MAPPING RESEARCH TRENDS IN ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION: A BIBLIOMETRIC ANALYSIS

Norhazren Izatie Mohd[1*], Hamizah Liyana Tajul Ariffin[1], Tantish Kamaruddin[1], Nurshikin Mohamad Shukery[1], Fuziah Ismail[1], Siti Rahmah Omar[2], Hamidah Kamarden[3], Nur Hidayah Abd Rahman[4], Nur Emma Mustaffa[5]

[1] Department of Quantity Surveying, Universiti Teknologi Malaysia, Malaysia
    Email: norhazren@utm.my, hamizah@utm.my, b-tantish@utm.my, b-nurshikin@utm.my, b-fuziah@utm.my,
[2] Department of Landscape Architecture, Universiti Teknologi Malaysia, Malaysia
    Email: siti.rahmah@utm.my
[3] Department of Chemical Engineering, Universiti Teknologi Malaysia, Malaysia
    Email: hamidahkamarden@utm.my
[4] Management with Tourism Programme, Universiti Sains Islam Malaysia, Malaysia
    Email: nhidayah.ar@usim.edu.my
[5] Quantity Surveying Department, Tunku Abdul Rahman University of Management and Technology, Malaysia.
    Email: nuremma@tarc.edu.my
* Corresponding Author

Article Info:

Abstract:

The integration of Artificial Intelligence (AI) in higher education has undergone rapid evolution, prompting a growing body of scholarly interest that necessitates a comprehensive overview of research patterns and trends. This study aims to map and analyse global research developments in the field of AI within higher education through a bibliometric approach. Despite the increasing relevance of AI in shaping educational practices, a lack of consolidated analysis remains regarding how this domain has matured over time, who the major contributors are, and what thematic directions currently dominate research. To address this gap, we collected bibliographic data from the Scopus database, yielding a final dataset of 1,570 documents published between 2020 and 2025. Using Scopus Analyzer, OpenRefine for data cleaning, and VOSviewer for visualisation, we systematically examined publication trends, top contributing authors, countries, institutional collaborations, keyword co-occurrences, and citation patterns. Our findings reveal a significant surge in publications from 2023 onwards, with the United States, China, and India emerging as leading contributors. The most cited works focus on generative AI applications, such as ChatGPT, alongside ethical, pedagogical, and policy implications. Keyword analysis reveals dominant

themes centred around "*artificial intelligence*," "*higher education*," "*ChatGPT*," and "*teaching and learning*." Co-authorship mapping indicates strong international collaboration, particularly among Western and Asian research institutions. The results highlight the dynamic and interdisciplinary nature of AI research in higher education, underscoring the growing global academic interest in exploring its transformative potential. This study provides a foundational reference for educators, policymakers, and researchers aiming to understand the trajectory and future direction of AI applications in the academic landscape.

Keywords:

Artificial Intelligence, Higher Education, Bibliometric Analysis, VOSviewer

Introduction

Artificial Intelligence (AI) is increasingly being integrated into higher education, offering transformative potential across various domains. AI enhances the quality of education by providing personalised learning experiences, automating administrative tasks, and supporting research activities. For instance, AI technologies enable the creation of personalised academic plans and the automation of routine tasks, allowing educators to focus more on student engagement and skill development (Hassan et al., 2023; Kshetri, 2025; Vázquez-Madrigal et al., 2024). Additionally, AI-driven tools such as chatbots, virtual tutors, and intelligent tutoring systems are being employed to streamline administrative operations and improve student support (Khandelwaal et al., 2025; Kshetri, 2025). These advancements contribute to a more efficient and effective educational environment. However, challenges such as cost, scalability, and ethical considerations must also be addressed (Burke & Crompton, 2024).

