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Mapping the Landscape of Critical Thinking Skills in Higher Education in the AI Era: A Bibliometric and Systematic Literature Review

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ABSTRACT

The emergence of artificial intelligence (AI) has transformed higher education, creating new demands for the cultivation of critical thinking skills in academic settings. This study combines bibliometric mapping and a systematic literature review to explore the publication landscape and examine how critical thinking is conceptualized and developed in AI-integrated higher education. Metadata were retrieved from the Scopus database on December 24, 2024, yielding 90 documents, with 22 selected for full-text analysis. The study findings reveal several influential authors, relevant journal sources, affiliations, key themes central to current studies, and potential themes for future research. The systematic review reveals a fragmented research landscape with limited theoretical consistency in defining critical thinking. Some studies refer to established frameworks such as Bloom's revised Taxonomy and Paul and Elder's intellectual standards, while others use the term “critical thinking” without a clear conceptual foundation. The review identifies key challenges, including overreliance on AI, diminished reflective engagement, and ethical issues such as academic dishonesty and misinformation. However, AI also presents notable opportunities for supporting critical thinking through adaptive feedback, personalized learning, collaborative reasoning, and immersive simulations. Various pedagogical strategies are proposed, including AI-integrated assessments, scaffolded feedback, ethics instruction, and AI literacy training, which aim to strengthen both cognitive processes and intellectual dispositions. These findings underscore the importance of intentional pedagogical design and stronger theoretical integration to ensure that AI enhances rather than undermines critical thinking. This study offers actionable insights for educators, researchers, and policymakers seeking to leverage AI in ways that uphold the integrity and depth of human reasoning.

KEYWORDS
AI Era; AI literacy; critical thinking; higher education; personalized learning.

INTRODUCTION

The advancement of artificial intelligence (AI) has transformed various sectors, including higher education, by reshaping learning methodologies and enhancing student engagement. AI enables personalized learning experiences, allowing students to develop customized learning strategies and progress at their own pace (Capinding & Dumayas, 2024; Rangavittal, 2024). Its integration into education necessitates the adaptation and redefinition of pedagogical approaches to ensure effective incorporation into the learning process (Imran et al., 2024). Through adaptive technologies, AI fosters self-directed learning strategies and improves accessibility to education (Baytak, 2024; Hongli & Leong, 2024; Singh, 2023). Additionally, generative AI models facilitate dynamic learning environments that promote interactive problem-solving and knowledge acquisition (Chauke et al., 2024; Moulin, 2024). Despite these advantages, concerns have been raised regarding students' over-reliance on AI, which may hinder the development of critical thinking and reasoning skills (Imran et al., 2024; Walter, 2024). The excessive dependence on AI-generated content presents challenges in fostering independent analytical abilities in higher education, particularly in an AI-driven era (Alshammari & Al-Enezi, 2024; Luo, 2024; Ogurlu & Mossholder, 2023; Walter, 2024; Vargas et al., 2024).

Critical thinking is a fundamental skill in higher education, requiring students to analyze, synthesize, and evaluate information effectively to make informed decisions and solve complex problems (Ennis, 2011; Paul & Elder, 2019). While AI's capacity to rapidly process and generate information enhances efficiency, it may inadvertently discourage students from engaging in deep analytical reasoning and independent problem-solving (Donnell et al., 2024; Sarwanti et al., 2024). Furthermore, AI systems generate responses based on existing patterns rather than authentic human-like reasoning, potentially limiting students’ ability to assess complex arguments critically (Rusandi et al., 2023). Ethical concerns related to academic integrity, algorithmic biases, and the authenticity of AI-generated content further complicate its role in fostering critical thinking skills (Ogunleye et al., 2024). Without well-structured educational strategies, AI risks becoming a substitute for intellectual engagement rather than a tool for cognitive enhancement. Therefore, exploring balanced approaches that integrate AI while simultaneously cultivating students' critical thinking abilities in higher education is crucial.

Various studies have highlighted the role of artificial intelligence in higher education and its impact on critical thinking skills. Kizilcec et al. (2024) and Sarwanti et al. (2024), for instance, conducted studies exploring negative consequences such as academic dishonesty and students' overreliance on AI tools, which may undermine the development of critical thinking. Vargas-Murillo et al. (2023) present a systematic literature review on the implications of ChatGPT, but their analysis is limited to identifying risks and challenges without offering practical pedagogical solutions. Similarly, Karaali (2023) observes a decline in students’ literacy and quantitative reasoning scores yet fails to address the potential of AI to support these cognitive skills. Despite their contributions, these studies are generally partial in scope and lack a comprehensive evaluative framework for assessing the relationship between AI and the broader goals of higher

education. As such, a significant research gap remains in systematically mapping the academic discourse on AI and critical thinking—particularly in identifying trends, challenges, opportunities, and effective pedagogical strategies to maximize AI's contribution to the development of students' critical thinking abilities.

This study adopts the revised Bloom's Taxonomy developed by Anderson et al. (2001) to interpret how critical thinking is conceptualized in this context. This framework classifies cognitive processes into six hierarchical levels—remembering, understanding, applying, analyzing, evaluating, and creating—each representing increasing levels of cognitive complexity. These categories provide a theoretical basis for assessing how AI-related educational practices promote higher-order thinking. Complementing this is the critical thinking model proposed by Paul and Elder (2019), which emphasizes intellectual standards such as clarity, depth, accuracy, logic, and fairness. The deliberate combination of these two frameworks provides a dual analytical lens: Bloom's Taxonomy offers a structured hierarchy to evaluate the cognitive demands of AI-integrated learning activities. At the same time, Paul and Elder's intellectual standards ensure the quality and rigor of the reasoning processes fostered by such activities. This integrated approach addresses the definitional inconsistencies in critical thinking identified in prior research by providing both a cognitive progression model and evaluative criteria, thereby ensuring a coherent and consistent foundation for analysis.

This study aims to bridge the identified gaps by mapping the research landscape on critical thinking in higher education during the AI era through a combined bibliometric and systematic literature review. Unlike prior works that address isolated issues, this study offers a comprehensive synthesis that not only identifies influential publications, journals, and institutional contributors but also classifies thematic trends, challenges, opportunities, and pedagogical strategies within the field. By grounding the analysis in established cognitive and critical thinking theories, this study contributes to a more coherent understanding of how AI may align—or fail to align—with the educational goal of cultivating higher-order thinking skills. Accordingly, this study seeks to contribute to the academic discourse by offering a theoretically grounded and methodologically rigorous synthesis of research on critical thinking in the context of artificial intelligence in higher education. By integrating bibliometric and systematic literature review approaches, this study presents a structured understanding of prevailing themes, scholarly patterns, and educational strategies relevant to the topic. The findings are expected to inform future pedagogical design, institutional policy, and academic research agendas aimed at ensuring the ethical and effective integration of AI to support higher-order thinking skills in university settings. Based on these objectives, the following research questions guide this inquiry:

1. What is the current publication landscape regarding critical thinking skills in the context of artificial intelligence in higher education, as revealed through a bibliometric analysis?

2. What challenges are identified in the literature related to fostering critical thinking skills—particularly higher-order thinking processes such as analyzing, evaluating, and creating—through the integration of AI in higher education?
3. What opportunities are discussed in the literature for utilizing AI to support the development of critical thinking skills in higher education?
4. What strategies are proposed in existing research to ethically and effectively integrate AI in ways that promote critical thinking in higher education?

METHODOLOGY

Research Design

This study employs a dual-method approach combining bibliometric analysis and systematic literature review (SLR) to examine the research landscape on critical thinking in higher education within the context of artificial intelligence (AI). The bibliometric analysis maps influential authors, relevant journals, institutional affiliations, and thematic developments based on metadata from a broad range of literature (Donthu et al., 2021). Its results provided an initial overview that informed the thematic categorization in the SLR. Following this mapping, the SLR offers a qualitative interpretation of how critical thinking is conceptualized and addressed, focusing on pedagogical strategies, challenges, and opportunities related to AI integration (Vargas-Murillo et al, 2023). These methods integrate quantitative mapping with qualitative synthesis, enabling findings to be interpreted within theoretical and pedagogical frameworks.

Data Collection

The data for this study were retrieved from the Scopus database, selected for its comprehensive coverage of peer-reviewed academic literature. The search was conducted on December 24, 2024, using the Boolean search string: "critical thinking" AND ("artificial intelligence" OR "AI") AND ("higher education" OR "university" OR "college"). The search identified 90 documents published between 2023 and 2024, which were shaped by the initial emergence of GPT in late 2022. These documents constituted the dataset for the bibliometric analysis and provided the initial pool for systematic screening in the literature review.

