrect.
Giray (2024)	Intellectual erosion and false confidence arise from automation; AI encourages shallow understanding and misinformation dissemination.
Liu and Tu (2024)	High critical thinking disposition is not matched by skill proficiency; adaptive AI systems demand deeper cognitive effort.
Alam et al. (2023)	AI hallucinations and plagiarism risk hinder medical students’ critical reasoning; reduced accountability affects ethical decision-making.
Michalon and Camacho-Zuñiga (2023)	Students uncritically accept flawed AI outputs; lack of source transparency delays the development of evaluative judgment.
Mirón-Mérida and García-García (2024)	Unregulated AI use inhibits soft skill development; current detection tools fail to prevent plagiarism, especially in non-English contexts.
Mahdi and Sahari (2024)	Anxiety toward AI usage correlates negatively with critical thinking; increased use raises apprehension, limiting cognitive openness.
Youssef et al. (2024)	Students must independently verify AI outputs due to inaccuracies; unverified information challenges academic reliability.
Darwin et al. (2024)	Echo chambers and algorithmic filtering restrict exposure to diverse viewpoints; AI cannot process emotional or interpretive nuance in complex texts.
Šedlbauer et al. (2024)	Students may over-trust AI outputs; response variability and ethical risks like bias and plagiarism require structured critical engagement.
Van den Berg and Du Plessis (2023)	AI lacks reasoning depth and factual verification; misuse can disrupt data integrity, raise plagiarism risks, and generate misleading conclusions.
Chaparro-Banegas et al. (2024)	AI use may cause skill deterioration, misinformation, and ethical violations; infrastructure gaps and untrained faculty exacerbate critical thinking challenges.
Murtiningsih et al. (2024)	Excessive ChatGPT use diminishes students’ analytical and reflective abilities; reliance on AI reduces cognitive autonomy.
Xu and Jumaat (2024)	ChatGPT may promote plagiarism and deliver fabricated references; digital literacy gaps limit effective AI use and hinder writing quality.
Tsopra et al. (2023)	Lack of faculty with dual expertise in medicine and AI-CDSS hinders effective instruction and critical engagement in digital health domains.
Essel et al. (2024)	Inaccurate AI responses and reference fabrication reduce content credibility; overreliance suppresses creative thinking and diminishes teacher engagement.

willingness to engage critically, as fear of misuse or misunderstanding may inhibit active exploration (Mahdi & Sahari, 2024). At the same time, AI tools’ inability to interpret human nuance—such as irony, emotion, or cultural context—limits their effectiveness in fostering deep, context-aware thinking (Darwin et al., 2024; Fakour & Imani, 2025). Institutional factors such as lack of faculty training, infrastructure inequality, and insufficient ethical frameworks further hinder efforts to integrate AI without compromising academic integrity and cognitive rigor (Chaparro-Banegas et al., 2024; Tsopra et al., 2023). These findings indicate that critical thinking development in AI-enhanced education requires student-level cognitive strategies and systemic interventions in pedagogy, faculty capacity building, and AI governance.

3.4. Instructional strategies for enhancing critical thinking in AI-supported learning environments

Table 6 shows the results of synthesizing 22 documents presenting instructional strategies to enhance critical thinking in AI-supported learning environments.

The synthesis of 22 studies in Table 6 reveals a diverse yet convergent set of instructional strategies to foster critical thinking in AI-supported learning environments. Many authors emphasize the importance of combining traditional pedagogical methods with AI-enhanced approaches to promote reflective, analytical, and independent thinking (Van den Berg & Du Plessis, 2023; Fakour & Imani, 2025; Ruiz-Rojas et al., 2024). Strategies such as integrating structured debates, real-world problem-based projects, and co-created learning spaces are proposed to cultivate students’ active engagement and cognitive autonomy (Cook, 2025; Mirón-Mérida & García-García, 2024; Tsopra et al., 2023). Several studies highlight the necessity of embedding critical thinking explicitly into AI literacy curricula and leveraging AI tools like ChatGPT to support, rather than replace, reasoning processes (Michalon & Camacho-Zuñiga, 2023; Qi et al., 2025; Xu & Jumaat, 2024). A shared emphasis is also placed on the role of guided prompt engineering, reflective use of generative AI, and structured feedback mechanisms to deepen student inquiry and conceptual understanding (Essel et al., 2024; Michalon & Camacho-Zuñiga, 2023; Zhou et al., 2024).