The application of AI in higher education also extends to enhancing online and distance learning. AI algorithms are utilised to predict learning outcomes, recommend resources, and provide real-time feedback, thereby significantly enhancing the online learning experience (Baba et al., 2024; Ouyang et al., 2022). During the COVID-19 pandemic, AI played a crucial role in adapting to distance learning modalities, automating administrative tasks, and personalising learning to mitigate the loss of student knowledge (Lopez-Zevallos et al., 2025). Moreover, AI's ability to analyse large datasets enables the continuous improvement of educational processes and the development of adaptive learning environments (Batsurovska et al., 2024; Montebello, 2021). However, the successful implementation of AI in online education requires addressing privacy concerns, algorithmic bias, and ensuring equitable access to technology (Mehrfar et al., 2024).
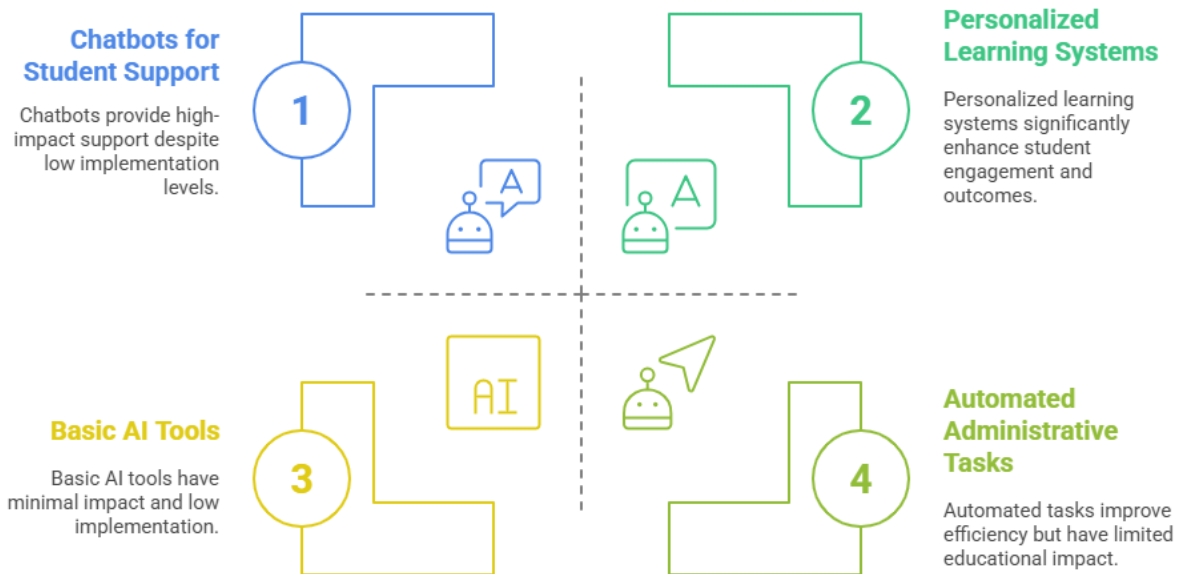
Chatbots for Student Support

Chatbots provide high-impact support despite low implementation levels.

1

2

Personalized Learning Systems

Personalized learning systems significantly enhance student engagement and outcomes.

Basic AI Tools

Basic AI tools have minimal impact and low implementation.

3

4

Automated Administrative Tasks

Automated tasks improve efficiency but have limited educational impact.

Figure 1: AI Integration in Higher Education

Despite the numerous benefits, the integration of AI in higher education is not without its challenges. Issues such as the digital divide, particularly in regions with limited access to technology, can hinder the effective use of AI. Additionally, the ethical implications of AI, including data privacy and the potential reduction of human interactions, need careful consideration (Burke & Crompton, 2024; Mehrfar et al., 2024). Institutions must develop guidelines and regulatory frameworks to ensure the ethical adoption and implementation of AI (Burke & Crompton, 2024). Furthermore, continuous innovation and empirical research are essential to maximise the potential of AI in enhancing educational outcomes and addressing the diverse needs of students (Baba et al., 2024; Ouyang et al., 2022). Overall, AI holds significant promise for the future of higher education, provided that its implementation is approached thoughtfully and inclusively.