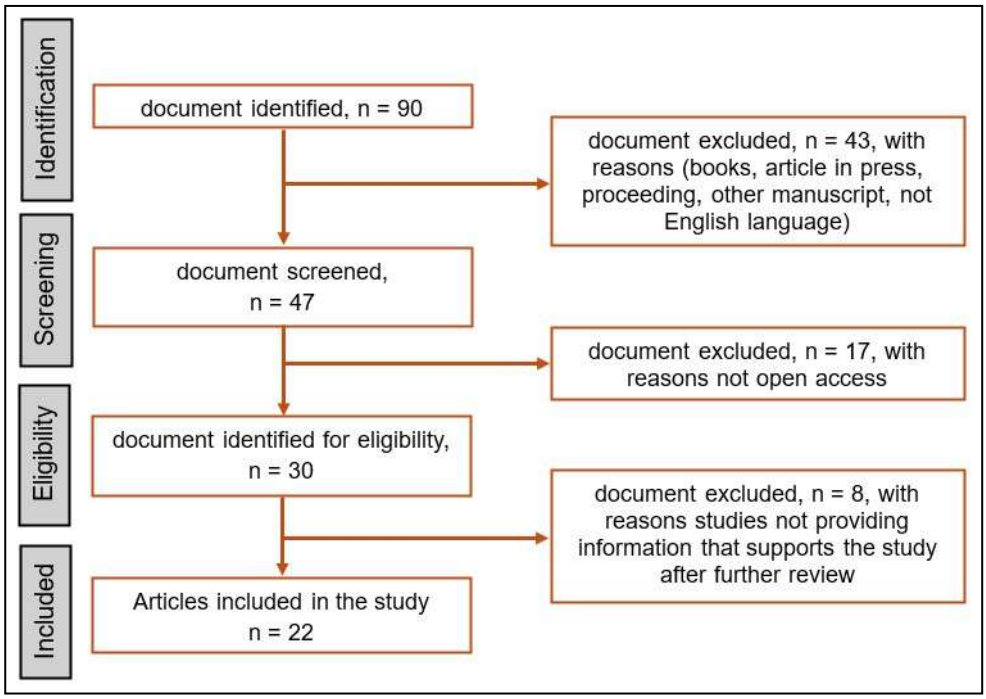
The bibliometric investigation followed five key stages: research design, data collection, data analysis, data visualization, and data interpretation (Salido et al., 2024; Zhu et al., 2023). All retrieved documents were included in the bibliometric analysis without an initial screening, aiming to map the overall publication landscape. This process involved identifying the ten most-cited documents, the ten most prominent journal sources, the ten leading affiliated institutions, and both key and emerging research themes in the field.

Simultaneously, the systematic literature review was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which consist of four stages: identification, screening, eligibility, and inclusion (Moher et al., 2016), as illustrated in Figure 1. During the screening stage, 43 documents were excluded for being non-journal publications, non-English texts, or articles still in press. In the eligibility phase, 17

documents were excluded for not being open access, followed by 8 more that were removed after full-text evaluation due to a lack of relevance to the research questions. Ultimately, 22 documents were included in the systematic review for in-depth qualitative analysis. This rigorous screening ensures that only studies directly aligned with the research focus—artificial intelligence and critical thinking in higher education—were subjected to thematic interpretation.

Figure 1.

PRISMA Flow Chart



Data Analysis

The bibliometric analysis was performed on all 90 documents using Biblioshiny for RStudio and VOSviewer. This phase focused exclusively on quantitative metadata, including influential authors, relevant journal sources, institutional affiliations, and keyword co-occurrences. The purpose of this analysis was to map the structural landscape of academic output in the field and to identify dominant research trends, emerging themes, and scholarly networks. No content analysis was conducted during this stage, as the bibliometric focus was limited to metadata-level insights.

Subsequently, 22 articles included in the SLR underwent detailed thematic analysis to examine how critical thinking is framed and discussed in AI-related educational research. The analysis followed the six-step process outlined by Nowell et al. (2017): familiarization with the data, generation of initial codes, theme identification, theme review, theme definition and naming, and final reporting. The coding process was deductively guided by Anderson et al.'s (2001) taxonomy and Paul and Elder's (2019) intellectual standards. The thematic coding and synthesis were conducted manually by three researchers working independently, after which all coding results were compared, and any differences were resolved through discussion until a

full consensus was reached. Specific attention was paid to identifying references to higher-order cognitive processes such as analyzing, evaluating, and creating, as well as pedagogical strategies intended to cultivate these skills through AI.

The thematic findings were grouped into four analytical categories: conceptualization of critical thinking, the role of AI in critical thinking development, challenges and ethical considerations, and instructional strategies proposed to support higher-order thinking. These themes were compared across studies to assess the consistency and diversity of perspectives within the literature. The integration of bibliometric and thematic analyses enables this study to respond robustly to the research questions by connecting macro-level patterns with micro-level pedagogical insights. Together, these approaches yield a comprehensive understanding of how critical thinking is situated within the AI-integrated higher education discourse.

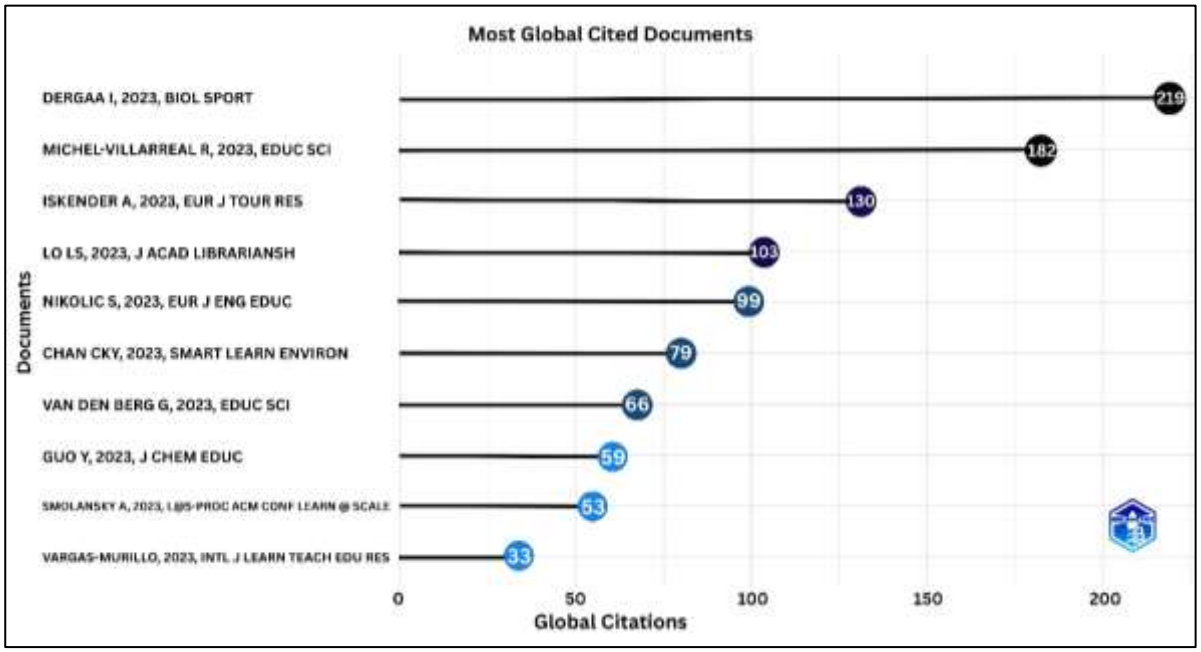
RESULTS

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 challenges, opportunities, and strategies for fostering critical thinking skills in the AI era.

Landscape of Critical Thinking Publications in Higher Education in the AI Era

Figure 2.

Top ten cited Documents



This study identifies ten influential authors who have significantly contributed to the discourse on critical thinking in the AI era in higher education. As illustrated in Figure 2, these

authors are determined based on citation metrics, which reflect their impact on the global academic literature. The analysis also considers the year of publication and the journal sources of the cited works.

Figure 2 highlights the three most highly cited authors: Dergaa, published in Biology of Sport with 219 citations; Michel-Villarreal, published in Education Sciences with 182 citations; and Iskender, published in the European Journal of Tourism Research with 130 citations. Other influential authors include Lo in the Journal of Academic Librarianship (103 citations), Nikolic in the European Journal of Engineering Education (99 citations), Chan in Smart Learning Environments (79 citations), Berg in Education Sciences (66 citations), Guo in the Journal of Chemical Education (59 citations), and Smolansky in the Proceedings of the 10th ACM Conference on Learning (53 citations). The tenth most-cited author, Vargas-Murillo, has 33 citations from work published in the International Journal of Learning, Teaching and Educational Research. Furthermore, the ten most relevant journal sources on this theme are depicted in Figure 3.

Figure 3.