Ethical and regulatory considerations are another recurring focus. Many authors advocate for the development of institutional policies, educator training, and curricular interventions to ensure responsible and transparent AI use (Alam et al., 2023; Chaparro-Banegas et al., 2024; Murtiningsih et al., 2024). Reducing AI-related anxiety and fostering positive attitudes are essential for meaningful engagement, especially in translation and language learning (Mahdi & Sahari, 2024; Youssef et al., 2024). Practical strategies such as oral presentations, video-based tasks, and in-class assignments are also recommended to prevent overreliance on AI and to reinforce student-generated output (Mirón-Mérida & García-García, 2024; Šedlbauer et al., 2024). Collectively, the literature underscores the importance of pedagogical designs that are adaptive, ethically grounded, and capable of equipping students with the critical competencies necessary to navigate the complexities of AI-enhanced education.

4. Discussion

4.1. Publication landscape and thematic trends in research on AI and critical thinking in higher education (2023–2025)

The publication landscape from 2023 to 2025 reveals a concentration of scholarly influence among a small group of highly cited authors, with Walter Y, Mohamed A.M., and Essel H.B. leading the field. Their contributions, published in high-impact journals such as International Journal of Educational Technology in Higher Education and Computers and Education: Artificial Intelligence, focus on key intersections of AI integration and cognitive development in higher education. For

Table 6
Summary of instructional strategies for enhancing critical thinking in AI-Supported learning environments.

Author(s)	Recommended Instructional Strategies
Cook (2025)	Adopt critical pedagogy; facilitate debate on controversial topics; promote co-creation of learning environments; engage students with professionals; balance free speech and cultural sensitivity.
Zhou et al. (2024)	Integrate self-regulation strategies into AI-supported learning; design interventions to enhance metacognitive skills; align AI use with cognitive processes and contextual needs.
Vieriu and Petrea (2025)	Integrate AI strategically into instruction; educate students on responsible AI use; provide clear usage guidelines and validation protocols; offer comprehensive training for stakeholders.
Qi et al. (2025)	Embed critical thinking in AI literacy curricula; guide responsible and reflective use of GenAI tools; strengthen students’ evaluative skills and independent problem-solving.
Kharis et al. (2024)	Develop AI literacy programs; integrate ethical and cognitive-skill-focused instruction; implement adaptive and collaborative teaching strategies; ensure balanced AI adoption.
Ruiz-Rojas et al. (2024)	Provide ongoing training and technical support; systematically integrate generative AI into curricula; combine AI with traditional pedagogy to foster collaboration and reflective analysis.
Fakour and Imani (2025)	Employ hybrid learning models combining AI and human-led teaching; invest in educator training; ensure equitable access to AI; conduct ongoing evaluation and involve students in development.
Giray (2024)	Emphasize core research skills; design tasks that promote independent academic work; offer AI literacy training; balance AI use with ethical academic practices.
Liu and Tu (2024)	Integrate AI-supported socio-scientific instruction; address discrepancies between disposition and skills; embed critical thinking into adaptive learning environments.
Alam et al. (2023)	Implement strict ethical policies; teach responsible AI usage; mandate disclosure of AI assistance in writing; develop faculty AI literacy and promote original thought.
Michalon and Camacho-Zuñiga (2023)	Encourage iterative and analytical AI interactions; assign tasks requiring conceptual application; teach AI limitations and prompt design; provide formative feedback on AI engagement.
Mirón-Mérida and García-García (2024)	Use AI as a supervised support tool; assign personalized tasks and oral assessments; establish ethical guidelines; build trust-based classroom environments.
Mahdi and Sahari (2024)	Reduce AI-related anxiety through education; foster positive attitudes toward AI adoption to support deeper critical engagement and cognitive readiness.
Youssef et al. (2024)	Promote verification of AI-generated content; encourage perspective-taking and independent research; integrate critical analysis into assignments and instruction.
Darwin et al. (2024)	Not explicitly stated.
Šedlbauer et al. (2024)	Incorporate practical elements such as oral defense; educate students on ethical AI use; embed AI-related debates and policies within academic programs.
Van den Berg and Du Plessis (2023)	Apply a critical lens to AI tools; validate AI-generated learning content; integrate academic integrity discussions; enhance digital literacy and reasoning.
Chaparro-Banegas et al. (2024)	Guide ethical and transparent AI use; reinforce critical reasoning through societal problem analysis; implement inclusive AI policies and continuous skill development.
Murtiningsih et al. (2024)	Assign open-ended critical thinking tasks; adapt digital pedagogy to foster autonomy and collaboration; evaluate AI-generated outputs within the curricular context.

