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MAPPING RESEARCH ON GENERATIVE AI AND CRITICAL THINKING IN EDUCATION

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Abstract:

The swift progress of Generative Artificial Intelligence (GenAI), especially large language models like ChatGPT, has transformed the educational landscape by presenting novel opportunities for enhancing critical thinking and higher-order cognitive skills. However, despite growing interest, there remains limited systematic evidence on how scholarship has conceptualized and investigated the intersection of GenAI, as well as critical thinking in education, creating a gap in understanding both the scope and direction of this emerging field. This study aims to map and synthesize existing research through a bibliometric analysis to identify patterns, trends, and thematic clusters. Data were gathered from the Scopus database employing advanced search strategies with the keywords "generative" and "critical thinking," restricted to English-language publications, and published between 2020 and 2025. The initial search yielded 645 publications that were further processed and refined using OpenRefine to ensure consistency and eliminate redundancies. Statistical trends, including annual publication output, country and institutional contributions, and leading sources, were examined using the Scopus Analyser, while intellectual structures and thematic networks were visualized through VOSviewer. The analysis revealed significant growth in publications since 2020, with strong contributions from the fields of computational linguistics, Artificial Intelligence (AI), and education. Co-occurrence keyword mapping highlighted seven clusters, with "language models," "reasoning ability," and "critical thinking" emerging as core research themes. These findings underscore the centrality of GenAI in advancing reasoning and pedagogical applications, while also identifying emerging subfields such as chain-of-

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thought reasoning, prompt engineering, and higher-order thinking skills. By providing a comprehensive overview of publication trends, thematic networks, and intellectual structures, this study contributes to the body of knowledge by clarifying the current state of research and pointing to future directions for exploring how generative AI can effectively support critical thinking in educational contexts.

Keywords:

Generative AI, Critical Thinking, Education

Introduction

Generative Artificial Intelligence (GenAI) has become a transformative force across multiple sectors, particularly in education. This technology, characterized by its ability to create content across multiple modalities, for instance, text, images, video and audio, is reshaping the landscape of teaching and learning. The incorporation of GenAI into education provides unparalleled opportunities for personalized learning, improved student engagement, and the cultivation of critical thinking skills. However, it also presents significant challenges, including potential biases, ethical considerations, and the risk of overreliance on AI-generated content. This research assesses the dual role of GenAI in enhancing critical thinking in educational settings, exploring both its promising benefits and the challenges it poses.

The transformative possibility of GenAI in education is well-documented. GenAI tools, such as ChatGPT, have been shown to facilitate personalized learning experiences by generating tailored content that meets the diverse needs of students (Pavlik, 2025; Tariq, 2024). These tools enable educators to design interactive and participatory curricula, moving away from passive learning models to those that emphasize active student engagement (Pavlik, 2025). For instance, students can use GenAI to generate prompts and critically evaluate the content produced, thereby enhancing their analytical and evaluative skills (Pavlik, 2025). Moreover, GenAI may automate routine tasks, enabling educators to devote more time to personalized instruction and student interaction (Vázquez-Madrigal et al., 2024).

Despite these advantages, the integration of GenAI in education comes with its own set of challenges. A major concern is the potential impact on students' critical thinking skills. While GenAI may support the development of these skills by offering opportunities for reflective thinking and problem-solving, there is a risk that students could become excessively dependent on AI-generated solutions, undermining their cognitive abilities (El Samaty, 2025; Jai Lamimi et al., 2025). Studies have shown that the frequency of AI use is not directly related to the enhancement of critical thinking skills. Rather, it is the reflective use of these tools that fosters cognitive development (Zhang & Liu, 2025). Moreover, AI-generated content quality can vary, and concerns exist about biases and inaccuracies that may be perpetuated through these technologies (Walczak & Cellary, 2025).

The need for ethical and responsible use further complicates the role with respect to GenAI in fostering critical thinking. Educators must navigate the challenges of ensuring that AI tools are used to support, rather than replace, the learning process. This involves addressing issues related to academic integrity, data privacy, and the potential for disinformation (Chiavarino et al., 2025; Walczak & Cellary, 2025). Note that effective integration of GenAI in education

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requires a balanced approach that combines traditional teaching methods with innovative AI-driven strategies. This includes developing new assessment models that can accurately measure higher-order cognitive skills and providing targeted training programs for educators to enhance their AI literacy (Gravino, Iannella, Marras, Pagliara, & Palomba, 2024; Rasul et al., 2023).