Top ten journal sources

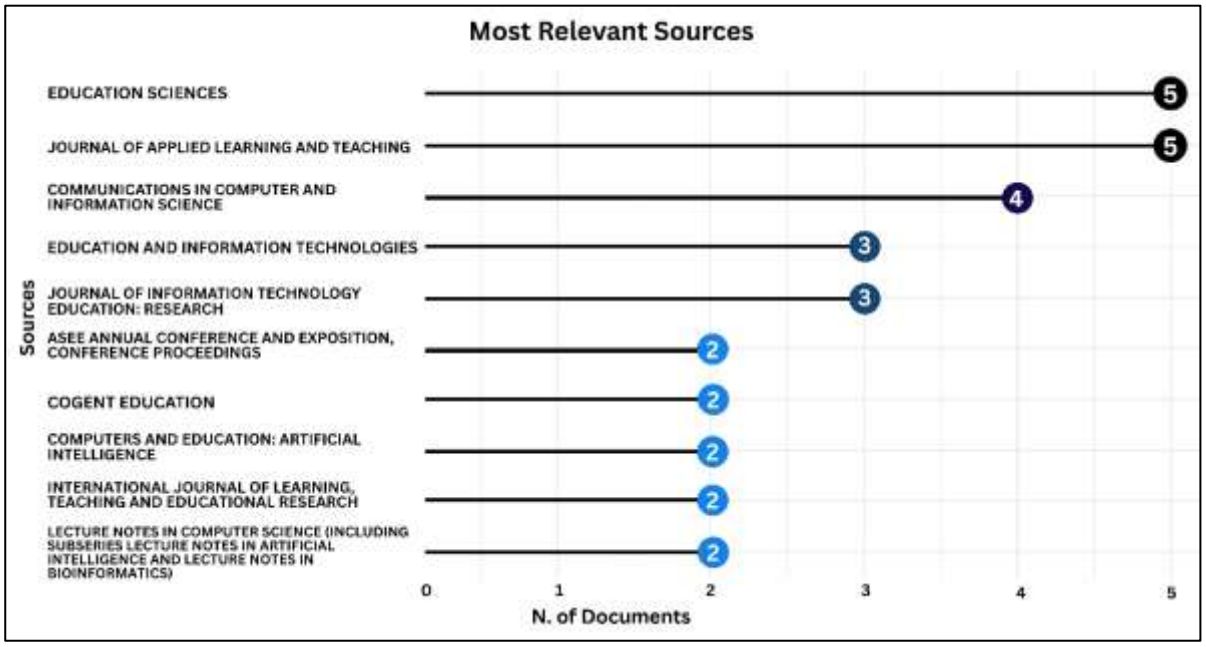


Figure 3 shows that the two leading journals in terms of publications on this theme are “Education Sciences” and the “Journal of Applied Learning and Teaching”, each featuring five papers on the topic. The third most prominent journal is “Communications in Computer and Information Science”, which contains four publications. The fourth and fifth positions are occupied by “Education and Information Technologies” and the “Journal of Information Technology Education: Research”, each contributing three papers. The remaining five sources—“ASEE Annual Conference and Exposition Conference Proceedings”, “Cogent Education”, “Computers & Education: Artificial Intelligence”, “International Journal of Learning, Teaching

and Educational Research", and "Lecture Notes in Computer Science (including its subseries on Artificial Intelligence and Bioinformatics)"—each feature two publications on this topic. Furthermore, the ten most active institutional affiliations contributing to this research theme are shown in Figure 4. These institutions demonstrate their active contribution to studying critical thinking in higher education during the AI era.

Figure 4.

Top Ten Affiliations

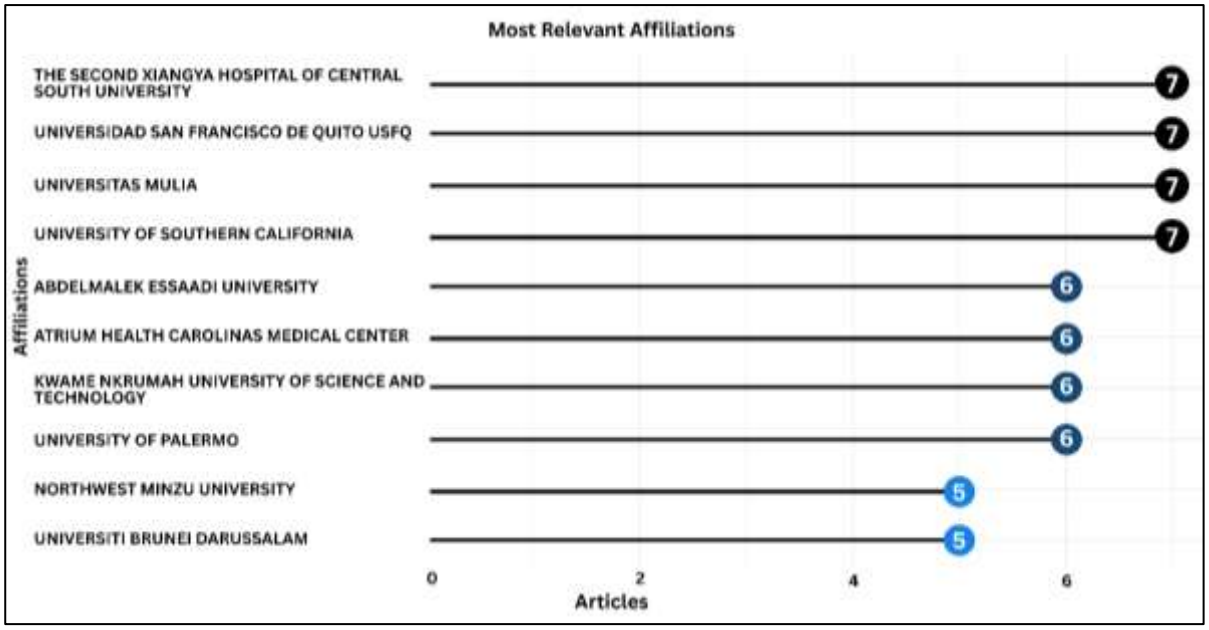


Figure 4 shows that the top four institutions affiliated with publications in this theme include "The Second Xiangya Hospital of Central South University", "Universidad San Francisco De Quito (USFQ)", "Universitas Mulia", and the "University of Southern California", each with seven published studies. Some of the institutions in the next positions include "Abdelmalek Essaadi University", "Atrium Carolinas Health Center", "Kwame Nkrumah University of Science and Technology", and the "University of Palermo", which has six publications. Meanwhile, "Northwest Minzu University" and "Universiti Brunei Darussalam" round out the top ten, each contributing five research publications to this theme.

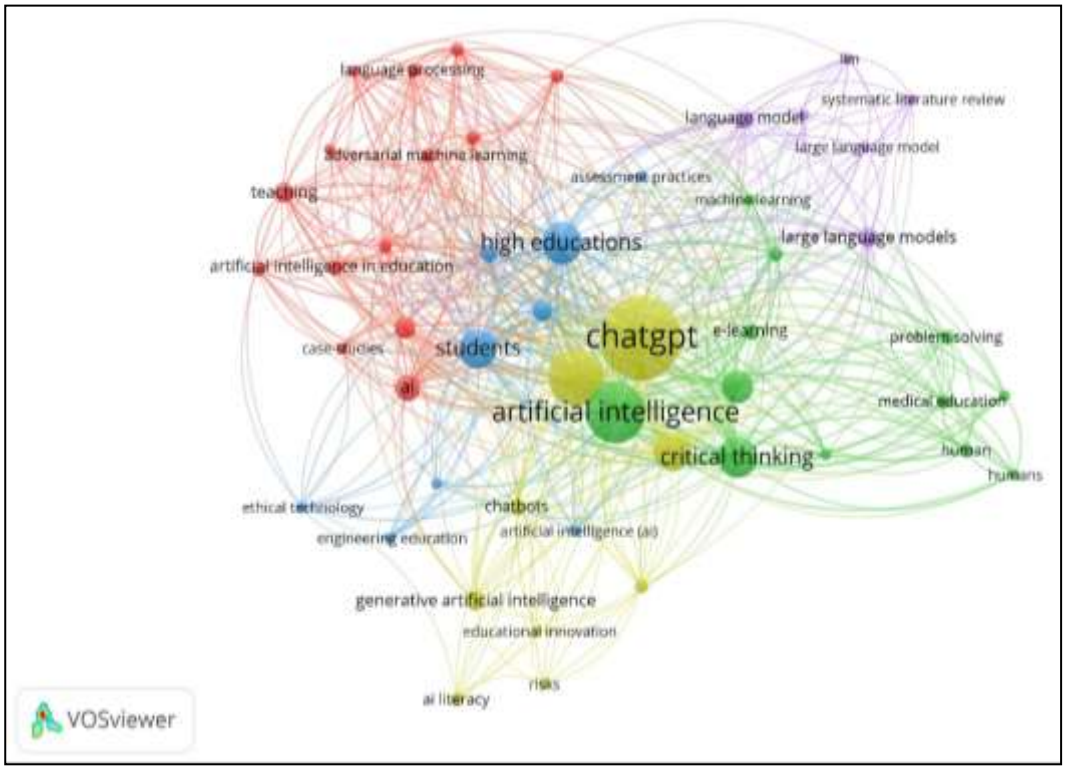
Furthermore, the visualization network analysis using VOSviewer displays the relationships between keywords that explain the general themes of the current research. The results of the analysis using the network visualization display with a minimum occurrence threshold of three are shown in Figure 5. This analysis identified five different groups of keywords, which highlight the thematic groupings in the study.

Figure 5 provides insight into the interconnected concepts that shape the discourse on critical thinking in the era of AI in higher education. There are five clusters based on the results of keyword mapping analysis in this field. The first cluster (red) includes several keywords, namely "adversarial machine learning", "artificial intelligence tools", "contrastive learning", "curricula", "language processing", "natural languages", "teaching", and "learning". The second

cluster (green) contains several keywords, namely “critical thinking”, “deep learning”, “e-learning”, “education”, “human”, “machine learning”, “problem solving”, and “learning engagement”. The third cluster (blue) contains several keywords, including “assessment”, “critical thinking skills”, “engineering education”, “ethical technology”, “higher education” and “students”. The fourth cluster (yellow) consists of several keywords including “academic integrity”, “ai literacy”, “chatbots”, “chatgpt”, “educational innovation”, “generative ai”, “higher education”, and “risks”. The fifth cluster (purple) contains several keywords, namely “ethical concerns”, “language model”, and “large language model”.

Figure 5.