(continued on next page)

Table 6 (continued)

Author(s)	Recommended Instructional Strategies
Xu and Jumaat (2024)	Teach evaluation of AI output; strengthen information literacy; emphasize ethical AI integration in writing tasks; improve prompt formulation skills.
Tsopra et al. (2023)	Use real-world design-based projects; position students as AI system co-creators; apply face-to-face instruction to promote iterative inquiry and critical judgment.
Essel et al. (2024)	Embed AI-facilitated critical dialogue into instruction; encourage perspective exchange; ensure instructor guidance and content accuracy in AI-based learning.

instance, Walter (2024) provides a comprehensive framework for embedding AI tools in pedagogical contexts while maintaining academic rigor and student agency. Similarly, Mohamed (2024) emphasizes ethical dimensions in AI-supported assessment practices, a concern also echoed by Essel et al. (2024), who highlights the implications of AI-generated content for academic integrity. These works underscore the prominence of ethical, pedagogical, and technological integration as dominant themes, consistent with current theoretical debates on responsible AI use in education (Mhlanga, 2023; Tubella et al., 2024).

The concentration of publications in journals such as Education and Information Technologies and Education Sciences, each contributing 15 articles, highlights their central role in shaping discourse on AI and critical thinking in higher education. These journals have consistently served as platforms for interdisciplinary dialogue, often publishing studies that bridge educational theory, technological innovation, and digital pedagogy. Their prominence suggests that researchers prioritize venues that support nuanced explorations of how AI tools influence cognitive development, ethical reasoning, and student engagement. Journals like Computers and Education: Artificial Intelligence, although newer and more specialized, also appear in the top tier, indicating growing scholarly interest in AI-specific educational applications. This trend aligns with broader shifts in academic publishing, where open-access, technology-focused journals are becoming preferred outlets for timely and impactful research on emerging educational challenges (Corrin et al., 2024, pp. 653–657).

Institutionally, the dominance of universities in the Middle East and Asia, such as King Saud University, Imam Abdulrahman Bin Faisal University, and Universitas Negeri Yogyakarta, reflects increasing global engagement with AI-integrated pedagogies. These institutions demonstrate productivity in terms of publication volume and reveal regional investment in digital transformation strategies within higher education systems. Their presence alongside institutions from Europe and Africa, including European University Cyprus and Kwame Nkrumah University of Science and Technology, points to a more inclusive research landscape. The diversity of institutional affiliations also signals a shift from traditional Western-centric knowledge production toward a more distributed and collaborative global research network. This finding may offer valuable opportunities for future cross-national studies, particularly in understanding how contextual factors, such as infrastructure, policy, and cultural pedagogies, mediate the integration of critical thinking frameworks in AI-supported learning environments (Rios et al., 2025).

The dominant themes identified across the five clusters reflect a maturing discourse on integrating artificial intelligence and critical thinking in higher education. The first cluster, which emphasizes pedagogical integration, underscores the increasing incorporation of AI—particularly generative AI—into curriculum development and instructional practices. However, the challenge lies in embedding AI into learning environments and aligning it with intellectual standards such as clarity, accuracy, and depth (Paul & Elder, 2019). The literature suggests that while AI tools can support learning, they must be paired with

pedagogical structures that ensure students are not merely consuming AI-generated outputs but actively questioning and analyzing them (Panit, 2024; Slade et al., 2025). Without such scaffolding, the development of evaluative reasoning may be compromised despite technological innovation.

The second and third clusters, focusing on learner-centered attributes and ethical considerations, reveal deeper cognitive and normative implications. Motivation, creativity, and psychological readiness emerge as mediating factors in the practical application of critical thinking, echoing the role of metacognitive and affective dimensions in Facione’s (2011) model. However, the ethical implications of AI use—mainly in academic writing and integrity—are still underexplored. The presence of keywords such as plagiarism, academic performance, and ethics signals growing concern over the authenticity of student work in AI-assisted contexts. This concern demands more than policy interventions, requiring deliberate instructional design that cultivates ethical reasoning and decision-making in line with critical thinking standards (Ennis, 2018; Tathahira, 2020).

