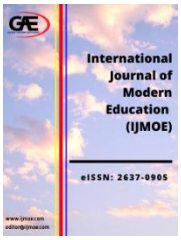
International Journal of Modern Education
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206



INTERNATIONAL JOURNAL OF MODERN EDUCATION (IJMOE)
www.gaexcellence.com/ijmoe

MAPPING ARTIFICIAL INTELLIGENCE–SUPPORTED SCAFFOLDING IN EDUCATION: A BIBLIOMETRIC ANALYSIS (2022–2026)

Siti Hajar Abd Hamid[1]*, Norah Md Noor[2]*, Noor Dayana Abd Halim[3]

[1]Department of Account, University of Technology Malaysia, Malaysia
siti83@graduate.utm.my https://orcid.org/0009-0001-7815-0389
[2]Department of Account, University of Technology Malaysia, Malaysia
norah@utm.my https://orcid.org/0000-0003-0051-0230
[3]Department of Account, University of Technology Malaysia, Malaysia
noordayana@utm.my https://orcid.org/0000-0003-3707-767X
*Corresponding Author

Article Info:

Article history:
Received date: 30.09.2026
Revised date: 15.10.2026
Accepted date: 04.11.2026
Published date: 01.12.2026

To cite this document:

Hamid, S. H. A., Noor, N. M., & Halim, N. D. A. (2026). Mapping Artificial Intelligence–Supported Scaffolding in Education: A Bibliometric Analysis (2022–2026). *International Journal of Modern Education, 8*(32), 193-206.

DOI: 10.35631/IJMOE.832011

Abstract:

Research on Artificial Intelligence (AI)-supported scaffolding in education has expanded rapidly, yet a systematic overview of its development remains limited. This study conducts a bibliometric analysis to map publication trends, influential studies, research themes, and collaboration patterns in this field. Data were collected using advanced Scopus searches, yielding 370 journal articles (2022-2026). Scopus Analyzer, OpenRefine, and VOSviewer were employed for statistical analysis, data cleaning, and visualization. The findings reveal accelerated growth, dominant thematic clusters around generative AI and scaffolding, and concentrated international collaboration, highlighting emerging directions for future educational research and practice.

Keyword:

Artificial Intelligence, Bibliometric Analysis, Scaffolding

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

© The authors (2026). This is an Open Access article distributed under the terms of the Creative Commons Attribution (CC BY NC) (http://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact ijmoe@gaexcllence.com.

Introduction

The increasing integration of digital technologies in education has significantly transformed teaching and learning, emphasizing the need for instructional approaches that effectively support learner development. Contemporary educational discourse underscores the significance of providing structured guidance to help learners progressively develop cognitive, metacognitive, and problem-solving skills. In this regard, scaffolding has long been a key pedagogical strategy, enabling learners to shift from assisted learning to independent knowledge construction. As educational environments continue to evolve, there is growing interest in enhancing traditional scaffolding practices through innovative technological solutions.

Artificial Intelligence (AI) has emerged as a transformative force in education, offering new possibilities for adaptive, personalized scaffolding. AI-supported scaffolding leverages data-driven algorithms, intelligent tutoring systems, and learning analytics to provide timely feedback, customized learning support, and dynamic instructional adjustments based on learners' needs. Unlike conventional scaffolding, which is often limited by time and instructor capacity, AI-enabled scaffolding can operate continuously and at scale, supporting diverse learners across digital and blended learning environments. Consequently, research on AI-supported scaffolding has expanded rapidly, particularly within the social sciences. This reflects its growing relevance to pedagogical design, learner engagement, and educational effectiveness.

Despite the increasing volume of studies in this area, existing research remains fragmented, with limited synthesis of publication trends, thematic focus, and knowledge structures related to AI-supported scaffolding in education. This lack of a comprehensive overview makes it challenging to identify dominant research themes, emerging directions, and potential gaps within the literature. This gap is addressed in the current research by conducting a bibliometric analysis of Scopus-indexed journal articles published between 2022 and 2026 on AI-supported scaffolding in education. By systematically mapping this research landscape, the study is guided by the following Research Questions (RQs):

- RQ1. What are the publication trends and growth patterns of research on AI-supported scaffolding in education from 2022 to 2026?
- RQ2. Which articles are the most influential, based on citation impact, in the field of AI-supported scaffolding in education?
- RQ3. Which countries are the leading contributors to research on AI-supported scaffolding in education in terms of publication output?
- RQ4. What are the most frequently occurring and prominent keywords that characterize research on AI-supported scaffolding in education?