Keyword network visualization

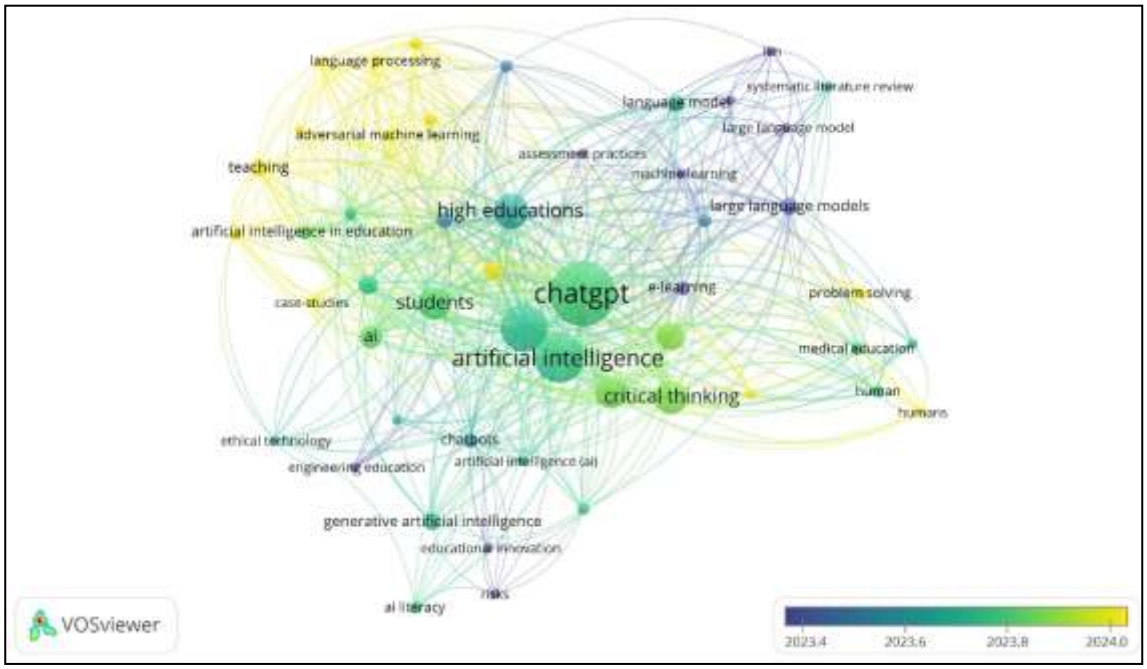


Furthermore, the overlay visualization analysis results, which track the temporal evolution of publication keywords, are presented in

Figure 6. This analysis identifies several keywords that reflect current research interests and potential future directions. Keywords marked with yellow circles indicate emerging areas of focus, including “teaching”, “humans”, “problem-solving”, “student engagement”, “educational computing”, “contrastive learning”, “feedback”, “language processing”, and “natural language”. These findings suggest that future research could explore these topics further to expand the discourse on the role of AI in fostering critical thinking development.

Figure 6.

Keyword overlay visualization



Thematic Analysis of Critical Thinking in AI-Integrated Higher Education

The review of 22 selected articles revealed variations in how critical thinking is conceptualized in the context of artificial intelligence integration in higher education as presented in

Table ***1***. Out of the total studies, only a portion clearly defined critical thinking or grounded it within an established theoretical framework. For example, Huang et al. (2024), Jayasinghe (2024), and Kurt and Kurt (2024) explicitly referred to cognitive processes such as analyzing, evaluating, and creating, while Taylor and Marino (2024), Guo and Lee (2023), and Alam et al. (2023) described critical thinking in terms of reasoning, logic, or analytical discernment. Other conceptualizations emphasized metacognitive and reflective processes, as found in studies by Susnjak and McIntosh (2024), Wang et al. (2024), and Michalon and Camacho-Zuñiga (2023), highlighting iterative thinking and feedback engagement.

Several authors incorporated broader dimensions into their definitions. Werdiningsih et al. (2024) introduced a culturally grounded understanding of critical thinking, while Kamoun et al. (2024), Valova et al. (2024), and Essien et al. (2024) framed it through ethical judgment, argumentation, and inquiry-based engagement. Others, such as Iskender (2023) and Almulla and Ali (2024), focused on autonomy and balanced reasoning when using AI. A few studies, including those by Nikolic et al. (2023) and Banihashem et al. (2024), presented critical thinking more as a support function facilitated by peer feedback or supplementary tools, without articulating a clear underlying model.

Table 1.

Summary of Critical Thinking Conceptualizations in Higher Education in the AI Era

Author(s)	Conceptualization of Critical Thinking
Kizilcec et al. (2024)	Evaluative and ethical-critical reasoning
Sarwanti et al. (2024)	Not explicitly conceptualized
Werdiningsih et al. (2024)	Culturally grounded critical thinking
Michel-Villarreal et al. (2023)	Not specified
Michalon and Camacho-Zuñiga (2023)	Reflective and process-based reasoning
Susnjak and McIntosh (2024)	Metacognitive and iterative thinking
Nikolic et al. (2023)	Supplementary thinking support
Kurt and Kurt (2024)	Self-directed learning and evaluative reasoning
Kamoun et al. (2024)	Dialogic reasoning and critical judgment
Huang et al. (2024)	Analyze, evaluate, and create
Banihashem et al. (2024)	Peer-based feedback facilitation
Ogunleye et al. (2024)	Applied reasoning and literacy
Iskender (2023)	Autonomy and simplification of complex reasoning
Guo and Lee (2023)	Evaluative and feedback-based reasoning
Alam et al. (2023)	Analytical verification and information discernment
Taylor and Marino (2024)	Logic-based reasoning and conceptual analysis
Jayasinghe (2024)	Analytical and creative thinking
Stampfl et al. (2024)	Application of knowledge through reflection
Valova et al. (2024)	Argument development and ethical judgment
Almulla and Ali (2024)	Balanced reasoning between AI and human input
Essien et al. (2024)	Inquiry-based critical engagement
Wang et al. (2024)	Reflective critique and iterative evaluation

Conversely, several articles did not provide any specific conceptualization of critical thinking. Studies by Sarwanti et al. (2024), Michel-Villarreal et al. (2023), and others mentioned the term without elaborating on its meaning or associated processes. This lack of clarity reflects a broader inconsistency across the literature, where critical thinking is often referenced but not systematically defined, making it difficult to assess the effectiveness of AI-driven interventions in supporting its development.

Challenges in Fostering Critical Thinking in AI-Integrated Higher Education

The reviewed literature, as presented in Table 2, identifies a range of challenges that hinder the effective integration of artificial intelligence (AI) to foster critical thinking in higher education. Kizilcec et al. (2024), Huang et al. (2024), and Alam et al. (2023) emphasize concerns related to academic integrity, including plagiarism, superficial engagement with content, and uncritical use of AI outputs. Similarly, Guo and Lee (2023), Kamoun et al. (2024), and Essien et al. (2024) report issues with low-quality or unvalidated feedback, which may lead to passive learning and inhibit

active cognitive engagement. These concerns are compounded by observations from Taylor and Marino (2024) and Jayasinghe (2024), who highlight students' limited understanding of the boundaries between AI and human reasoning, and a declining awareness of authentic learning processes.

Table 2.

Summary of Challenges in Fostering Critical Thinking in Higher Education in the AI Era

Author(s)	Challenges Identified
Kizilcec et al. (2024)	Academic integrity issues, diluted critical thinking, assessment challenges
Sarwanti et al. (2024)	Over-reliance on AI, reduced motivation and autonomy
Werdiningsih et al. (2024)	Balancing AI-human input, ethical sensitivity, cultural complexity
Michel-Villarreal et al. (2023)	Not mentioned
Michalon and Camacho-Zuñiga (2023)	AI overuse, lack of awareness of limits
Susnjak and McIntosh (2024)	Not mentioned
Nikolic et al. (2023)	Not mentioned
Kurt and Kurt (2024)	Dependency on AI, inconsistency in feedback, teacher readiness
Kamoun et al. (2024)	Potential inhibition of thinking, content validation
Huang et al. (2024)	Integrity concerns, uncritical AI usage
Banihashem et al. (2024)	Not mentioned
Ogunleye et al. (2024)	Ethical misuse, redesign of assessments
Iskender (2023)	Dependency, reduced interpersonal exchange
Guo and Lee (2023)	Low-quality feedback, validation problems, passive learning
Alam et al. (2023)	Plagiarism, superficiality, misinformation
Taylor and Marino (2024)	Limited AI reasoning, understanding AI-human boundaries
Jayasinghe (2024)	Neglect of authentic learning, reduced awareness
Stampfl et al. (2024)	Not mentioned
Valova et al. (2024)	Maintaining human agency, ethical concerns
Almulla and Ali (2024)	Maintaining AI as supportive tool
Essien et al. (2024)	Bias and reliability issues
Wang et al. (2024)	Repetitive, robotic language, creativity suppression

Another major challenge noted by Sarwanti et al. (2024), Michel-Villarreal et al. (2023), Kurt and Kurt (2024), and Iskender (2023) is the over-reliance on AI tools, which can reduce student autonomy, intrinsic motivation, and interpersonal learning opportunities. This dependency may be exacerbated by inconsistencies in AI-generated feedback and the lack of teacher readiness to manage AI-enhanced instruction. Ethical dilemmas also feature prominently in studies by Ogunleye et al. (2024), Werdiningsih et al. (2024), Valova et al. (2024), and Almulla and Ali (2024), who stress the importance of maintaining human agency, cultural

sensitivity, and responsible AI use. Finally, Wang et al. (2024) note that AI-generated content often lacks linguistic variation and originality, potentially suppressing creativity and diminishing the learner's capacity for independent thought. These findings collectively reflect systemic, pedagogical, and cognitive barriers that must be addressed to effectively support critical thinking through AI integration.