Clusters four and five suggest that institutional readiness and student perceptions are equally pivotal in shaping critical engagement with AI. The prominence of digital competence and AI literacy reflects a collective awareness that reflective dispositions must complement technological fluency. However, disparities in digital literacy and a lack of clarity about AI’s role in learning outcomes can hinder the cultivation of higher-order thinking skills (Walter, 2024). As universities attempt to innovate through AI integration, the literature highlights an urgent need for frameworks that simultaneously address technological, ethical, and cognitive dimensions, ensuring that AI serves as a tool for intellectual development, not a substitute for it (Chauncey & McKenna, 2023; Nasir et al., 2024).

Recent trajectories in research on artificial intelligence and critical thinking highlight the need for pedagogical adaptability, ethical sensitivity, and contextual relevance. Instead of assuming AI tools to be inherently beneficial, future investigations should interrogate the specific conditions under which technologies such as personalized learning platforms or intelligent tutoring systems contribute to, or potentially undermine, metacognitive development. The increasing reliance on automated feedback mechanisms presents complex dynamics in their implementation. While AI tools can provide tailored instructional support, they can inadvertently undermine students’ capacities for self-regulation, evaluate alternative perspectives, and make reasoned judgments, core elements in Facione’s (2011) and Ennis’s (2018) frameworks. Future inquiry should assess how these systems can be designed to enhance, not bypass, students’ reflective engagement.

Incorporating digital competence and AI literacy into curriculum design also calls for critically exploring how educators conceptualize and operationalize these competencies in various disciplines. There remains a gap in understanding how faculty members navigate the alignment between AI-mediated instruction and intellectual standards such as clarity, logical consistency, and relevance (Paul & Elder, 2019). Research that investigates institutional readiness, instructional capacity, and curricular coherence will be key in bridging this gap—especially in engineering, health sciences, and language education, where critical thinking manifests through domain-specific reasoning. Such studies could provide actionable frameworks for embedding AI literacy in ways that sustain ethical awareness, disciplinary depth, and critical independence.

Finally, there is a growing need for research that addresses the equity and accessibility dimensions of AI integration. As digital tools become more embedded in higher education, students from resource-constrained institutions or underserved communities may face disproportionate challenges in developing AI-related competencies. This highlights the urgency for culturally responsive and ethically sound pedagogical models that democratize access to AI-supported learning while safeguarding cognitive rigor and intellectual agency. Investigating how these models perform across diverse socio-educational settings can

help ensure that the future of AI in education is not only innovative but also inclusive.

4.2. Conceptualizations of critical thinking and expected student competencies in the AI era

The synthesized findings from the literature review reveal varied conceptualizations of critical thinking within AI-integrated learning environments in higher education. Some studies, such as those by Vieri and Petrea (2025), Kharis et al. (2024), and Mirón-Mérida and García-García (2024), do not explicitly define the concept of critical thinking they adopt, but instead highlight its importance in general terms. In contrast, several other studies refer to established theoretical frameworks—for example, Facione's (2011) definition of critical thinking as a purposeful and self-regulated process of judgment, and Paul and Elder's (2019) emphasis on reasoning guided by intellectual standards such as clarity, relevance, and consistency. Other studies have conducted specific contextual interpretations, framing the concept of critical thinking with students' ability to analyze, interpret, and transmit AI-generated content (Alam et al., 2023; Liu & Tu, 2024; Michalon & Camacho-Zuñiga, 2023). This perspective aligns with Ennis's (2018) characterization of critical thinking as a logical and reflective process directed toward deciding what to believe or do. However, the lack of explicit theoretical grounding in many studies underscores the urgency of pedagogical models that are theoretically sound and contextually relevant, especially in digitally mediated environments (Walter, 2024). In line with this need, Holmes and Miao (2023) emphasizes that integrating generative AI in education must follow a human-centered approach that prioritizes human agency, critical discernment, and cognitive autonomy to ensure students remain active, reflective participants in the learning process.