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

- RQ5. What are the patterns of international collaboration among countries in research on AI-supported scaffolding in education, as revealed through co-authorship analysis?.

Literature Review

Recent studies demonstrate that AI-supported writing tools offer substantial potential for enhancing academic writing when implemented within pedagogically sound frameworks. Research indicates that AI-based feedback systems can improve students' essay organization, language proficiency, and writing clarity across various educational levels (Li & Wilson, 2025; Weda & De Vega, 2024). Investigations into digital writing assistance and generative AI tools, particularly ChatGPT, reveal that these technologies can support iterative writing and provide immediate formative feedback that helps students refine their work (Hermanns, 2021; Reddy et al., 2024). However, practical concerns remain regarding citation accuracy, content similarity, and the potential for over-reliance on AI-generated suggestions (Keller & Hermanns, 2023; Mahalingam et al., 2019). Together, these findings suggest that while AI tools can enhance writing instruction, their effectiveness depends heavily on thoughtful integration within existing pedagogical frameworks that maintain student autonomy and critical engagement with content.

Effectively integrating AI into writing instruction requires careful attention to the teacher's facilitative role in managing student interactions with AI tools. Studies emphasize that AI should function as a supporting tool rather than a replacement for critical thinking and human creativity. Accordingly, hybrid approaches combining traditional instruction with AI-based feedback show promise for fostering inquiry-based learning environments (Katsenou et al., 2025; Kinto-Ramirez et al., 2025). While AI-supported writing can improve short-term learning outcomes, concerns regarding dependency and reduced cognitive challenge require cautious implementation of pedagogical strategies that preserve intellectual rigor (Deep & Chen, 2025; Kong et al., 2024). In line with this, teachers play an essential preventive and regulatory function by critically examining AI-generated outputs and using them to reinforce students' writing skills without impeding autonomy through excessive reliance on technological support. This balanced approach ensures that AI tools serve as scaffolds for learning rather than shortcuts that bypass essential cognitive processes.

Current research highlights significant ethical and technological concerns surrounding AI use in academic writing, particularly regarding originality, idea quality, and potential reductions in critical thinking. These challenges require the adoption of substantial ethical frameworks and implementation of progressive support-fading strategies to ensure long-term skill retention (Berber et al., 2025; Iyamuremye et al., 2024). Academic integrity threats, including plagiarism and contract cheating, are becoming increasingly evident as AI-generated content becomes more sophisticated and difficult to distinguish from authentic student work, particularly in STEM disciplines (Erümit & Sarıalioğlu, 2025). Notably, short-term findings suggest potential benefits of AI-assisted writing support across disciplines. However, considerable research gaps remain regarding enduring learning effects, appropriate support-fading strategies, and discipline-specific assessment approaches. Most existing studies focus on general academic writing support with limited attention to the unique requirements of disciplinary writing, such as evidence-based argumentation in scientific contexts or discipline-specific reasoning patterns (Li & Wilson, 2025; Tawfik et al., 2018; Vo et al., 2025). This gap underscores the need for bibliometric analyses that systematically map the research landscape and identify trends in AI

International Journal of Modern Education
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

for writing research. It further highlights opportunities to develop targeted, discipline-specific applications that address the particular demands of various academic fields.

Methodology

Bibliometric analysis refers to the systematic collection, management, and examination of bibliographic data from scientific publications to identify research patterns, trends, and intellectual structures within a specific field (Verbeek et al., 2002). This approach combines descriptive statistical techniques, such as publication output, citation counts, and authorship analysis, with more advanced bibliometric methods to provide a comprehensive overview of a research domain (Wu & Wu, 2017). Bibliometric analysis is particularly suitable for mapping emerging and rapidly expanding research areas, such as AI-supported scaffolding in education, where large volumes of scholarly literature require systematic synthesis.

Data Search Strategy

This study employed Scopus as the primary database for data collection due to its extensive coverage of peer-reviewed journals in the social sciences and education, as well as its robustness for bibliometric research (Aghaei Chadegani et al., 2013). Scopus provides comprehensive bibliographic metadata, including citation information, author affiliations, and keyword indexing, which are essential for bibliometric mapping and network analysis. To ensure the relevance and quality of the retrieved literature, this study included only journal articles published in English within the Social Sciences (SOCI) subject area. Conference papers, reviews, books, book chapters, and other non-article document types were excluded.

An advanced search was conducted in Scopus using predefined search strings and selection criteria, as summarized in Table 1 and Table 2.