Empirical research has highlighted the good impact of GenAI on critical thinking when used appropriately. For example, structured workshops that incorporate GenAI tools into activities aimed at establishing critical thinking skills have shown significant improvements in students' analytical and evaluative abilities (MagdielOliva-Córdova, Álvarez-Icaza, & EnriqueGeorge-Reyes, 2025; Rasul et al., 2023). Furthermore, the purposeful integration of GenAI technologies, when aligned with well-defined educational objectives, may lead to meaningful and positive outcomes in cognitive development (MagdielOliva-Córdova et al., 2025). However, the effectiveness of these interventions relies on the careful design and implementation of AI-driven educational practices, ensuring that they are scalable, adaptable, and equitable (Pang & Wei, 2025).

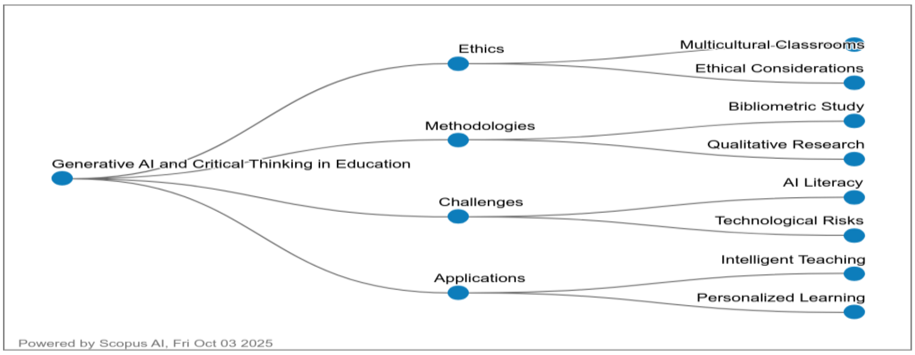

Figure 1: Concept Map on Generative AI And Critical Thinking in Education

Figure 1 illustrates four major thematic clusters that highlight the connections between GenAI and critical thinking in education. The concept map in Figure 1 highlights the multifaceted connections between GenAI as well as critical thinking in education, emphasizing four main domains: ethics, methodologies, challenges, and applications. Ethical concerns revolve around multicultural classrooms and the moral implications of integrating AI into diverse learning contexts, underscoring the need for inclusive and responsible practices. Methodologies include bibliometric studies and qualitative research, reflecting the growing scholarly efforts to examine AI's impact through systematic and context-specific approaches. The challenges focus on AI literacy and technological risks, drawing attention to the necessity to equip students and educators with the abilities to critically engage with AI tools while mitigating potential harm. Finally, applications such as intelligent teaching systems and personalized learning illustrate AI's transformative potential in tailoring educational experiences and fostering student engagement. Taken together, the map reveals that while GenAI allows powerful opportunities to promote critical thinking and learning personalization, its integration requires careful consideration of ethical, methodological, and literacy-related challenges to ensure it contributes positively to education in diverse contexts.

In conclusion, while GenAI holds great promise for enhancing critical thinking in education, its integration must be approached with caution. Educators and policymakers must work together to establish frameworks that maximize the benefits of GenAI while mitigating its risks. This involves fostering a culture of critical engagement with AI tools, promoting ethical use,

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and continuously evaluating the influence of these technologies on student learning outcomes. In doing so, we can leverage the potential of GenAI to foster a more dynamic, inclusive, and effective educational environment.

Research Questions
1. What are the trends in these studies according to the year of publication?
2. What are the top 10 most cited articles?
3. Where are the top 10 countries based on the number of publications?
4. What are the popular keywords related to the study?
5. What is co-authorship by countries' collaboration?