To operationalize this vision, students must acquire specific competencies that enable them to engage with AI technologies while maintaining independent and critical thinking. These include AI and information literacy, evaluative reasoning, prompt engineering, and self-regulated learning strategies such as goal-setting and reflective monitoring (Essel et al., 2024; Qi et al., 2025; Zhou et al., 2024). These skills enable students to engage with AI-generated content actively and questioningly, rather than passively consuming it. They are consistent with Facione's (2011) cognitive taxonomy—particularly inference, evaluation, and self-regulation—and are further supported by Paul and Elder's (2019) notion of intellectual discipline. Ethical awareness and academic integrity are crucial for fostering independent and critical engagement with AI tools (Chaparro-Banegas et al., 2024; Kharis et al., 2024). Holmes and Miao (2023) underscores the importance of embedding these competencies into curricula, arguing that doing so protects learners from overreliance on AI systems and ensures that these technologies serve as cognitive support rather than cognitive substitutes. Several studies indicate that students must learn to question AI-generated outputs rather than accept them at face value, reflecting Tathahira (2020) call for students to develop discernment when interpreting digital content. As noted in multiple studies, the risk is that AI can diminish cognitive effort without pedagogical scaffolding and undermine students' ability to engage in sustained analysis (Gonsalves, 2024; Sarwanti et al., 2024). Thus, developing students' ability to evaluate and regulate their use of AI tools is central to maintaining the integrity of critical thinking in higher education.

4.3. Challenges in fostering critical thinking in AI-integrated higher education

The synthesized findings from the reviewed literature highlight a critical concern in AI-mediated education: students' tendency to accept AI-generated content without adequate critical oversight. This pattern is antithetical to core definitions of critical thinking, which emphasize evaluative reasoning, reflective judgment, and intellectual autonomy

(Ennis, 2018; Facione, 2011; Paul & Elder, 2019). Studies such as those by Zhou et al. (2024), Xu and Jumaat (2024), and Michalon and Camacho-Zuñiga (2023) highlight that when students uncritically accept AI outputs, opportunities for practicing interpretation, inference, and evaluation are diminished. These are precisely the processes Facione (2011) identifies as essential for critical thinking. Furthermore, the unverified and sometimes erroneous nature of AI responses, such as hallucinated citations or misleading information (Alam et al., 2023; Essel et al., 2024), intensifies the need for higher-order reasoning and source validation, as emphasized by Tathahira (2020) and Lau (2011). The literature thus indicates a critical disconnect between the affordances of AI and the actual pedagogical outcomes when critical thinking is not intentionally scaffolded. Without structured reflection activities and source triangulation strategies, AI use may promote convenience over comprehension, thus weakening students' cognitive resilience. Holmes and Miao (2023) echoes these concerns by warning that generative AI systems risk diminishing learners' capacity for discernment and judgment without clear pedagogical validation. The guidance calls for systematic efforts to evaluate AI tools for their ethical and educational appropriateness, reinforcing the need for institutional oversight and learner agency.

In addition to cognitive challenges, emotional and contextual factors such as anxiety, digital skill gaps, and institutional readiness emerge as significant barriers to cultivating critical thinking. As Mahdi and Sahari (2024) noted, fear and uncertainty regarding AI tools can limit students' willingness to engage critically, undermining Ennis's (2018) notion of deliberate and rational judgment. Darwin et al. (2024) and Fakour and Imani (2025) add that AI's inability to recognize nuance—such as irony, emotional tone, or socio-cultural context—limits its effectiveness in supporting deep thinking, especially in disciplines that rely on qualitative or interpretive reasoning. Furthermore, institutional factors such as faculty training, inconsistent digital infrastructure, and the lack of ethical guidelines (Chaparro-Banegas et al., 2024; Tsopra et al., 2023) signal a systemic gap between AI adoption and pedagogical alignment. These constraints compromise the broader conditions needed to support the development of Paul and Elder's (2019) intellectual standards, such as fairness, depth, and relevance.

While some recent studies highlight the potential of AI to support cognitive development—for instance, by enhancing argument construction or promoting metacognitive awareness (Melisa et al., 2025; Raitskaya & Tikhonova, 2025)—these benefits are contingent on proper guidance and ethical implementation. This duality is echoed in Gonsalves (2024) and Panit (2024), who caution that the cognitive effort required for deep analysis may be bypassed when AI is used without structured reflection. The present review reinforces these concerns by showing that in many cases, students are not sufficiently equipped to navigate the epistemic risks posed by AI (Zhai et al., 2024). This finding indicates an urgent need for AI-integrated curricula to embed systematic strategies that strengthen students' analytical skepticism, source literacy, and self-regulation. Holmes and Miao (2023) advocates for embedding AI-related competencies into curricula—technical skills and critical, ethical, and reflective capacities—to ensure that AI use enhances, rather than replaces, meaningful learning. By integrating these dimensions within institutional and instructional frameworks, higher education can more effectively foster the conditions under which critical thinking thrives, even in digitally mediated learning environments.