Table 1: The Search String

SCOPUS	**TITLE-ABSTITLE-ABS-KEY ((“ai” OR “artificial intelligence”) AND (“scaffolding” OR “scaffold”)) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2025) OR LIMIT-TO (PUBYEAR , 2026)) AND (LIMIT-TO (SUBJAREA , “SOCI”)) AND (LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”)) **

Table 2: Selection Criteria for the Search

Criterion	Inclusion	Exclusion
Language	English	Non-English
Subject	Social Science	Others
Document Type	Article	Conference paper, Review, Book chapter, Editorial, Note, Letter, Erratum
Timeline	2022-2026	<2022

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

Data Analysis

The bibliographic data were retrieved from the Scopus database in PlainText format, including publication year, article title, authors, source journals, citations, author affiliations, and keywords. The dataset comprised 370 journal articles published between 2022 and 2026, which were subsequently analyzed using VOSviewer software (version 1.6.15). VOSviewer was used for its effectiveness in bibliometric mapping and visualizing large-scale scientific literature through network-based analysis.

VOSviewer applies Visualization of Similarities (VOS) mapping and clustering techniques, which position items in a low-dimensional space to ensure that the distance between any two items accurately reflects their degree of relatedness (Van Eck & Waltman, 2010). Unlike traditional Multidimensional Scaling (MDS), which relies on similarity measures such as cosine similarity or Jaccard indices, VOSviewer utilizes a more robust normalization method for co-occurrence data, known as the Association Strength (AS) (Van Eck & Waltman, 2007). The AS between two items i and j is calculated as:

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

where C_{ij}represents the number of co-occurrences between items i and j, and $W_i$and $W_j$denote the total occurrences of items i and j, respectively. This normalization allows VOSviewer to generate bibliometric maps by minimizing the weighted sum of squared distances between all item pairs. In this study, LinLog/modularity normalization was applied to enhance the clarity and interpretability of network structures (Appio et al., 2016).

To address the RQs, several bibliometric analyses were conducted. Temporal publication analysis examined yearly publication trends. Citation analysis identified the most influential articles by citation count, while keyword co-occurrence analysis revealed dominant research themes and emerging topics related to AI-supported scaffolding in education (Zhao, 2017; Li et al., 2016). In addition, country-level co-authorship analysis was conducted to explore patterns of international research collaboration. Together, these analyses provide a comprehensive mapping of the intellectual structure, thematic focus, and collaborative landscape of research on AI-supported scaffolding in education.

Results and Discussion

The data collected in this study were systematically analyzed and interpreted to address five RQs.

Temporal Publication Trends and Growth Patterns

The pattern of research publications on AI-supported scaffolding in education from 2022 to 2026 demonstrates a rapid yet uneven growth. In the early phase of the study, particularly in 2022 and 2023, the number of publications remained relatively moderate, reflecting the initial stage of scholarly engagement in this research area.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

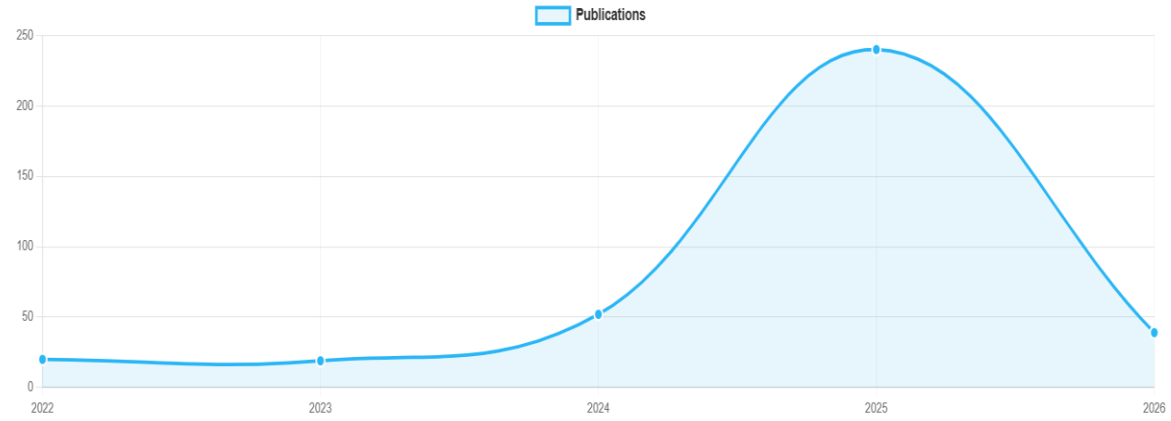


Figure 1: Temporal Publication Trends of Research on AI-Supported Scaffolding in Education (2022-2026)

The temporal analysis of publications reveals a rapid yet uneven growth pattern in research on AI-supported scaffolding in education from 2022 to 2026. As illustrated in Figure 1, the number of publications remained relatively modest during the early years of the period, particularly in 2022 and 2023, indicating an initial exploratory phase of scholarly interest in this research domain. Publication output increased noticeably from 2024 onward, followed by a sharp surge in 2025, suggesting heightened academic engagement driven by the expanding adoption of AI technologies in educational scaffolding practices. Although a decline is evident in 2026, this may reflect partial coverage of publications for the year at the time of data retrieval. Overall, the trend reflects the growing prominence and accelerating development of AI-supported scaffolding as an emerging research area within education.