Methodology
Bibliometric analysis encompasses the organization, systematic collection, as well as examination of bibliographic data derived from scientific publications (Alves, Borges, & Nadae, 2021; Assyakur & Rosa, 2022; Verbeek, Debackere, Luwel, & Zimmermann, 2002). Moving beyond elementary indicators, for instance, publishing outlets, temporal trends, and prolific authors (Wu & Wu, 2017), bibliometrics employs advanced methodologies, including document co-citation analysis, to shape intellectual structures and knowledge trajectories within a field. Conducting a rigorous literature review necessitates an iterative and methodical process of selecting precise keywords, executing comprehensive searches, and engaging in in-depth analytical procedures. Such an approach facilitates the construction of an authoritative bibliography and ensures the production of reliable insights (Fahimnia, Sarkis, & Davarzani, 2015). Confirming this, the current study concentrated on high-impact publications, recognizing their capacity to illuminate dominant theoretical frameworks that shape scholarly discourse. To safeguard data validity, Scopus was designated as the principal database for data retrieval (Al-Khoury et al., 2022; Di Stefano, Peteraf, & Verona, 2010; Khiste Babasaheb Ambedkar, Rameshchandra Paithankar, Khiste, & Paithankar, 2017). Moreover, to further uphold quality, only peer-reviewed journal articles were incorporated, whereas lecture notes, books, and other non-refereed sources were intentionally excluded (Gu, Li, Wang, Yang, & Yu, 2019). Data collection from Elsevier's Scopus—renowned for its expansive and multidisciplinary coverage—was restricted to publications issued between 2020 and December 2023, ensuring both relevance and temporal precision.

Data Search Strategy
To obtain strategic data for the bibliometric analysis, the Scopus advanced search function was employed due to its broad coverage of peer-reviewed publications and robust search capabilities. The search strategy was carefully designed to capture studies at the intersection of GenAI and critical thinking. The string applied was: *TITLE ((“generative AI” OR “large language model” OR “ChatGPT” OR “GPT-3” OR “GPT-4”) AND (“critical thinking” OR “higher-order thinking” OR “reasoning”)) AND PUBYEAR > 2020 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (PUBSTAGE, “final”))**. This formulation ensured that only publications explicitly addressing GenAI technologies (including ChatGPT and large language models such as GPT-3 and GPT-4) in relation to cognitive constructs, such as critical thinking, higher-order thinking, and reasoning, were retrieved. Furthermore, the inclusion and exclusion criteria were clearly established: studies had to be published between 2020 and 2025, reflecting the most recent and relevant contributions in this rapidly evolving field, while works before 2020 were excluded to avoid outdated perspectives. Only final-stage publications written in English were retained, while

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non-English outputs and preprints were excluded to maintain consistency and academic rigor. These parameters ensured that the dataset was both comprehensive and aligned with the research's scope. After systematically applying these criteria, a total of 645 records were determined, forming the final dataset for subsequent bibliometric mapping and analysis. This deliberate methodological approach provided a reliable foundation for examining how scholarly discourse has evolved in connecting GenAI with the development regarding critical thinking skills in education.

Table 1: Search String

Scopus	TITLE ((“generative AI” OR “large language model*” OR “ChatGPT” OR “GPT-3” OR “GPT-4”) AND (“critical thinking” OR “higher-order thinking” OR “reasoning”)) AND PUBYEAR > 2020 AND PUBYEAR < 2026 AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (LANGUAGE, “English”)) Access date: October 2025

Table 2: Searching Selection Criteria

The Selection Criterion In Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020 - 2025	>1999 and <2026
Publication Stage	Final	In Press

Data Analysis

VOSviewer, established by Nees Jan van Eck and Ludo Waltman at Leiden University in the Netherlands, has become one of the most widely adopted bibliometric visualization tools in scholarly research (van Eck & Waltman, 2010, 2017). Designed with user accessibility in mind, the software enables researchers to generate intuitive network visualizations, cluster related entities, and construct density maps that reveal structural patterns in scientific literature. Its methodological versatility extends across co-citation, co-authorship, as well as keyword co-occurrence analyses, thus providing comprehensive insights into the intellectual and collaborative landscapes of a research domain. The interactive interface, combined with continuous updates, enables scholars to navigate and interrogate extensive datasets dynamically and efficiently.

Furthermore, VOSviewer's capacity to compute bibliometric indicators, customize graphical outputs, and integrate multiple data sources reinforces its status as an indispensable analytical platform for contemporary research evaluation. A distinctive strength of VOSviewer lies in its ability to transform complex bibliometric datasets into visually interpretable knowledge maps. By emphasizing network visualization, the software excels at identifying clusters of related items, tracing keyword co-occurrence patterns, as well as constructing density maps that

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highlight research hotspots. Its user-friendly interface ensures accessibility for both novice and advanced users, while its ongoing development maintains alignment with evolving trends in bibliometric methodologies. Importantly, its adaptability across diverse bibliometric data types, which includes co-authorship, citation, and keyword networks, positions VOSviewer as a versatile and vital instrument for generating meaningful insights into knowledge production and dissemination.