Opportunities for Enhancing Critical Thinking Using AI in Higher Education

Table 3.

Summary of Opportunities to Enhance Critical Thinking in Higher Education in the AI Era

Author(s)	Opportunities Identified
Kizilcec et al. (2024)	Personalized, interactive, simulated learning
Sarwanti et al. (2024)	Writing support, brainstorming, productivity enhancement
Werdiningsih et al. (2024)	Creativity, diverse perspectives, critical evaluation training
Michel-Villarreal et al. (2023)	ChatGPT as a transformative educational tool
Michalon and Camacho-Zuñiga (2023)	AI-driven curriculum, interactive engagement
Susnjak and McIntosh (2024)	Self-reflection, multimodal assessment, advanced reasoning
Nikolic et al. (2023)	AI-supported higher-order learning
Kurt and Kurt (2024)	Student agency, adaptive feedback, AI literacy
Kamoun et al. (2024)	Distance learning, active reflection
Huang et al. (2024)	Adaptive learning, cognitive support
Banihashem et al. (2024)	Feedback automation, peer review enhancement
Ogunleye et al. (2024)	Diverse assessment tools, interactive formats
Iskender (2023)	Personalized learning, simplification of complex content
Guo and Lee (2023)	Confidence in evaluation, critical comparison
Alam et al. (2023)	Interactive platforms, diagnostic skill development
Taylor and Marino (2024)	Varied feedback, productive classroom AI use
Jayasinghe (2024)	Personalized and collaborative learning activities
Stampfl et al. (2024)	Student engagement, adaptive teaching, applied knowledge
Valova et al. (2024)	Organized information processing, interactive learning
Almulla and Ali (2024)	Innovative learning environments, personalization
Essien et al. (2024)	Accelerated learning, task automation
Wang et al. (2024)	Enhanced revision and critique via AI

The literature review identifies 22 authors who explore various opportunities to leverage artificial intelligence (AI) in fostering critical thinking within higher education, as summarized in Table 3. For instance, Kizilcec et al. (2024), Iskender (2023), and Jayasinghe (2024) highlight the potential of personalized AI tools to support collaborative learning by enabling individualized instruction and peer engagement. Similarly, Sarwanti et al. (2024) and Banihashem et al. (2024) emphasize the role of AI applications in writing support, brainstorming, feedback automation, and productivity enhancement. Michel-Villarreal et al. (2023) underscore the transformative potential of ChatGPT as a pedagogical tool, while Michalon and Camacho-Zuñiga (2023), Kurt and Kurt (2024), and Almulla and Ali (2024) focus on AI-driven curriculum innovation, adaptive

feedback, and the development of personalized and innovative learning environments. Nikolic et al. (2023) also identify AI as a means to support higher-order learning, whereas Huang et al. (2024) emphasize adaptive learning and cognitive scaffolding as critical for enhancing evaluative skills.

Furthermore, Werdiningsih et al. (2024), Guo and Lee (2023), and Alam et al. (2023) discuss AI's contributions to fostering creativity, critical comparison, and the development of diagnostic skills through interactive platforms and diverse perspectives. Susnjak and McIntosh (2024), Taylor and Marino (2024), and Wang et al. (2024) highlight the role of AI in promoting advanced reasoning, multimodal assessment, and enhanced revision and critique. Kamoun et al. (2024) and Ogunleye et al. (2024) assert that AI facilitates distance learning and supports a variety of assessment tools that encourage active reflection and comparative approaches. Valova et al. (2024) add that AI can enhance interactive learning and the structured processing of information. Stampfl et al. (2024) emphasize adaptive teaching and the transfer of applied knowledge, while Essien et al. (2024) identify AI's potential to accelerate learning and automate routine tasks. Collectively, these findings illustrate that the integration of AI offers multifaceted opportunities to foster cognitive engagement, evaluative thinking, and reflective learning—core dimensions of critical thinking.

Pedagogical Strategies for Supporting Critical Thinking in the AI Era

The synthesis of the reviewed articles reveals a range of pedagogical strategies proposed to support the development of critical thinking in higher education through AI integration, as summarized in Table 4. Several authors emphasize assessment reform as a primary entry point. Kizilcec et al. (2024) advocate for AI-adaptive assessments and process-oriented learning, while Susnjak and McIntosh (2024), along with Wang et al. (2024), propose personalized assessment design and iterative learning cycles, including post-writing analysis and self-reflective activities. Similarly, Michalon and Camacho-Zuñiga (2023) recommend process-oriented instruction facilitated by AI, and Jayasinghe (2024) highlights the importance of structured feedback and reflective writing supported by AI tools.

Collaborative and feedback-based strategies are also extensively discussed. Werdiningsih et al. (2024), Kurt and Kurt (2024), and Kamoun et al. (2024) advocate for peer feedback, peer evaluation, collaborative AI interaction, and ethical validation frameworks as essential elements for engaging students in critical dialogue. In line with this, Huang et al. (2024) propose integrating AI literacy modules and formative assignments into the curriculum to promote student agency. Other strategies focus on ethics and responsible use. Alam et al. (2023), Valova et al. (2024), Almulla and Ali (2024), and Essien et al. (2024) emphasize the importance of AI ethics training, responsible AI usage, and embedding ethical guidelines into instructional design. Additionally, Taylor and Marino (2024) recommend conceptual analysis and strategic feedback to support evaluative reasoning.

Table 4.

Summary of Pedagogical Strategies to Support Critical Thinking in Higher Education in the AI Era

Author(s)	Pedagogical Strategies Proposed
Kizilcec et al. (2024)	AI-adapted assessments, process-focused learning
Sarwanti et al. (2024)	Not mentioned
Werdiningsih et al. (2024)	Peer feedback, ethical guidelines, task revision
Michel-Villarreal et al. (2023)	Not mentioned
Michalon and Camacho-Zuñiga (2023)	AI-enhanced classroom activities, process-oriented instruction
Susnjak and McIntosh (2024)	Personalized assessment, self-reflective learning cycles
Nikolic et al. (2023)	AI as learning enhancement tool
Kurt and Kurt (2024)	Peer evaluation, literacy training, active participation
Kamoun et al. (2024)	Collaborative AI interaction, validation frameworks, ethical use
Huang et al. (2024)	AI literacy modules, formative tasks, curriculum integration
Banihashem et al. (2024)	Not mentioned
Ogunleye et al. (2024)	AI-based comparative approaches
Iskender (2023)	Balanced use of AI and traditional teaching
Guo and Lee (2023)	Structured guidelines, privacy education
Alam et al. (2023)	AI ethics training, interactive simulations
Taylor and Marino (2024)	Conceptual analysis, strategic feedback
Jayasinghe (2024)	Scaffolded feedback, AI-based reflective writing
Stampfl et al. (2024)	Simulation tools, adaptive strategies
Valova et al. (2024)	Responsible AI usage, ethics-oriented discussion
Almulla and Ali (2024)	Ethical frameworks, holistic integration
Essien et al. (2024)	Ethical guidelines, integrated teaching models
Wang et al. (2024)	Guided post-writing analysis, iterative learning cycles

Additional strategies identified include the use of AI as a cognitive aid and a means of instructional enhancement. Nikolic et al. (2023) propose AI as a learning support tool, while Stampfl et al. (2024) recommend simulation tools and adaptive instructional strategies to strengthen knowledge application. Ogunleye et al. (2024) advocate for AI-based comparative methods to facilitate deeper analysis, and Guo and Lee (2023) emphasize the benefits of structured guidelines and privacy education. Iskender (2023) underscores the importance of a balanced pedagogical approach that integrates AI with traditional teaching methods to preserve human-centered learning. Collectively, these strategies illustrate the growing efforts to harness AI technologies in ways that enhance students' analytical, reflective, and evaluative capacities.

DISCUSSION

Landscape of Critical Thinking Publications in Higher Education in the AI Era

The exploration of the publication landscape on AI-integrated critical thinking in higher education reveals a concentrated yet uneven distribution of scholarly influence. Ten influential authors—Dergaa, Michel-Villarreal, Iskender, Lo, Nikolic, Chan, Berg, Guo, Smolansky, and

Vargas-Murillo—have emerged as key references in this field. This concentration suggests that the study of AI integration in critical thinking development within higher education remains in the early stages of conceptual consolidation. Furthermore, among the top 10 journals contributing to this discourse, Education Sciences, Journal of Applied Learning and Teaching, and Communications in Computer and Information Science stand out, publishing five and four documents, respectively, on this topic. The prominence of this theme reflects its strategic positioning at the intersection of education, science, learning, and information technology. Other journal sources have each published no more than three, and in most cases, only two documents. Additionally, contributions from conference proceedings, such as the ASEE Annual Conference and Exposition Conference Proceedings (two documents), indicate that scholarly development in this area is still largely exploratory. This disparity in contributions implies that the discourse remains emergent and requires further scholarly focus to broaden its scope and depth.

Global institutional contributions indicate that this theme has gained traction across institutions in Asia, the Americas, and Europe, with the top four contributors being the Second Xiangya Hospital of Central South University, Universidad San Francisco de Quito (USFQ), Universitas Mulia, and the University of Southern California. This geographical diversity reflects ongoing efforts to enrich theoretical perspectives on AI and critical thinking skills in higher education. Nevertheless, institutional contributions remain uneven across this theme, leading to disparities in how AI accessibility and pedagogical adoption are understood. These differences may, in turn, influence how critical thinking is interpreted and implemented within higher education contexts.