Most Influential Articles Based on Citation Impact

The citation analysis reveals a group of highly influential publications that have substantially shaped research on AI-supported scaffolding in education. As presented in Table 3, the most cited study is Kim et al. (2022), which examines learning design approaches to support student-AI collaboration, accumulating 413 citations. This is followed by Darvishi et al. (2024), with 271 citations, which focuses on the impact of AI assistance on student agency. Another work by Kim et al. (2022) explored teachers' perceptions of AI-based tools for scientific writing. These highly cited studies indicate that early conceptual and empirical investigations into AI-supported instructional scaffolding have played a central role in shaping the field's research agenda.

Table 3: Most Cited Publications in AI-Supported Scaffolding in Education

No.	Authors	Title	Source title	Cited by
1	Kim et al. (2022)	Learning design to support student–AI collaboration: Perspectives of leading teachers for AI in education	Education and Information Technologies	413
2	Darvishi et al. (2024)	Impact of AI assistance on student agency	Computers & Education	271

3	Kim et al. (2022)	Teachers' perceptions of using an artificial intelligence–based educational tool for scientific writing	Frontiers in Education	196
4	Ng et al. (2022)	Using digital story writing as a pedagogy to develop AI literacy among primary students	Computers and Education: Artificial Intelligence	173
5	Guo et al. (2022)	Using chatbots to scaffold EFL students' argumentative writing	Assessing Writing	156
6	Loeffler et al. (2024)	Reinvent 4: Modern AI-driven generative molecule design	Journal of Cheminformatics	154
7	Fan et al. (2025)	Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance	British Journal of Educational Technology	148
8	Chen et al. (2023)	Integrating generative AI in knowledge building	Computers and Education: Artificial Intelligence	106
9	Li et al. (2024)	Expert or machine? Comparing the effect of pairing student teachers with in-service teachers and ChatGPT on critical thinking, learning performance, and cognitive load in an integrated STEM course	Asia Pacific Journal of Education	74
10	Li et al. (2023)	Effects of a ChatGPT-based flipped learning guiding approach on learners' courseware project performances and perceptions	Australasian Journal of Educational Technology	73

The remaining influential articles further highlight the diversity of educational contexts and pedagogical applications within this research area. Several studies emphasize AI-supported scaffolding in writing and literacy development, such as digital storytelling, chatbots, and flipped learning approaches, while others focus on learner cognition, motivation, and critical thinking in AI-enhanced learning environments. Notably, a substantial proportion of the most cited publications were published between 2022 and 2024, demonstrating the rapid accumulation of citation impact within a relatively short period. In general, these findings suggest that research on AI-supported scaffolding is driven by a core set of impactful studies that emphasize learner-AI interaction, pedagogical design, and the educational implications of generative AI technologies.

Leading Contributing Countries by Publication Output

The analysis of country-level publication output reveals that research on AI-supported scaffolding in education is dominated by a small number of leading countries. As presented in Table 4, the United States emerged as the most productive contributor with 85 publications, followed closely by China with 79 publications. Other prominent contributors include Taiwan,

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

Hong Kong, and Australia, indicating strong research activity in both Western and Asia-Pacific regions. In terms of citation impact, the United States and Hong Kong recorded particularly high citation counts, suggesting high research productivity and substantial scholarly influence within the field.

Table 4: Leading Contributing Countries in AI-Supported Scaffolding Research by Publication Output and Citations

No.	Country	Number of Publications	Citations
1	United States	85	1,065
2	China	79	618
3	Taiwan	35	252
4	Hong Kong	32	798
5	Australia	26	637
6	United Kingdom	22	279
7	South Korea	19	475
8	Indonesia	13	82
9	Germany	12	93
10	Malaysia	12	102

Figure 2 further illustrates the global distribution of publication output across countries. The geographical visualization highlights a concentration of research activity in North America, East Asia, and Oceania, with notable contributions from Europe and Southeast Asia. Countries such as the United Kingdom, South Korea, Indonesia, Germany, and Malaysia also demonstrate meaningful participation, reflecting broader international engagement in this research domain. Overall, the findings suggest that while AI-supported scaffolding research is globally distributed, it remains driven by a core group of countries with strong research infrastructure and growing interest in AI-enhanced educational practices.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