For this study, datasets in Plain Text format were extracted from the Scopus database, covering publications from January 2020 to December 2025. Note that each dataset contained information on publication year, author name, title, journal source, citation counts, and keywords. These data were subsequently analyzed utilizing VOSviewer software version 1.6.20. Using VOS clustering and mapping techniques, the tool enabled the creation of bibliometric maps that reveal relationships within the dataset. Similar to the Multidimensional Scaling (MDS) approach, VOSviewer positions items in a low-dimensional space where the spatial distance between them directly reflects their degree of relatedness (Appio, Cesaroni, & Di Minin, 2014; van Eck & Waltman, 2010). Nevertheless, unlike MDS, which commonly uses similarity measures such as Jaccard or cosine indices, VOSviewer utilizes a more robust normalization method based on Association Strength (AS_{ij}), calculated as follows (Van Eck & Waltman, 2007):

$$AS_{ij} = \frac{C_{ij}}{w_i w_j},$$

in which (C_{ij}) represents the observed number of co-occurrences between items *i* and *j*, and (w_i w_j) refers to the expected frequency of such co-occurrences under the assumption of statistical independence. This formulation ensures that the measure of relatedness is proportional to the ratio between observed and expected co-occurrences, providing a theoretically grounded and empirically reliable normalization framework (Van Eck & Waltman, 2007).

Findings And Discussion

What Are the Trends in These Studies According To the Year of Publication?

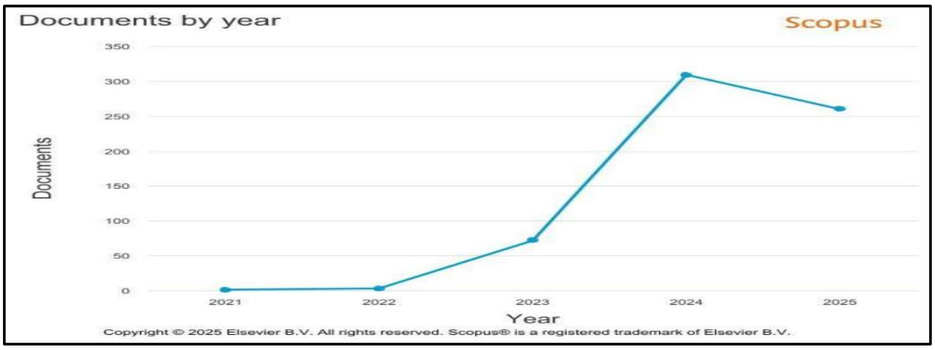

Figure 2: Number Of Documents Cited by Year

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The publication trend from 2020 to 2025 demonstrates an exponential growth in studies on GenAI and critical thinking in education, reflecting the rapid acceleration of interest in this domain. In 2020, no publications were recorded, followed by a single publication in 2021 and three in 2022, indicating that the scholarly community had yet to fully engage with the topic during the early stages of GenAI development. The turning point occurred in 2023, when 72 documents were published, marking the initial surge of academic attention. This sharp increase corresponds with the global release and mainstream adoption of ChatGPT and other large language models in late 2022, which catalyzed widespread debates on their educational applications. The dramatic rise in 2024, with 309 publications, underscores the topic's emergence as a prominent area of research, as scholars from diverse fields investigate its potential to foster reasoning, higher-order thinking, and innovative pedagogical practices.

By 2025, the dataset recorded 260 publications, slightly lower than the peak in 2024, yet still substantially higher compared to earlier years. This pattern suggests that while 2024 marked the exploratory surge, 2025 reflects a phase of consolidation and deeper investigation, as researchers move beyond initial enthusiasm toward more critical, systematic, and application-focused studies. The temporary decline may also be attributed to publication cycles, indexing delays, or a natural stabilization after an extraordinary burst of activity. Overall, this trajectory illustrates how technological breakthroughs directly shape academic discourse: the rise of GenAI tools rapidly redefined educational research agendas, placing critical thinking and higher-order reasoning at the forefront of scholarly inquiry. The data clearly underscore the responsiveness of the academic community to technological disruptions, with the period from 2023 to 2025 emerging as pivotal for establishing the foundations of this research field.

What Are the Top 10 Most Cited Articles?