Further analysis of keyword co-occurrence networks reveals five major themes emerging within the academic discourse on this topic. The first centers on AI-based learning technologies, including natural language processing and adversarial learning. While not always explicitly linked to critical thinking, these tools are integrated into learning environments that challenge students to interpret, compare, and revise texts—activities closely aligned with the “analyzing” and “evaluating” dimensions in the revised Bloom’s Taxonomy (Anderson et al., 2001). The second cluster highlights pedagogical terms such as problem-solving, deep learning, and e-learning, which suggest instructional strategies aimed at fostering inquiry, metacognition, and student-centered reflection. These approaches serve as a foundation for nurturing both the procedural and dispositional aspects of critical thinking. As noted by Nobutoshi (2023), metacognition and reflective teaching practices can synergistically enhance the development of students’ critical thinking skills.

The third cluster centers on assessment strategies, reflecting a growing interest in measuring critical thinking within AI-mediated contexts. Terms such as educational computing and AI-based assessment indicate that scholars have examined ways to automate the evaluation of students’ reasoning processes, including the extent to which learners apply analysis and synthesis in problem-solving contexts. This emphasis points to an emerging need for robust and

ethical AI tools capable of reliably assessing higher-order thinking skills. The fourth cluster explores ethical dimensions, featuring keywords such as AI literacy, academic integrity, and ChatGPT. This theme aligns with the perspective of Paul and Elder (2019), who highlight intellectual virtues such as integrity, courage, and fairness in reasoning. In this regard, evaluating the appropriateness and implications of AI-generated content fosters ethical judgment—a core component of critical thinking (Bearman et al., 2024).

The final cluster—focusing on bias, fairness, and privacy—illustrates how the discourse has expanded to include sociotechnical critiques of AI. These issues highlight studies that encourage students to move beyond understanding and application toward a critical examination of the systems they engage with, fostering epistemic awareness and reflective skepticism. This aligns with Paul and Elder's (2019) call for students to question assumptions, evaluate implications, and engage in disciplined thinking when navigating complex and ambiguous problems.

The overlay visualization analysis highlights several promising yet underexplored research directions. Adaptive AI tutoring systems, for instance, offer individualized scaffolding that can support students in navigating complex cognitive tasks while reinforcing self-regulated learning. Similarly, AI-assisted debate tools and structured argumentation platforms present novel approaches for cultivating evaluative reasoning, iterative judgment, and perspective-taking. Another critical direction involves bias detection in educational AI systems, which can prompt students to interrogate data sources and assess the validity of machine-generated conclusions. Finally, gamified learning simulations that embed ethical dilemmas and problem-solving challenges demonstrate potential for making critical thinking more contextualized and profound. These emerging trends signal a shift from viewing AI as merely a content delivery tool to recognizing it as a dynamic environment for fostering higher-order cognition in higher education.

Thematic Analysis of Critical Thinking in AI-Integrated Higher Education

Findings from the literature review indicate that the conceptualization of critical thinking in the context of AI-based higher education remains highly diverse and theoretically inconsistent. Some studies, such as those by Huang et al. (2024), Jayasinghe (2024), and Kurt and Kurt (2024), explicitly link critical thinking to higher-order cognitive processes such as analyzing, evaluating, and creating—core dimensions of the Revised Bloom's Taxonomy (Anderson et al., 2001). This approach positions AI as a pedagogical tool that can foster learners' cognitive engagement when used to design open-ended, reflective, and exploratory tasks. In addition, studies by Susnjak and McIntosh (2024), Wang et al. (2024), and Michalon and Camacho-Zuñiga (2023) emphasize the importance of metacognitive and iterative thinking processes. These studies represent advanced cognitive domains and suggest opportunities for leveraging AI as a tool for reflection and enhanced feedback.

Nevertheless, the majority of articles continue to employ the term "critical thinking" in a general sense, often without an explicit theoretical framework, as observed in studies by

Sarwanti et al. (2024), Michel-Villarreal et al. (2023), and Banihashem et al. (2024). The absence of clear definitions obscures whether critical thinking is being treated as a targeted instructional objective or merely as a byproduct of AI integration. In this context, Paul and Elder's (2019) framework becomes particularly relevant, as it adds a dispositional dimension to critical thinking—emphasizing qualities such as accuracy, relevance, and intellectual traits like empathy and perseverance. This conceptualization is more apparent in studies that highlight dialogue, ethics, and autonomy in AI use, such as Kamoun et al. (2024), Valova et al. (2024), and Essien et al. (2024). However, few studies explicitly anchor their approaches in Paul and Elder's principles, leaving the potential for fostering critical thinking dispositions through AI underexplored. This finding suggests a pressing need for stronger theoretical integration in future research to develop AI-based interventions that support not only critical thinking processes but also the cultivation of deep intellectual character.

Challenges in Fostering Critical Thinking in AI-Integrated Higher Education

The challenges identified in fostering critical thinking through AI integration in higher education closely relate to the upper levels of Bloom's Revised Taxonomy—particularly the cognitive processes of evaluating and creating (Anderson et al., 2001). Over-reliance on AI tools, as reported by Sarwanti et al. (2024), Iskender (2023), and Jayasinghe (2024), risks diminishing student autonomy, intrinsic motivation, and reflective engagement. This dependency can inhibit students' ability to critically appraise or generate original ideas, undermining the instructional aim of cultivating evaluative and creative thinking. Furthermore, studies by Guo and Lee (2023) and Kamoun et al. (2024) reveal weaknesses in content validation and feedback mechanisms, which reduce opportunities for learners to make informed judgments or refine their reasoning—core attributes of critical thinking. Without instructional scaffolds that challenge students to critique and synthesize information actively, AI may inadvertently reinforce surface-level processing rather than stimulating higher-order cognition.

From the perspective of Paul and Elder's (2019) critical thinking framework, these challenges also reflect a gap in fostering essential intellectual traits such as intellectual humility, integrity, and perseverance. Ethical and academic integrity issues noted by Kizilcec et al. (2024), Huang et al. (2024), and Alam et al. (2023)—including plagiarism and uncritical acceptance of AI-generated content—suggest a need for pedagogical interventions that promote ethical reasoning and evaluative rigor. Ogunleye et al. (2024) and Taylor and Marino (2024) call for reimagining assessment practices to distinguish between human cognitive processes and AI outputs, reinforcing the role of intentional evaluation. Meanwhile, Kurt and Kurt (2024) emphasize the lack of faculty readiness to guide reflective AI use, and studies by Valova et al. (2024), and Almulla and Ali (2024) caution against eroding human agency in learning. Collectively, these findings point to a pressing need for pedagogical and institutional strategies that ensure AI integration nurtures—not replaces—the critical dispositions and reasoning capacities foundational to transformative education.

Opportunities for Enhancing Critical Thinking Using AI in Higher Education

The reviewed studies consistently highlight the potential of artificial intelligence to support the development of critical thinking, particularly when aligned with higher-order cognitive processes as defined in Bloom's Revised Taxonomy (Anderson et al., 2001). Numerous authors—such as Kizilcec et al. (2024), Huang et al. (2024), and Wang et al. (2024)—emphasize how adaptive and personalized AI systems can challenge students to analyze, evaluate, and create, thereby reinforcing the upper tiers of the taxonomy. The simulated environments and interactive platforms proposed by Stampfl et al. (2024), Michalon and Camacho-Zuñiga (2023), and Almulla and Ali (2024) offer contextualized learning experiences that stimulate creativity and problem-solving. Similarly, research by Nikolic et al. (2023), Kurt and Kurt (2024), and Valova et al. (2024) support the use of AI in promoting cognitive independence and organized reasoning, which are essential for fostering deep analytical engagement. AI's role in enabling diverse forms of feedback (Taylor & Marino, 2024; Banihashem et al., 2024) and facilitating interactive assessment formats (Ogunleye et al., 2024; Alam et al., 2023) further reinforces the critical comparison and synthesis of ideas, further encouraging learners to engage in complex evaluative tasks.

From the lens of Paul and Elder's (2019) critical thinking framework, which integrates intellectual standards such as clarity, accuracy, and relevance alongside essential traits like integrity and perseverance, the reviewed literature also demonstrates AI's potential to cultivate reflective and ethical reasoning. Studies by Susnjak and McIntosh (2024) and Taylor and Marino (2024) highlight how AI can foster self-monitoring and metacognitive reflection, allowing students to assess their reasoning processes and refine their judgments systematically. Additionally, the integration of AI into collaborative and dialogic contexts—such as those described by Werdiningsih et al. (2024), Guo and Lee (2023), and Kamoun et al. (2024)—encourages intellectual empathy and fairness in evaluation, echoing Paul and Elder's emphasis on dispositional attributes. Contributions by Jayasinghe (2024), Sarwanti et al. (2024), and Essien et al. (2024) further emphasize AI's capacity to enhance productivity and critical engagement through task automation and collaborative learning. When used deliberately, AI can transcend its role as a technical instrument and serve as a scaffold for cultivating both cognitive and moral dimensions of critical thinking in higher education.