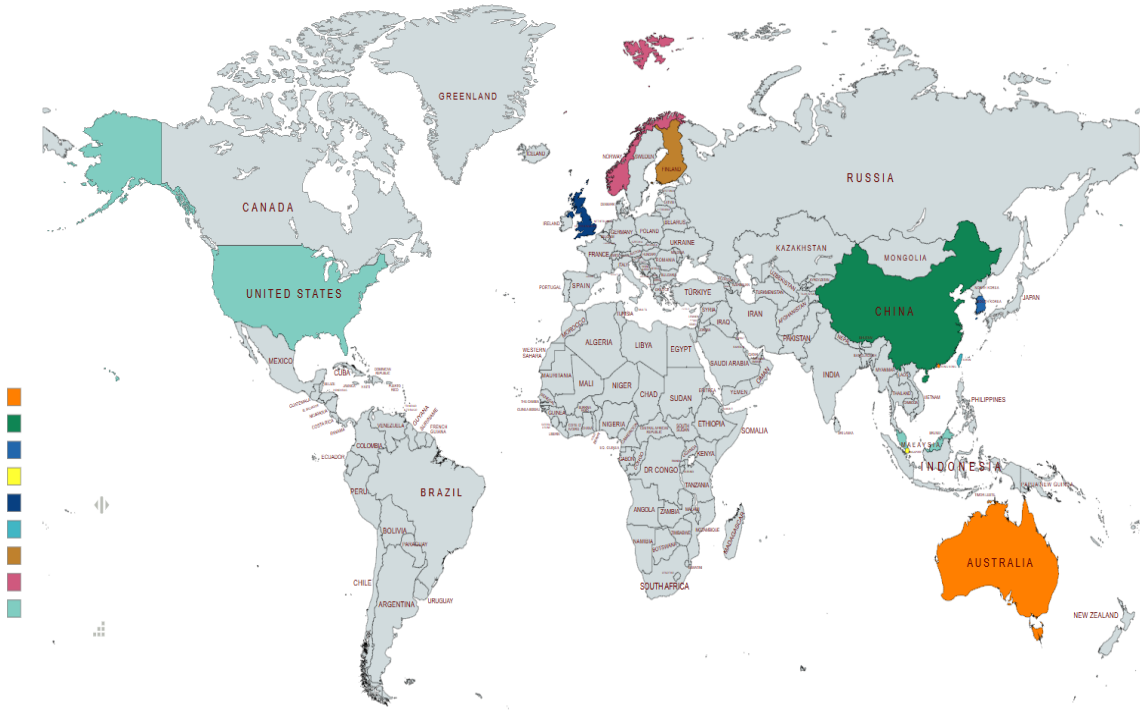


Figure 2: Global Distribution of Publication Output on AI-Supported Scaffolding in Education

Prominent Keywords in Artificial Intelligence-Supported Scaffolding Research

Keyword co-occurrence analysis using VOSviewer is a bibliometric technique that examines the conceptual structure of a research field by identifying patterns of keywords that frequently appear together in the same publications. This method assumes that keywords with higher co-occurrence frequencies represent closely related concepts or shared research themes. In the generated network visualization, each node represents a keyword. The size of the node indicates its frequency of occurrence, and the links between nodes reflect the strength of co-occurrence relationships, measured as total link strength. The formation of clusters, represented by different colors, highlights major thematic groupings within research on AI-supported scaffolding in education.

To generate the keyword co-occurrence map, the analysis used the full counting method, in which each keyword occurrence is counted equally across publications. A minimum occurrence threshold of five was applied to ensure that only relevant and frequently used keywords were included in the analysis. As a result, 65 keywords were selected from an initial pool of 864, allowing the visualization to focus on dominant concepts while reducing noise from infrequently occurring terms. This filtering process enabled clearer identification of central research themes and their interrelationships within the literature.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