Research Questions

RQ1 : What are the research trends in artificial intelligence in higher learning education according to the publication year?
RQ2 : What are the most cited articles?
RQ3 : What is the 10-country based on the number of publications?
RQ4 : What are the popular keywords related to the study?
RQ5 : What is the co-authorship by countries collaboration?

Methodology

Bibliometrics involves gathering, organising, and analysing bibliographic data from scientific publications (Alves et al., 2021; Assyakur & Rosa, 2022; Verbeek et al., 2002) beyond basic statistics, such as identifying publishing journals, publication years, and leading authors (Wu & Wu, 2017). Bibliometrics includes more sophisticated techniques, such as document co-citation analysis. Conducting a successful literature review requires a careful, iterative process to select suitable keywords, search the literature, and perform an in-depth analysis. This approach facilitates the compilation of a comprehensive bibliography and yields viable results (Fahimnia et al., 2015). With this in mind, the study focused on high-impact publications, as they provide meaningful insights into the theoretical frameworks that shape the research field. To ensure data accuracy, Scopus served as the primary source for data collection (Al-Khoury et al., 2022; di Stefano et al., 2010; Khiste & Paithankar, 2017). Additionally, to maintain quality, the study only considered articles published in peer-reviewed academic journals, deliberately excluding books and lecture notes (Gu et al., 2019). Using Elsevier's Scopus, known for its broad coverage, publications were collected from 2020 through December 2023 for further analysis.

Data Search Strategy

The study began with a screening process to identify appropriate search terms for retrieving relevant articles. Initially, a query string was formulated using the keywords "AI" and "education," which generated a total of 1,577 articles. This query was then refined to focus specifically on English-language journal articles published between 2020 and 2025, addressing the topic of AI. The revised search further narrowed the results to articles classified under the subject areas of Social Sciences. This systematic approach ensured the inclusion of recent, high-quality, and contextually relevant publications, ultimately yielding a final collection of 1,570 articles suitable for analysis.

Table 1: The Search String

Scopus	TITLE (AI AND education) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (LANGUAGE, "English"))

Table 2: The Selection Criterion is Searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Subject	Social Sciences	Besides Social Sciences
Timeline	2020 – 2025	< 2021

Data Analysis

VOSviewer is a user-friendly bibliometric software developed by Nees Jan van Eck and Ludo Waltman at Leiden University, Netherlands (van Eck & Waltman, 2010a, 2017). Widely utilised for visualising and analysing scientific literature, the tool specialises in creating intuitive network visualisations, clustering related items, and generating density maps. Its versatility allows for the examination of co-authorship, co-citation, and keyword co-occurrence networks, providing researchers with a comprehensive understanding of research landscapes. The interactive interface, coupled with continuous updates, ensures efficient and dynamic exploration of large datasets. VOSviewer's ability to compute metrics, customise

visualisations, and its compatibility with various bibliometric data sources make it a valuable resource for scholars seeking insights into complex research domains.

One of the standout features of VOSviewer is its capacity to transform intricate bibliometric datasets into visually interpretable maps and charts. With a focus on network visualisation, the software excels in clustering related items, analysing keyword co-occurrence patterns, and generating density maps. Researchers benefit from its user-friendly interface, enabling both novice and experienced users to explore research landscapes efficiently. VOSviewer's continuous development ensures it remains at the forefront of bibliometric analysis, offering valuable insights through metrics computation and customisable visualisations. Its adaptability to different types of bibliometric data, such as co-authorship and citation networks, positions VOSviewer as a versatile and indispensable tool for scholars seeking a deeper understanding and more meaningful insights within their research domains.