Pedagogical Strategies for Supporting Critical Thinking in the AI Era

The various pedagogical strategies identified in the literature indicate a growing effort to integrate AI in ways that support critical thinking through structured and reflective learning. Several studies emphasize the value of process-oriented instruction and personalized assessment to enhance analytical reasoning, aligning with the conception of critical thinking outlined by Anderson et al. (2001). Kizilcec et al. (2024), Susnjak and McIntosh (2024), and Wang et al. (2024) propose strategies such as AI-adaptive assessments, self-reflective learning cycles, and guided post-writing analysis to engage learners in ongoing cognitive refinement. Similarly, Michalon and Camacho-Zuñiga (2023) and Jayasinghe (2024) advocate for the use of AI-

enhanced classroom activities and structured feedback to support learners in processing complex information and constructing new understanding. Stampfl et al. (2024) contribute to this approach by promoting simulation-based learning and adaptive strategies, while Nikolic et al. (2023) recommend leveraging AI as a means to augment—rather than replace—deep thinking processes.

In addition to supporting cognitive engagement, several strategies focus on developing ethical awareness and collaborative reasoning—dimensions aligned with the dispositional and evaluative aspects of critical thinking as proposed by Paul and Elder (2019). Werdiningsih et al. (2024), Essien et al. (2024), and Kamoun et al. (2024) highlight peer feedback, ethical guidelines, and integrated instructional models that encourage students to reflect on AI-generated content critically. Valova et al. (2024), Almulla and Ali (2024), and Ogunleye et al. (2024) advocate for ethical frameworks and comparative approaches that promote responsible AI use while maintaining human agency. These strategies are consistent with Paul and Elder's (2019) emphasis on intellectual virtues such as fairness, integrity, and empathy. Furthermore, approaches such as structured thinking guidelines by Guo and Lee (2023), AI ethics training by Alam et al. (2023), and curriculum-integrated AI literacy (Huang et al., 2024; Kurt & Kurt, 2024) equip learners with essential tools to assess the credibility and implications of AI technologies in their academic work.

Finally, several studies emphasize the importance of maintaining a pedagogical balance between AI assistance and traditional teaching methods. Iskender (2023) recommends a blended learning approach to preserve human judgment and critical inquiry, while Taylor and Marino (2024) propose strategic feedback and conceptual analysis to deepen students' evaluative capacity. Kurt and Kurt (2024) and Huang et al. (2024) highlight the need for ongoing AI literacy training to ensure that students become not only consumers of AI-generated outputs but also critical evaluators. Collectively, these strategies align with the higher-order cognitive processes of analyzing, evaluating, and creating outlined in the Revised Bloom's Taxonomy (Anderson et al., 2001), while also fostering the intellectual virtues described by Paul and Elder (2019). When thoughtfully implemented, such approaches position AI as a pedagogical ally that enhances both the skills and dispositions essential for cultivating critical thinking in higher education.

CONCLUSION

This study provides a comprehensive examination of how artificial intelligence (AI) intersects with the development of critical thinking skills in higher education by combining bibliometric mapping and a systematic literature review. The bibliometric analysis shows that while research in this area is growing, it remains fragmented, with limited theoretical underpinnings and a concentration of publications among a small group of authors, journals, and institutions. Thematic mapping reveals dominant areas of inquiry, such as AI-assisted pedagogy, assessment reform, and ethical issues. It also highlights emerging but underexplored topics, including

adaptive AI tutoring systems, AI-assisted argumentation and debate, bias detection in educational algorithms, and gamification approaches to critical thinking. These areas require further empirical investigation to better understand how AI can enhance higher-order thinking in diverse educational settings.

The thematic analysis reveals that the conceptualization of critical thinking within the context of AI integration in higher education remains varied and, in many cases, underdeveloped theoretically. A small subset of studies has aligned with the Revised Bloom's Taxonomy by emphasizing higher-order cognitive processes such as analyzing, evaluating, and creating. In contrast, others fail to articulate a clear theoretical foundation. Similarly, only a limited number of works incorporate the dispositional dimensions proposed by Paul and Elder, which emphasize intellectual traits such as empathy, perseverance, and ethical reasoning. This gap highlights the need for future research to adopt stronger theoretical frameworks in defining and operationalizing critical thinking within AI-supported learning environments.

The review also identifies several pressing challenges in fostering critical thinking through AI integration in higher education, including cognitive dependency on AI, diminished reflective engagement, validation issues, and ethical concerns such as academic dishonesty and superficial learning. Nevertheless, the literature reveals significant opportunities when AI is used purposefully to support higher-order thinking—particularly through adaptive feedback mechanisms, personalized and reflective learning cycles, peer-based dialogue, and collaborative reasoning environments. To leverage these opportunities and address the risks, scholars have proposed a range of pedagogical strategies, including AI-integrated assessments, scaffolded and iterative feedback, structured thinking guidelines, ethics-focused instruction, AI literacy training, interactive simulations, and the balanced integration of AI with traditional pedagogies. When these strategies are intentionally aligned with the higher-order cognitive processes in Bloom's Revised Taxonomy—such as analyzing, evaluating, and creating—they provide a solid foundation for critical thinking development. Supported by the intellectual standards and traits emphasized by Paul and Elder, including clarity, accuracy, fairness, and intellectual integrity, AI can then serve not only as a technical tool but also as a pedagogical partner in cultivating deep, ethical, and critically engaged learners in higher education.

These findings carry important implications for educational practitioners, curriculum designers, and institutional policymakers. First, integrating AI into higher education demands not only technical infrastructure but also a thoughtful pedagogical framework grounded in well-established theories of learning and thinking. Institutions should prioritize faculty development initiatives that build competencies in AI literacy and ethical instructional design. Moreover, interdisciplinary collaboration between educators, technologists, and ethicists is essential to ensure that AI tools are harnessed to promote—not replace—student reasoning and intellectual character.

This study has several methodological and conceptual limitations that should be acknowledged. The scope of analysis is restricted to predefined research questions, focusing on

the publication landscape, challenges, opportunities, and strategies for integrating AI to foster critical thinking in higher education, without examining in detail the seven types of critical thinking skills, the 5C model, or their direct pedagogical applications. The analysis also relies solely on theoretical frameworks and secondary literature, with data limited to open-access sources indexed in Scopus, potentially excluding relevant studies from other databases or non-open-access publications. Future research should incorporate empirical and cross-disciplinary approaches, including classroom observations, experimental designs, and stakeholder perspectives, to validate and extend the findings. Expanding the scope to systematically classify critical thinking skills and linking them explicitly to Bloom's Taxonomy would enhance conceptual clarity and pedagogical applicability. Furthermore, developing adaptive educational frameworks that evolve alongside AI technologies will be essential to ensure that these tools effectively support, rather than substitute, higher-order cognitive processes.

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Conflict of Interest

The authors affirm that there are no conflicts of interest in the preparation and dissemination of this study.

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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.

REFERENCES

Alam, F., Lim, M. A., & Zulkipli, I. N. (2023). Integrating AI in medical education: embracing ethical usage and critical understanding. *Frontiers in Medicine*, *10*. https://doi.org/10.3389/fmed.2023.1279707

Almulla, M., & Ali, S. I. (2024). The changing educational landscape for sustainable online experiences: implications of ChatGPT in Arab students' learning experience. *International Journal of Learning, Teaching and Educational Research*, *23*(9), 285–306.

https://doi.org/10.26803/ijlter.23.9.15

Alshammari, A. & Al-Enezi, S. (2024). Role of Artificial Intelligence in Enhancing Learning Outcomes of Pre-Service Social Studies Teachers, *Journal of Social Studies Education Research, 15*(4), 163-196. https://jsser.org/index.php/jsser/article/view/5787/699

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A Taxonomy for Learning Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Longman.

Banihashem, S. K., Kerman, N. T., Noroozi, O., Moon, J., & Drachsler, H. (2024). Feedback sources in essay writing: peer-generated or AI-generated feedback? *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00455-4

Baytak, A. (2024). The Content Analysis of the Lesson Plans Created by ChatGPT and Google Gemini. *Research in Social Sciences and Technology, 9*(1), 329-350. https://doi.org/10.46303/ressat.2024.19

Bearman, M., Tai, J., Dawson, P., Boud, D., & Ajjawi, R. (2024). Developing evaluative judgement for a time of generative artificial intelligence. *Assessment and Evaluation in Higher Education*, *49*(6), 893–905. https://doi.org/10.1080/02602938.2024.2335321

Capinding, A. T., & Dumayas, F. T. (2024). Transformative pedagogy in the digital age: unravelling the impact of artificial intelligence on higher education students. *Problems of Education in the 21st Century*, *82*(5), 630–657. https://doi.org/10.33225/pec/24.82.630

Chauke, T., Mkhize, T., Methi, L., & Dlamini, N. (2024). Postgraduate Students' Perceptions on the Benefits Associated with Artificial Intelligence Tools on Academic Success: In Case of ChatGPT AI tool. *Journal Of Curriculum Studies Research, 6*(1), 44-59. https://doi.org/10.46303/jcsr.2024.4

Donnell, F. O., Porter, M., & Fitzgerald, D. S. (2024). The role of artificial intelligence in higher education: higher education students use of AI in academic assignments. *Irish Journal of Technology Enhanced Learning*, *8*(1). https://doi.org/10.22554/szwjfy54

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: an overview and guidelines. *Journal of Business Research*, *133*(May), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Ennis, R. (2011). Critical thinking: reflection and perspective. *Inquiry: Critical Thinking Across the Disciplines*, *26*(1), 4–18. https://doi.org/10.5840/inquiryctnews201126215