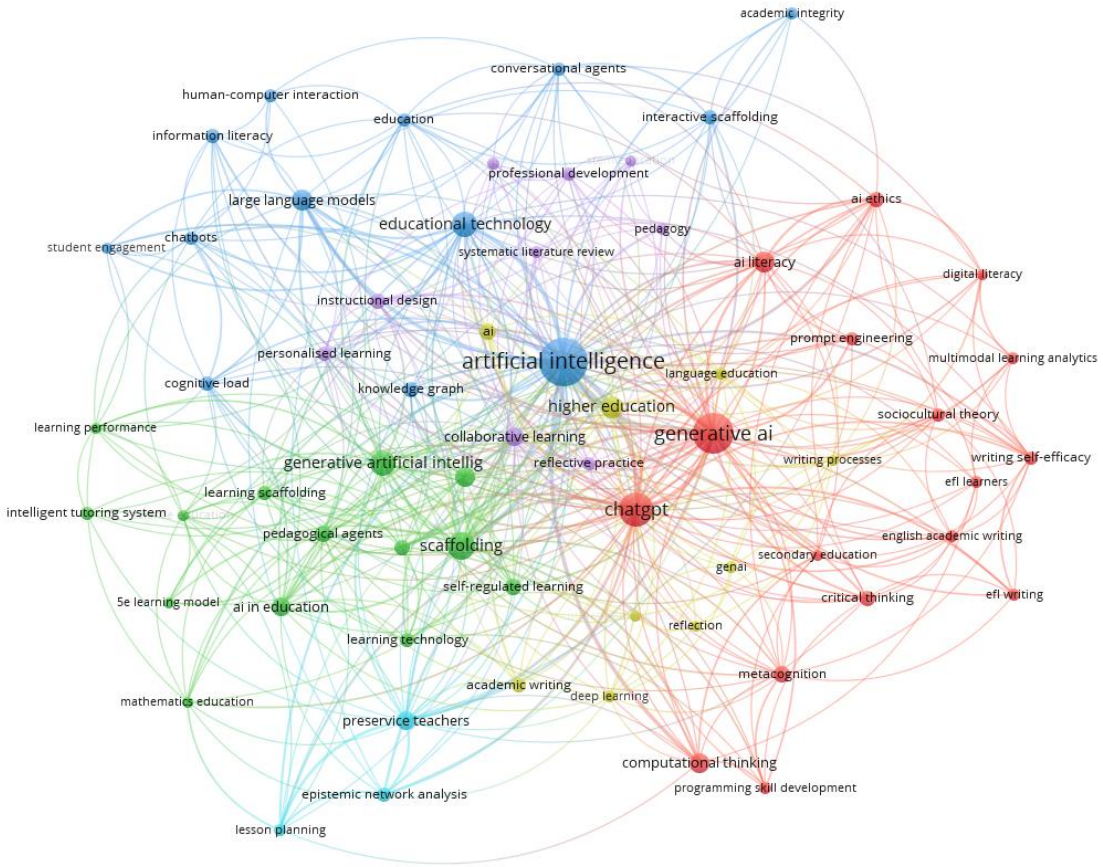


Figure 3: Network Visualization of Keyword Co-occurrence in AI-Supported Scaffolding Research

The keyword co-occurrence analysis contributes to the body of knowledge by revealing the dominant themes and emerging research directions in AI-supported scaffolding in education. High-frequency, centrally positioned keywords such as *artificial intelligence*, *generative AI*, *ChatGPT*, *scaffolding*, and *educational technology* imply a strong emphasis on AI-driven instructional support and generative technologies. Additionally, keywords related to *AI literacy*, *learning analytics*, *self-regulated learning*, *critical thinking*, and *AI ethics* reflect increasing scholarly attention to cognitive, ethical, and skill-based dimensions of AI integration in education. In essence, this analysis provides a systematic understanding of how research themes are interconnected and evolving, offering valuable insights for future studies and the development of AI-enhanced scaffolding practices.

International Collaboration Patterns Based on Country Co-authorship

Country-level co-authorship analysis was conducted using VOSviewer to examine patterns of international research collaboration in studies on AI-supported scaffolding in education. In this network, each node represents a country, with node size indicating publication output and links reflecting collaborative relationships between countries, measured by total link strength. Figure 4 illustrates the international co-authorship network, suggesting how countries are interconnected through joint research activities and revealing the structural configuration of global collaboration within this research domain.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