Datasets comprising information on the publication year, title, author name, journal, citation, and keywords in PlainText format were procured from the Scopus database, spanning the period from 2004 to December 2024. These datasets were then analysed using VOSviewer software version 1.6.19. Through the application of VOS clustering and mapping techniques, this software facilitated the examination and generation of maps. Offering an alternative to the Multidimensional Scaling (MDS) approach, VOSviewer focuses on situating items within low-dimensional spaces, ensuring that the proximity between any two items accurately reflects their relatedness and similarity (van Eck & Waltman, 2010b). In this respect, VOSviewer shares a similarity with the MDS approach (Appio et al., 2014). Diverging from MDS, which primarily engages in the computation of similarity metrics like cosine and Jaccard indices, VOS utilises a more fitting method for normalising co-occurrence frequencies, such as the Association Strength (ASij), and it is calculated as (Van Eck & Waltman, 2007):

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

which is "proportional to the ratio between, on the one hand, the observed number of co-occurrences of i and j and, on the other hand, the expected number of co-occurrences of i and j under the assumption that co-occurrences of i and j are statistically independent" (Van Eck & Waltman, 2007).

Findings

RQ1: What Are The Research Trends In Artificial Intelligence In Higher Learning Education According To The Publication Year?
The trend in publications on AI in higher education has demonstrated exponential growth over the past few years, with a significant spike in recent years. In 2020 and 2021, the number of publications was relatively low, at 18 and 43, respectively. This indicates that AI in education was still an emerging topic or limited to niche research interests. This gradual start suggests early-stage exploration, possibly due to limited practical applications, resources, or awareness in academic circles during that period.

A notable shift began in 2022 with 57 publications, followed by a significant surge in 2023 with 212 publications, accounting for 14% of the total. This surge likely corresponds with the widespread adoption and public discourse surrounding generative AI tools, such as ChatGPT,

which were introduced in late 2022. The acceleration of research reflects the academic community's growing interest in assessing the implications, challenges, and potential of AI technologies in the higher education landscape.

The momentum continues into 2024 and 2025, with 718 and 522 publications, respectively, making up a combined 79% of the total output. The peak in 2024 (46%) suggests that this year is the most prolific period for AI research in higher education to date, driven by increased funding, policy emphasis, and institutional prioritisation of digital transformation. Although 2025 is still in progress, its already substantial output (33%) implies the trend is ongoing, with sustained interest and possibly maturing research themes that now focus on ethical use, integration frameworks, and long-term educational impacts.

Table 3: Publications by Years from 2020 to 2025

Year	Total publication	Percentage (%)
2025	522	33%
2024	718	46%
2023	212	14%
2022	57	4%
2021	43	3%
2020	18	1%

RQ2:   What Are The Most Cited Articles?

Table 4 provides insight into the top 10 most cited authors in the context of generative AI in education, based on Scopus data. Lim W.M. and colleagues top the list with 661 citations for their work discussing the paradoxical impact of generative AI on education, reflecting significant scholarly engagement. Closely following is Chan C.K.Y., with two high-impact articles, one focused on student perceptions (577 citations) and the other on AI policy education frameworks (498 citations), indicating their prominent role in shaping the discourse around AI integration in higher education.

A recurring theme among these highly cited works is the critical evaluation of generative AI tools, such as ChatGPT, and their potential to revolutionise, challenge, or enhance educational practices. For instance, authors such as Grassini and Adiguzel et al. explore both the transformative potential and the ethical implications of adopting AI in academic settings. The publication venues, ranging from the International Journal of Educational Technology in Higher Education to Education Sciences and IEEE EDUCON, demonstrate an interdisciplinary interest and suggest that AI in education is a global concern that spans management, engineering, and teaching fields.

Furthermore, the list features collaborative and community-oriented perspectives, especially in the works of Holmes W. and colleagues, who contributed to both ethical frameworks and the broader state of AI in education. The consistent citation figures (ranging from 302 to 661) across diverse topics, such as ethics, policy, pedagogy, and technological challenges, reflect a growing academic consensus on the importance of responsible and inclusive AI integration. This trend highlights the critical need for continued research, collaborative dialogue, and the establishment of standardised guidelines in AI-assisted education.