4.4. Instructional strategies for enhancing critical thinking in AI-supported learning environments

The synthesis findings reveal that instructional strategies that can foster critical thinking in AI-integrated higher education environments emphasize a combination of traditional pedagogy and AI-enhanced learning. This pedagogical hybridity reflects the theoretical alignment with Ennis's (2018) view of critical thinking as a deliberative, reflective process and Paul and Elder's (2019) conception of it as purposeful and

self-regulatory thinking. By integrating structured debates, problem-based learning, and real-world design tasks, educators encourage interpretation, inference, and evaluative reasoning—core skills outlined by [Facione \(2011\)](#). These findings support earlier research by [Melisa et al. \(2025\)](#) and [Raitskaya and Tikhonova \(2025\)](#), who note that AI tools can stimulate idea generation and metacognitive reflection when embedded within well-structured instructional environments. However, without strategic pedagogical design, AI use may reinforce passive learning behaviors and reduce students' opportunities for engaging in deep conceptual inquiry ([Cookson, 2025](#)). [Holmes and Miao \(2023\)](#) similarly cautions that generative AI has pedagogical potential but must be embedded within intentional instructional design grounded in clear learning outcomes, ethical considerations, and human-centered educational values.

Another central dimension emerging from the literature is the role of explicit AI literacy training as a vehicle for critical thinking development. Several studies advocate for embedding critical thinking instruction into digital literacy curricula, emphasizing guided prompt engineering, source verification, and the reflective use of generative AI tools ([Michalon & Camacho-Zuñiga, 2023](#); [Qi et al., 2025](#)). This finding aligns with [Lau's \(2011\)](#) argument that critical thinking involves systematic logic and [Sachdeva and Eggen's \(2021\)](#) emphasis on reflective reasoning. Institutional initiatives—such as faculty training, assessment reform, and ethical policy development—are likewise positioned as necessary scaffolds for supporting critical thinking. These insights parallel [Deroncele-Acosta et al. \(2025\)](#), who stress that critical thinking must be cultivated as a transversal competency across domains, particularly when addressing challenges posed by algorithmic outputs and digital misinformation. [Holmes and Miao \(2023\)](#) reinforces this view by calling for instructor capacity-building programs, policy alignment, and curriculum development frameworks that support the integration of AI-related competencies—including critical discernment, digital ethics, and epistemic responsibility—into all levels of education. Therefore, fostering critical thinking in AI-enhanced classrooms is not solely a cognitive task but also an institutional responsibility requiring alignment between curricular intent and instructional practice.

Finally, the reviewed studies underscore the importance of ethical awareness and affective engagement in supporting critical thinking under AI mediation. Positive student attitudes toward AI and reduced anxiety—especially in domains such as translation and language learning—are associated with deeper and more autonomous thinking ([Mahdi & Sahari, 2024](#); [Youssef et al., 2024](#)). This finding echoes [Facione's \(2011\)](#) argument that critical thinking encompasses cognitive skills and dispositions such as open-mindedness, truth-seeking, and confidence in reasoning. Additionally, strategies such as oral presentations, video tasks, and classroom-based assessments serve as counterbalances to AI dependency by reinforcing student-authored work and real-time reasoning ([Mirón-Mérida & García-García, 2024](#); [Sedlbauer et al., 2024](#)). Collectively, the evidence suggests that cultivating critical thinking in AI-supported education requires an instructional ecosystem that is ethically grounded, affectively responsive, and structurally designed to promote sustained reflection and intellectual independence.

5. Conclusions

This study aims to map the academic landscape of integrating AI and critical thinking in higher education and provide insights that can help shape curriculum design and teaching practices. The publication landscape between 2023 and 2025 reflects a growing scholarly consolidation around influential authors, prominent journals, and diverse institutional affiliations. Among the most impactful contributors are Walter Y., Mohamed A.M., and Essel H.B., each of whom has received over 100 citations, indicating significant influence in shaping the discourse on artificial intelligence and critical thinking in higher education. Journals such as *Education and Information Technologies* and *Education Sciences*

have emerged as leading publication venues, consistently disseminating research that bridges technological innovation with pedagogical development. The geographic spread of contributing authors—from Asia and the Middle East to Africa and Europe—underscores the global relevance of this field and signals the emergence of new centers of academic productivity. This trend presents opportunities for cross-national collaboration and comparative studies that examine how contextual factors influence the integration of AI into higher education systems.