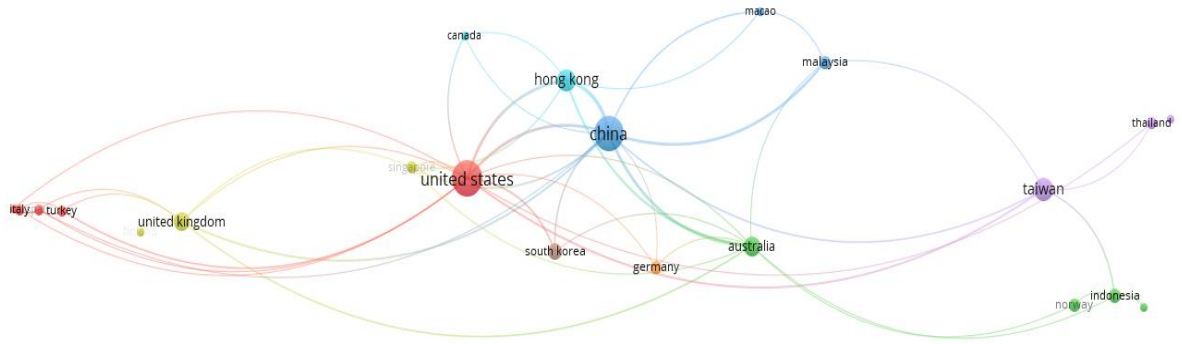


Figure 4: International Co-authorship Network of Research on AI-Supported Scaffolding in Education

To generate this co-authorship network, the analysis used the full counting method, in which each country appearing in a publication was counted equally, regardless of the number of co-authors. A minimum threshold of five documents was applied to ensure that only countries with sustained research contributions were included in the analysis. As a result, 23 countries were selected from an initial pool of 59, allowing the visualization to focus on meaningful and stable collaboration patterns while reducing the influence of marginal contributors. This methodological setting improves interpretability by highlighting countries that play a substantive role in international research collaboration.

Building on this network structure, the findings contribute to the body of knowledge by revealing an increasingly interconnected global research landscape in AI-supported scaffolding in education. Countries such as the United States and China emerge as central collaboration hubs, combining high publication output with strong international linkages. At the same time, regions including Hong Kong, Australia, Taiwan, and the United Kingdom serve as important connectors within the network. At the same time, several countries exhibit moderate publication activity yet weaker collaborative ties, indicating potential opportunities for expanding cross-national partnerships. Overall, this analysis underscores the importance of international collaboration in advancing research on AI-supported scaffolding. It further highlights how global knowledge production in this field is shaped by a core group of highly connected countries.

Conclusion

This bibliometric analysis aimed to map the research landscape of AI-supported scaffolding in education by examining publication trends, influential articles, leading contributing countries, prominent research themes, and international collaboration patterns between 2022 and 2026. By addressing five RQs, the study provided a systematic overview of how scholarly work in this area has developed over time and how knowledge production is structured across themes and geographical regions.

The findings indicate a rapid yet uneven growth in publication output, with a notable increase in recent years, reflecting heightened academic interest in the educational applications of AI. Citation analysis revealed that a relatively small number of studies have substantially shaped research directions, particularly in areas related to learner-AI interaction, instructional design,

writing support, and learner agency. Keyword co-occurrence analysis highlighted core themes such as generative AI, scaffolding, educational technology, higher education, and self-regulated learning, alongside emerging concerns related to ethics, critical thinking, and AI literacy. In addition, country-level analyses indicated that research productivity and collaboration are concentrated among a limited number of countries, while international co-authorship patterns demonstrate an increasingly interconnected yet uneven global research network.

Overall, this study contributes to the field by consolidating fragmented literature into a coherent bibliometric overview that clarifies key trends, thematic orientations, and collaboration structures in AI-supported scaffolding research. The findings offer useful insights to guide future research, inform pedagogical development, and support more balanced international collaboration. Although database scope and methodological constraints inherent to bibliometric approaches limited the analysis, it establishes a foundation for subsequent studies that may incorporate broader data sources, extended timeframes, or qualitative perspectives. Continued systematic mapping and empirical investigation remain essential for advancing understanding and responsible implementation of AI as a scaffold for learning in educational contexts.

Acknowledgements:	This study was supported by the Ministry of Education Malaysia under the Hadiah Latihan Persekutuan (HLP) scheme.
Funding Statement:	This research received no specific research grant funding.
Conflict of Interest Statement:	The authors declare that there are no conflicts of interest regarding the publication of this manuscript.
Ethics Statement:	This study was based exclusively on bibliographic data obtained from published scientific literature and did not involve human participants, animals, or the collection of personal or sensitive data. Therefore, ethical approval was not required. The research was conducted in accordance with accepted academic integrity and ethical publishing standards.
Author Contribution Statement:	The first author contributed to the conceptualization, methodology, data collection, bibliometric analysis, visualization, and preparation of the original manuscript. The co-authors contributed to the supervision, interpretation of findings, and critical review and editing of the manuscript. All authors read and approved the final version of the manuscript.
Declaration on the Use of Artificial Intelligence (AI)	The authors declare that ChatGPT (OpenAI) was used during the preparation of this manuscript to assist with language editing, grammar improvement, and sentence refinement. All AI-assisted content was reviewed and verified by the authors, who take full responsibility for the accuracy, originality, integrity, and final content of the manuscript.