Table 4: The Top 10 Most Cited Authors

Sources	Title	Source title	Cited by
(Lim et al., 2023)	Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators	International Journal of Management Education	661
(Chan & Hu, 2023)	Students' voices on generative AI: perceptions, benefits, and challenges in higher education	International Journal of Educational Technology in Higher Education	577
(Chan, 2023)	A comprehensive AI policy education framework for university teaching and learning	International Journal of Educational Technology in Higher Education	498
(Grassini, 2023)	Shaping the Future of Education: Exploring the Potential and Consequences of AI and ChatGPT in Educational Settings	Education Sciences	437
(Rudolph et al., 2023)	War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. The new AI gold rush and its impact on higher education	Journal of Applied Learning and Teaching	421
(Adiguzel et al., 2023)	Revolutionising education with AI: Exploring the transformative potential of ChatGPT	Contemporary Educational Technology	413
(Qadir, 2023)	Engineering Education in the Era of ChatGPT: Promise and Pitfalls of Generative AI for Education	IEEE Global Engineering Education Conference, EDUCON	380
(Holmes et al., 2022)	Ethics of AI in Education: Towards a Community-Wide Framework	International Journal of Artificial Intelligence in Education	350
(Michel-Villarreal et al., 2023)	Challenges and Opportunities of Generative AI for Higher Education as Explained by ChatGPT	Education Sciences	321
(Holmes & Tuomi, 2022)	State of the art and practice in AI in education	European Journal of Education	302

RQ3: What Is The 10-Country Based On The Number Of Publications?

The data from the Scopus analyser highlights the global research distribution in the domain of AI in education, with the United States (U.S.) leading significantly, accounting for 358 publications. This suggests a strong research infrastructure and sustained investment in educational technology and AI integration by American institutions. Following the U.S., China (183) and India (155) also demonstrate robust research activity, indicating their growing

influence and commitment to advancing AI applications in education, likely driven by their large academic populations and national strategies emphasising digital transformation.

The United Kingdom (131) and Australia (76) also feature prominently, reflecting their proactive roles in educational innovation and their involvement in global AI discourse. Regions like Hong Kong (62) and Germany (59) maintain a solid presence, which could be attributed to their emphasis on research excellence and collaboration with international institutions. Interestingly, the representation of the United Arab Emirates (UAE) (51) highlights the Middle East's emerging investment in AI, likely tied to national visions such as the UAE's AI Strategy 2031. Canada's presence with 49 publications further emphasises the country's active role in tech-enhanced learning and ethical AI development.