Table 3: Top 10 Most Cited Articles

No	Author(s)	Title	Year	Source Title	Cited By
1	Wei et al. (2022)	Chain-of-Thought Prompting Elicits Reasoning in Large Language Models	2022	Advances in Neural Information Processing Systems	6374
2	Zhou et al. (2023)	Least-To-Most Prompting Enables Complex Reasoning In Large Language Models	2023	11th International Conference on Learning Representations Iclr 2023	337
3	Webb, Holyoak, & Lu (2023)	Emergent analogical reasoning in large language models	2023	Nature Human Behaviour	227
4	van den Berg & du Plessis (2023)	ChatGPT and Generative AI: Possibilities for Its Contribution to Lesson Planning, Critical	2023	Education Sciences	189

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		Thinking and Openness in Teacher Education			
5	Huang & Chang (2023)	Towards Reasoning in Large Language Models: A Survey	2023	Proceedings of the Annual Meeting of the Association for Computational Linguistics	185
6	Goh et al. (2024)	Large Language Model Influence on Diagnostic Reasoning: A Randomised Clinical Trial	2024	JAMA Network Open	162
7	Wang et al. (2023)	Plan-and-Solve Prompting: [32] Chain-of-Thought Reasoning by Large Language Models	2023	Proceedings of the Annual Meeting of the Association for Computational Linguistics	158
8	Guo & Lee (2023)	Leveraging ChatGPT for Enhancing Critical Thinking Skills	2023	Journal of Chemical Education	135
9	Pan, Albalak, Wang, & Wang (2023)	LOGIC-LM: Empowering Large Language Models with Symbolic Solvers for Faithful Logical Reasoning	2023	Findings of the Association for Computational Linguistics Emnlp 2023	126
10	Savage, Nayak, Gallo, Rangan, & Chen (2024)	Diagnostic reasoning prompts reveal the potential for large language model interpretability in medicine	2024	npj Digital Medicine	114

The citation analysis of the top ten most influential articles from 2020 to 2025 reveals a striking disparity in impact, with a few landmark papers accounting for the majority of scholarly attention. The most cited article, "Chain-of-Thought Prompting Elicits Reasoning in Large Language Models" (Wei et al., 2022), amassed 6,374 citations, far surpassing those of others in the dataset. This overwhelming citation count reflects its pioneering role in establishing chain-of-thought prompting as a foundational concept in reasoning with large language models, a methodological breakthrough that has shaped subsequent research trajectories in AI and education. The next tier of influential works includes "Least-to-Most Prompting Enables Complex Reasoning in Large Language Models" (Zhou et al., 2023) with 337 citations and "Emergent Analogical Reasoning in Large Language Models" (Webb et al., 2023) (227 citations), both of which build upon and extend reasoning capabilities in AI systems. Together, these highly cited contributions illustrate that early, technically groundbreaking works are disproportionately influential, providing the theoretical and methodological scaffolding for the rapid expansion of studies that followed.

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Interestingly, educational applications began to appear prominently among the most cited works from 2023 onward, such as *"ChatGPT and Generative AI: Possibilities for Innovative Teaching and Learning in Higher Education"* (van den Berg & du Plessis, 2023) (189 citations) and *"Leveraging ChatGPT for Enhancing Critical Thinking in Education"* (Guo & Lee, 2023) (135 citations). These publications, although not as highly cited as their technically oriented counterparts, demonstrate the scholarly community's growing concern with pedagogical integration and the development of critical thinking. Their relatively high citation counts within a short timeframe suggest that education-focused research resonates strongly with both academics and practitioners seeking practical insights into AI's role in teaching and learning. The strong presence of diagnostic reasoning studies in 2024, as evidenced by notable works such as *"Large Language Model Influence on Diagnostic Reasoning in Medicine"* (Goh et al., 2024) (162 citations) and *"Diagnostic Reasoning Prompts Reveal the Potential of Generative AI"* (Savage et al., 2024) (114 citations), highlights a diversification of applications beyond general education into domain-specific reasoning tasks. Collectively, the results confirm that the body of knowledge is shaped first by foundational technical innovations, followed closely by interdisciplinary explorations that translate these methods into real-world contexts, particularly in education and healthcare.

Where Are the Top 10 Countries Based on the Number of Publications?