Thematic trends identified through keyword mapping reveal an evolving research agenda marked by five interconnected clusters: pedagogical innovation, psychological dimensions, academic ethics, systemic integration, and AI-related literacies. These clusters indicate a broadening conceptualization of critical thinking, where technological fluency must be accompanied by reflective judgment, ethical awareness, and domain-specific reasoning. Current research underscores the necessity for balanced AI integration—one that enhances, rather than replaces, core cognitive processes. Future research directions point to the need for investigating adaptive curriculum design, disciplinary applications of AI, and inclusive pedagogical models that ensure equity, autonomy, and intellectual rigor in AI-enhanced learning environments.

Based on a systematic literature review perspective, critical thinking is generally defined as a purposeful, evaluative, and self-regulated process that includes interpretation, analysis, inference, and reflection. Some studies adopt explicit theoretical frameworks—such as those proposed by [Facione](#), [Ennis](#), and [Paul and Elder](#)—while others emphasize more applied perspectives, framing critical thinking as the ability to assess, verify, and use AI-generated content critically. Despite these differences, there is agreement that critical thinking in AI-mediated education demands intellectual autonomy, ethical awareness, and contextual sensitivity.

To cultivate these capacities, students need a combination of digital and AI literacy, metacognitive regulation, prompt engineering, argument construction, and ethical reasoning. However, the development of these competencies is often constrained by uncritical dependence on AI, limited system transparency, digital literacy gaps, and psychological barriers such as anxiety and uncertainty. Institutional limitations—including insufficient faculty training, inadequate infrastructure, and weak ethical governance—further complicate efforts to foster critical thinking. In response, the literature emphasizes the need for pedagogical strategies that combine traditional and AI-enhanced methods, embed ethical and digital literacy, and promote reflective learning tasks. Future research is encouraged to examine inclusive instructional models, discipline-specific AI applications, and approaches that ensure critical thinking development remains equitable and intellectually rigorous in increasingly automated academic environments.

This study acknowledges several limitations in its analysis. The findings are primarily derived from a synthesis of theoretical and bibliometric literature without direct empirical validation. As such, future research should prioritize qualitative and quantitative empirical investigations that assess the effectiveness of proposed instructional strategies in real-world learning environments. This study excluded conference proceedings, book chapters, and other non-peer-reviewed outputs regarding data coverage. While certain conference proceedings—particularly in computer science education—are subject to rigorous selection, many do not undergo standardized peer review, leading to variability in methodological rigor and limited long-term citability. This exclusion was intended to maintain the reliability and comparability of the dataset.

Additionally, the analysis focuses exclusively on publications explicitly referring to “critical thinking”. It does not encompass related constructs such as “computational thinking”, which, although conceptually distinct, can overlap in skills and competencies when applied in AI-enhanced educational contexts. This distinction is important for future research adopting a broader conceptual scope. Moreover, given the rapid pace of AI development and its varying applications across disciplines, there is a need for adaptable and context-sensitive

educational frameworks. These frameworks should be designed to optimize the integration of AI tools in higher education and ensure the sustained development of students' critical thinking competencies across diverse cultural and institutional contexts.

CRedit authorship contribution statement

Achmad Salido: Writing – original draft, Software, Formal analysis, Conceptualization. **Irman Syarif:** Formal analysis, Conceptualization. **Melyani Sari Sitepu:** Visualization, Methodology. **Suparjan:** Validation, Supervision, Investigation. **Prima Rias Wana:** Validation, Data curation. **Ryan Taufika:** Writing – review & editing, Resources. **Rahyuni Melisa:** Writing – review & editing, Writing – original draft.

Generative AI statement

During the preparation of this study, we employed AI tools, including ChatGPT 4o, to improve the article's readability, and Grammarly to ensure grammatical accuracy. Following the use of these tools, we carefully reviewed and validated the final version of the manuscript. As the authors, we assume full responsibility for the content of the published work.

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Declaration of competing interest

All author affirms that there are no conflicts of interest in the composition and dissemination of this study.

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