Although Malaysia is at the bottom of the list with 47 publications, its inclusion among the top ten signifies growing interest and participation in the global AI education research landscape. This can be attributed to regional policies that encourage digital education and the efforts of local universities to engage with AI technologies. As Malaysia continues to develop its research capacity and invest in higher education, it holds the potential to increase its influence in the AI and education research space, primarily through regional collaborations and a focus on context-specific challenges and applications.
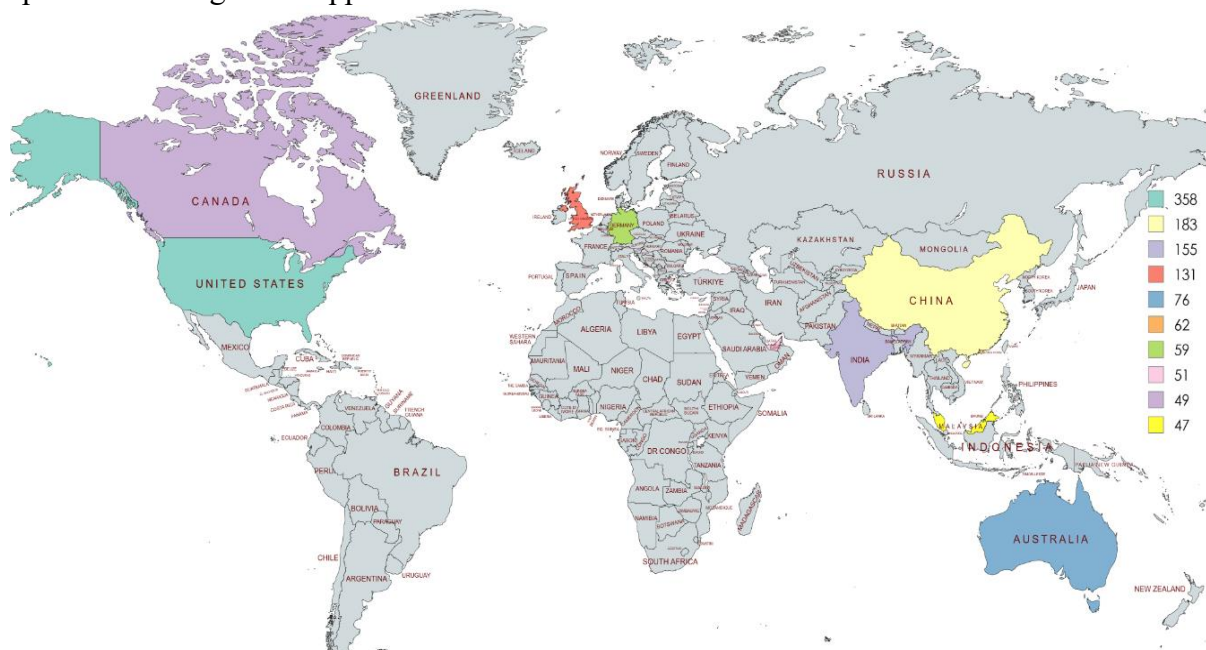

Figure 2: Top 10 Countries Based On The Number Of Publications

RQ4: *What Are The Popular Keywords Related To The Study?*

Based on the VOSviewer analysis, the keyword with the highest occurrence is "*artificial intelligence*", reflecting its centrality in the research field. Closely linked terms include "*higher education*", "*ChatGPT*", and "*teaching and learning*", indicating a strong thematic focus on the application of AI tools in academic contexts. This underscores that researchers are particularly interested in how AI tools, especially generative AI, can transform the way teaching is delivered and how students learn within university environments.

The total link strength associated with keywords such as "*ChatGPT*", "*ethics*", "*policy*", and "*curriculum*" suggests that these concepts are frequently mentioned and are highly interconnected with other keywords within the network. This demonstrates a research trend that goes beyond mere adoption of technology. Scholars are actively exploring the implications, challenges, and structural adjustments necessary to integrate AI meaningfully and responsibly in educational systems. Ethical considerations and policy development are, therefore, emerging as critical subthemes.