Essien, A., Bukoye, O. T., O'Dea, X., & Kremantzis, M. (2024). The influence of AI text generators on critical thinking skills in UK business schools. *Studies in Higher Education*, *49*(5), 865–882. https://doi.org/10.1080/03075079.2024.2316881

Guo, Y., & Lee, D. (2023). Leveraging ChatGPT for enhancing critical thinking skills. *Journal of Chemical Education*, *100*, 4876 – 4883. https://doi.org/10.1021/acs.jchemed.3c00505

Hongli, Z., & Leong, W. Y. (2024). AI solutions for accessible education in underserved

communities. *Journal of Innovation and Technology*, *2024*(11). https://doi.org/10.61453/joit.v2024no11

Huang, D., Huang, Y., & Cummings, J. J. (2024). Exploring the integration and utilisation of generative AI in formative e-assessments: A case study in higher education. *Australasian Journal of Educational Technology*, *40*(4), 1 – 19. https://doi.org/10.14742/ajet.9467

Imran, M., Almusharraf, N., Sayed, M., Milana, A., & Abbasova, Y. (2024). Artificial intelligence in higher education: enhancing learning systems and transforming educational paradigms. *International Journal of Interactive Mobile Technologies*, *18*(18), 34–48. https://doi.org/10.3991/ijim.v18i18.49143

Iskender, A. (2023). Holy or unholy? Interview with open AI's ChatGPT. *European Journal of Tourism Research*, *34*. https://doi.org/10.54055/ejtr.v34i.3169

Jayasinghe, S. (2024). Promoting active learning with ChatGPT: a constructivist approach in Sri Lankan higher education. *Journal of Applied Learning & Teaching*, *7*(2), 141–154. https://doi.org/10.37074/jalt.2024.7.2.26 Abstract

Kamoun, F., Ayeb, W. El, Jabri, I., Sifi, S., & Iqbal, F. (2024). Exploring students' and faculty's knowledge, attitudes, and perceptions towards ChatGPT: A cross-sectional empirical study. *Journal of Information Technology Education: Research*, *23*, 1–33. https://doi.org/10.28945/5239

Karaali, G. (2023). Artificial intelligence, basic skills, and quantitative literacy. *Numeracy*, *16*(1). https://doi.org/10.5038/1936-4660.16.1.1438

Kizilcec, R. F., Huber, E., Papanastasiou, E. C., Cram, A., Makridis, C. A., Smolansky, A., Zeivots, S., & Raduescu, C. (2024). Perceived impact of generative AI on assessments: comparing educator and student perspectives in Australia, Cyprus, and the United States. *Computers and Education: Artificial Intelligence*, *7*. https://doi.org/10.1016/j.caeai.2024.100269

Kurt, G., & Kurt, Y. (2024). Enhancing L2 writing skills: ChatGPT as an automated feedback tool. *Journal of Infromation Technology Education: Research*, *23*, 1–17. https://doi.org/10.28945/5370

Luo, Y. (2024). Revolutionizing education with AI: the adaptive cognitive enhancement model (ACEM) for personalized cognitive development. *Proceedings of the 2nd International Conference on Machine Learning and Automation*, *82*(1), 71–76. https://doi.org/10.54254/2755-2721/82/20240929

Michalon, B., & Camacho-Zuñiga, C. (2023). ChatGPT, a brand-new tool to strengthen timeless competencies. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1251163

Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*, *13*(9). https://doi.org/10.3390/educsci13090856

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., Estarli, M., Barrera, E. S. A., Martínez-Rodríguez, R., Baladia, E., Agüero, S. D., Camacho, S., Buhring, K., Herrero-López, A., Gil-González, D. M., Altman, D. G., Booth, A., … Whitlock, E. (2016). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Revista Espanola de Nutricion Humana y Dietetica*, *20*(2), 148–160. https://doi.org/10.1186/2046-4053-4-1

Moulin, T. C. (2024). Learning with AI language models: guidelines for the development and scoring of medical questions for higher education. *Journal of Medical Systems*, *48*(1). https://doi.org/10.1007/s10916-024-02069-9

Nikolic, S., Daniel, S., Haque, R., Belkina, M., Hassan, G. M., Grundy, S., Lyden, S., Neal, P., & Sandison, C. (2023). ChatGPT versus engineering education assessment: a multidisciplinary and multi-institutional benchmarking and analysis of this generative artificial intelligence tool to investigate assessment integrity. *European Journal of Engineering Education*, *48*(4), 559 – 614. https://doi.org/10.1080/03043797.2023.2213169

Nobutoshi, M. (2023). Metacognition and reflective teaching: a synergistic approach to fostering critical thinking skills. *Research and Advances in Education*, *2*(9), 1–14. https://doi.org/10.56397/rae.2023.09.01

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, *16*(1), 1–13. https://doi.org/10.1177/1609406917733847

Ogunleye, B., Zakariyyah, K. I., Ajao, O., Olayinka, O., & Sharma, H. (2024). Higher education assessment practice in the era of generative AI tools. *Journal of Applied Learning and Teaching*, *7*(1), 46 – 56. https://doi.org/10.37074/jalt.2024.7.1.28

Ogurlu, U., & Mossholder, J. (2023). The Perception of ChatGPT among Educators: Preliminary Findings. *Research in Social Sciences and Technology, 8*(4), 196-215. https://doi.org/10.46303/ressat.2023.39

Paul, R., & Elder, L. (2019). *The miniature guide to critical thinking concepts and tools*. Rowman & Littlefield.

Rangavittal, P. B. (2024). Transforming higher education with artificial intelligence - benefits, challenges, and future directions. *International Journal of Science and Research (IJSR)*, *13*(5), 1635–1642. https://doi.org/10.21275/sr24525214415

Rusandi, M. A., Ahman, Saripah, I., Khairun, D. Y., & Mutmainnah. (2023). No worries with ChatGPT: building bridges between artificial intelligence and education with critical thinking soft skills. *Journal of Public Health (United Kingdom)*, *45*(3), E602–E603. https://doi.org/10.1093/pubmed/fdad049

Salido, A., Sugiman, S., Fauziah, P. Y., Kausar, A., Haskin, S., & Azhar, M. (2024). Parental involvement in students' mathematics activities: a bibliometric analysis. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*(10), 1–13.

https://doi.org/https://doi.org/10.29333/ejmste/15179

Sarwanti, S., Sariasih, Y., Rahmatika, L., Islam, M. M., & Riantina, E. M. (2024). Are they literate on ChatGPT? University language students' perceptions, benefits and challenges in higher education learning. *Online Learning*, *28*(3), 105–130. https://doi.org/10.24059/olj.v28i3.4599

Singh, S. V. (2023). The prospects for advancing adaptive learning technology through AI methods. *2023 Future of Educational Innovation-Workshop Series Data in Action*, 1–9. https://doi.org/10.1109/IEEECONF56852.2023.10105111

Stampfl, R., Geyer, B., Deissl-O'meara, M., & Ivkic, I. (2024). Revolutionising role-playing games with ChatGPT. *Advances in Artificial Intelligence and Machine Learning*, *4*(2), 2244 – 2257. https://doi.org/10.54364/aaiml.2024.42129

Susnjak, T., & McIntosh, T. R. (2024). ChatGPT : the end of online exam integrity ? *Education Sciences*, *14*(6). https://doi.org/10.3390/educsci14060656

Taylor, P. R., & Marino, M. C. (2024). On feedback from bots: intelligence tests and teaching writing. *Journal of Applied Learning & Teaching*, *7*(2), 110–117. https://doi.org/10.37074/jalt.2024.7.2.22

Valova, I., Mladenova, T., & Kanev, G. (2024). Students' perception of ChatGPT usage in education. *International Journal of Advanced Computer Science and Applications*, *15*(1), 466 – 473. https://doi.org/10.14569/IJACSA.2024.0150143

Vargas, E.G., Chiappe, A. & Durand, J. (2024). Reshaping education in the era of artificial intelligence: insights from Situated Learning related literature. *Journal of Social Studies Education Research, 15(*2), 1-28. https://jsser.org/index.php/jsser/article/view/5428/665

Vargas-Murillo, A. R., Pari-Bedoya, I. N. M. de la A., & Guevara-Soto, F. de J. (2023). Challenges and opportunities of AI-assisted learning: a systematic literature review on the impact of ChatGPT usage in higher education. *International Journal of Learning, Teaching and Educational Research*, *22*(7), 122 – 135. https://doi.org/10.26803/ijlter.22.7.7

Walter, Y. (2024). Embracing the future of artificial intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, *21*, 1–29. https://doi.org/10.1186/s41239-024-00448-3

Wang, C., Aguilar, S. J., Bankard, J. S., Bui, E., & Nye, B. (2024). Writing with AI: what college students learned from utilizing ChatGPT for a writing assignment. *Education Sciences*, *14*(9), 1–16. https://doi.org/10.3390/educsci14090976

Werdiningsih, I., Marzuki, & Rusdin, D. (2024). Balancing AI and authenticity: EFL students' experiences with ChatGPT in academic writing. *Cogent Arts and Humanities*, *11*(1). https://doi.org/10.1080/23311983.2024.2392388

Zhu, H., Li, J., Yuan, Z., & Li, J. (2023). Bibliometric analysis of spatial accessibility from 1999–2022. *Sustainability (Switzerland)*, *15*(18), 1–17. https://doi.org/10.3390/su151813399