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume: 8 Issue: 32 (December 2026) PP. 193-206

References

Berber, S., Brückner, M., Maurer, N., & Huwer, J. (2025). Artificial intelligence in chemistry research─Implications for teaching and learning. *Journal of Chemical Education, 102*(4), 1445–1456. https://doi.org/10.1021/acs.jchemed.4c01033

Deep, P. D., & Chen, Y. (2025). The role of AI in academic writing: Impacts on writing skills, critical thinking, and integrity in higher education. *Societies, 15*(9), Article 247. https://doi.org/10.3390/soc15090247

Erümit, A. K., & Sarıalioğlu, R. Ö. (2025). Artificial intelligence in science and chemistry education: A systematic review. *Discover Education, 4*(1), Article 622. https://doi.org/10.1007/s44217-025-00622-3

Hermanns, J. (2021). The task navigator following the STRAKNAP concept: Development, application, and evaluation of a new scaffold to support nonmajor chemistry students while solving tasks in organic chemistry. *Journal of Chemical Education, 98*(4), 1077–1087. https://doi.org/10.1021/acs.jchemed.0c01162

Iyamuremye, A., Niyonzima, F. N., Mukiza, J., Twagilimana, I., Nyirahabimana, P., Nsengimana, T., Habiyaremye, J. D., Habimana, O., & Nsabayezu, E. (2024). Utilization of artificial intelligence and machine learning in chemistry education: A critical review. *Discover Education, 3*(1), Article 197. https://doi.org/10.1007/s44217-024-00197-5

Katsenou, R., Kotsidis, K., Papadopoulou, A., Anastasiadis, P., & Deliyannis, I. (2025). Beyond assistance: Embracing AI as a collaborative co-agent in education. *Education Sciences, 15*(8), Article 1006. https://doi.org/10.3390/educsci15081006

Keller, D., & Hermanns, J. (2023). The digital task navigator as a scaffold for supporting higher education students while solving tasks in organic chemistry. *Journal of Chemical Education, 100*(10), 3818–3824. https://doi.org/10.1021/acs.jchemed.2c00518

Kinto-Ramirez, H., Yunes-Rojas, J. A., Nieto-Jalil, J. M., Morales-Nava, R., Sayeg-Sanchez, G., & Lozano-Aponte, J. (2025). Integrating narrative learning and AI for collaborative problem solving in engineering education. In *2025 6th International Conference of the Portuguese Society for Engineering Education* (CISPEE 2025). https://doi.org/10.1109/CISPEE64787.2025.11124044

Kong, S.-C., Lee, J. C.-K., & Tsang, O. (2024). A pedagogical design for self-regulated learning in academic writing using text-based generative artificial intelligence tools: 6-P pedagogy of plan, prompt, preview, produce, peer-review, portfolio-tracking. *Research and Practice in Technology Enhanced Learning, 19*, Article 030. https://doi.org/10.58459/rptel.2024.19030

Li, M., & Wilson, J. (2025). AI-integrated scaffolding to enhance agency and creativity in K-12 English language learners: A systematic review. *Information, 16*(7), Article 519. https://doi.org/10.3390/info16070519

Mahalingam, M., Morlino, E. A., & Fasella, E. (2019). The impact of technology-assisted "scaffolding" on student learning in general chemistry. *ACS Symposium Series, 1318*, 233–245. https://doi.org/10.1021/bk-2019-1318.ch015

Reddy, M. R., Walter, N. G., & Sevryugina, Y. V. (2024). Implementation and evaluation of a ChatGPT-assisted special topics writing assignment in biochemistry. *Journal of Chemical Education, 101*(7), 2740–2748. https://doi.org/10.1021/acs.jchemed.4c00226

Tawfik, A. A., Law, V., Ge, X., Xing, W., & Kim, K. (2018). The effect of sustained vs. faded scaffolding on students' argumentation in ill-structured problem solving. *Computers in Human Behavior, 87*, 436–449. https://doi.org/10.1016/j.chb.2018.01.035

Vo, K., Sarkar, M., White, P. J., & Yuriev, E. (2025). Exploring problem-solving scaffolds in general chemistry: A systematic review of scaffolding goals and instructional approaches. *Journal of Chemical Education, 102*(3), 1004–1018. https://doi.org/10.1021/acs.jchemed.4c01327

Weda, S., & De Vega, N. (2024). Artificial intelligence in writing instruction: A self-determination theory perspective. *XLinguae, 17*(1), 234–244. https://doi.org/10.18355/XL.2024.17.01.16