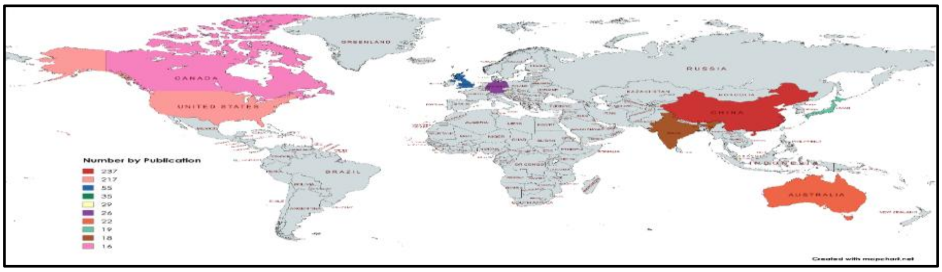

Figure 3: Country Mapping Based on Number of Publications

The publications distribution highlights a geographical concentration of research activity in China and the United States, with 237 and 217 publications, respectively. Together, these two countries account for more than two-thirds of the total output, indicating their dominant role in shaping global discourse on GenAI and critical thinking. This trend is unsurprising given their significant investments in AI research and development, both at governmental and institutional levels. China's leading position can be attributed to its national AI strategy, strong funding mechanisms, and the government's emphasis on integrating AI technologies into education and innovation. Similarly, the United States benefits from its robust academic ecosystem, industry–academia collaborations, and the presence of major technology companies—such as OpenAI, Google, and Microsoft—that directly drive research outputs related to large language models.

In contrast, countries like the United Kingdom (55), Hong Kong (35), Singapore (29), and Germany (26) contribute moderate yet notable outputs, reflecting their specialized focus on higher education and digital transformation. Smaller but research-active nations like Australia, Japan, India, and Canada also appear on the list, showing a growing recognition of AI's pedagogical implications within their academic systems. The comparatively lower numbers from these regions may reflect differences in funding priorities, research infrastructure, and scale of higher education systems. Nonetheless, their presence suggests a globalizing trend, where both developed and emerging economies acknowledge the significance of GenAI in

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enhancing critical thinking and reasoning skills. Collectively, the data underscores the uneven but expanding global landscape of AI-related educational research, shaped largely by economic resources, policy frameworks, and the proximity of academic institutions to technological innovation hubs.

What Are the Popular Keywords Related to the Study?

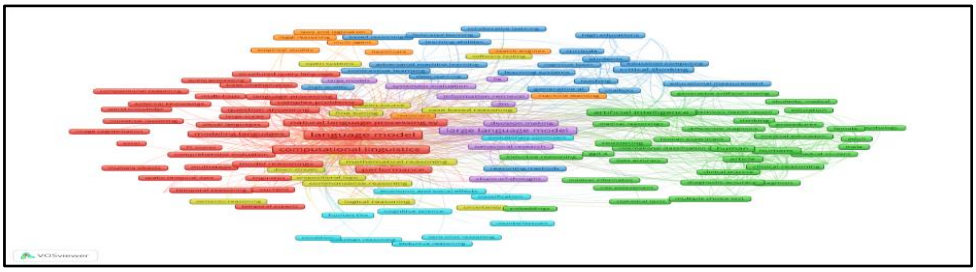

Figure 4: Network Visualization Map of Keywords' Co-occurrence

The co-occurrence analysis of author keywords in VOSviewer operates on the principle that the frequency with which keywords appear together in publications reflects their conceptual proximity and intellectual relatedness within a research domain. By mapping these co-occurrences, the software generates network visualizations that highlight how ideas, methods, and thematic concerns interconnect, revealing both the structure and emerging trends of a field. In this study, the analysis was conducted using the full counting method, with a minimum threshold of five occurrences to ensure robustness. Out of a total of 2,308 extracted keywords, 235 met the inclusion threshold. To further enhance interpretability, a minimum cluster size of five was applied. These parameters led to the generation of seven distinct clusters, each representing a cohesive body of concepts tied together by frequent co-occurrence patterns. This methodological choice allowed for the identification of both dominant and peripheral themes in the literature, while filtering out noise from rarely used or isolated keywords.

The findings substantially enrich the body of knowledge by offering a panoramic view of how scholarly attention on GenAI and critical thinking has evolved and clustered around foci. The most frequent keywords, such as *"language model"* (427 occurrences, 3,000 link strength), *"large language model"* (236 occurrences, 1,777 link strength), and *"computational linguistics"* (223 occurrences, 1,637 link strength), illustrate the centrality of language-based AI systems in contemporary discourse. Related terms such as *"reasoning ability," "natural language processing systems,"* and *"critical thinking"* highlight the pedagogical and cognitive dimensions of this research trajectory, suggesting that the integration of GenAI into educational and reasoning tasks is an emerging focal point. By delineating these clusters and connections, the visualization underscores the dominant role of AI-driven linguistic models. It reveals how peripheral yet growing topics—such as *chain-of-thought reasoning, prompt engineering,* and *higher-order thinking skills* are shaping new frontiers of inquiry. This structured mapping thus advances understanding of the field's intellectual architecture and provides researchers with a scaffold to situate future investigations.

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What Is Co-Authorship by Countries' Collaboration?

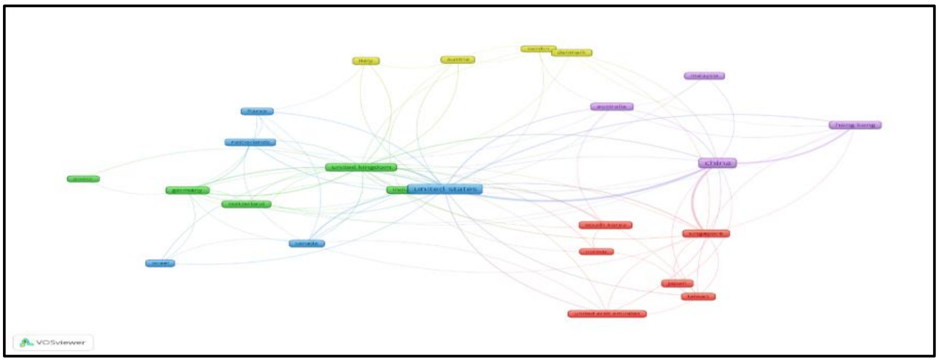

Figure 5: Network Visualisation Map of Author's Collaboration by Country

The co-occurrence co-authorship by countries in VOSviewer illustrates how nations collaborate in scholarly publishing by mapping the frequency and strength of their joint publications. In this context, each country represents a node, and connections between them indicate co-authorship ties, with stronger links reflecting more intensive collaboration. Using the full counting method with a minimum threshold of five publications, the analysis included 83 countries, of which 27 met the criteria. To further refine the visualization, a minimum cluster size of five was applied, resulting in five clusters of countries grouped according to their collaborative patterns. This approach allows for the identification of international networks, highlighting the most prolific countries in terms of output and how they engage with one another to shape global discourse on GenAI and critical thinking in education.

Consequently, the results reveal significant insights into the structure of global collaboration. The United States (221 documents, 9,419 citations, total link strength 129) and China (238 documents, 1,199 citations, link strength 114) dominate in both influence and productivity, underscoring their leadership in advancing research at this intersection. The United Kingdom, Hong Kong, Singapore, and Germany form strong secondary hubs with notable cross-national connections, suggesting active roles in bridging collaborations between leading and emerging research regions. Countries such as Canada, Australia, India, and the Netherlands contribute modestly in volume but serve as important nodes of international linkage. Interestingly, nations such as Malaysia, Indonesia, and the Russian Federation appear in the dataset but exhibit weaker or no collaborative ties, highlighting the need for stronger integration into global research networks. Overall, these patterns underscore the centrality of established research powers in shaping the discourse, while also highlighting opportunities for greater South–South collaboration and regional partnerships to diversify and enrich the body of knowledge in GenAI and critical thinking research.

Conclusion

This study set out to map a study on GenAI and critical thinking in education by analyzing publication trends, citation impact, keyword networks, and international collaborations. The findings confirm a steep rise in publications from 2023 onwards, driven by the release of large language models and their adoption in education. Highly cited works demonstrate that methodological innovations, such as chain-of-thought prompting, have established the technical foundation, while recent educational studies indicate a growing attention to critical thinking skills and classroom practices. Keyword clustering reveals seven thematic areas, with reasoning

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and pedagogy at the core, while country collaboration analysis highlights the dominance of the United States and China alongside emerging regional contributions.

The study adds to the field by clarifying the intellectual structure of this rapidly expanding domain and underscoring the interplay between technical innovation and educational application. The findings suggest that educators, policymakers, and researchers should critically engage with GenAI to support higher-order reasoning without fostering overreliance. Limitations include the restriction to a single database and English-only publications, which may underrepresent perspectives from other contexts. Future work should expand to multiple databases and include qualitative studies to explore classroom-level practices. In conclusion, bibliometric analysis proves essential in capturing how GenAI reshapes educational research, offering both a foundation for theoretical development and practical direction for its responsible integration into teaching and learning.

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