Another pattern evident from the data is the clustering of keywords around innovation in pedagogy and digital transformation, such as "*online learning*", "*student engagement*", and "*learning analytics*". These clusters imply a growing body of work that investigates how AI technologies can be leveraged to personalise learning experiences, enhance assessment methods, and optimise educational outcomes. In summary, the keyword map reveals a maturing research landscape focused on both the technological potential and the pedagogical, ethical, and institutional implications of AI in higher education.
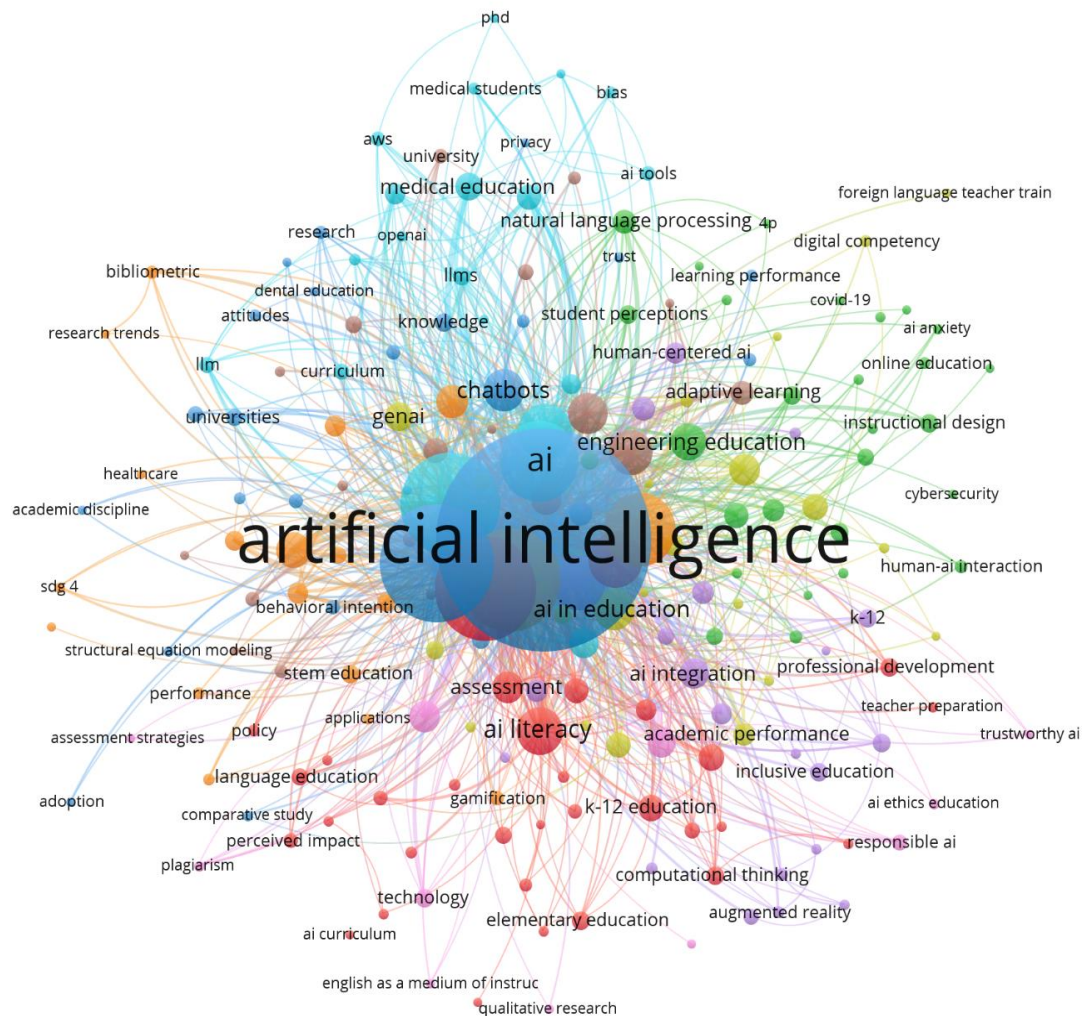

Figure 3: The popular keywords related to AI in higher learning education

RQ5: What Is The Co-Authorship By Countries Collaboration?

The VOSviewer analysis of co-authorship by countries highlights significant international collaboration in the field of AI in higher education. The U.S. leads with the highest occurrence and total link strength, indicating that it contributes the most research output and maintains strong collaborative ties with many other countries. Other prominently connected nations include China, the United Kingdom, and Australia, suggesting that these countries are central nodes in the global AI education research network.

The total link strength metric reflects the depth and frequency of collaborations rather than just the volume of publications. Countries such as Canada, Germany, and India demonstrate substantial link strengths, signifying that they play important roles as research partners, even if their publication counts may not be the highest. This reveals a trend of cross-border research that likely enhances the quality, reach, and applicability of findings in this rapidly evolving field.

Interestingly, the presence of emerging countries, such as the UAE and Malaysia, in the co-authorship network suggests a growing global interest and inclusiveness in AI-related educational research. These nations may be leveraging partnerships with more established research hubs to build local capacity and contribute region-specific perspectives. Overall, the co-authorship patterns reflect a well-connected, increasingly internationalised scholarly community working toward understanding and implementing AI in higher education systems.
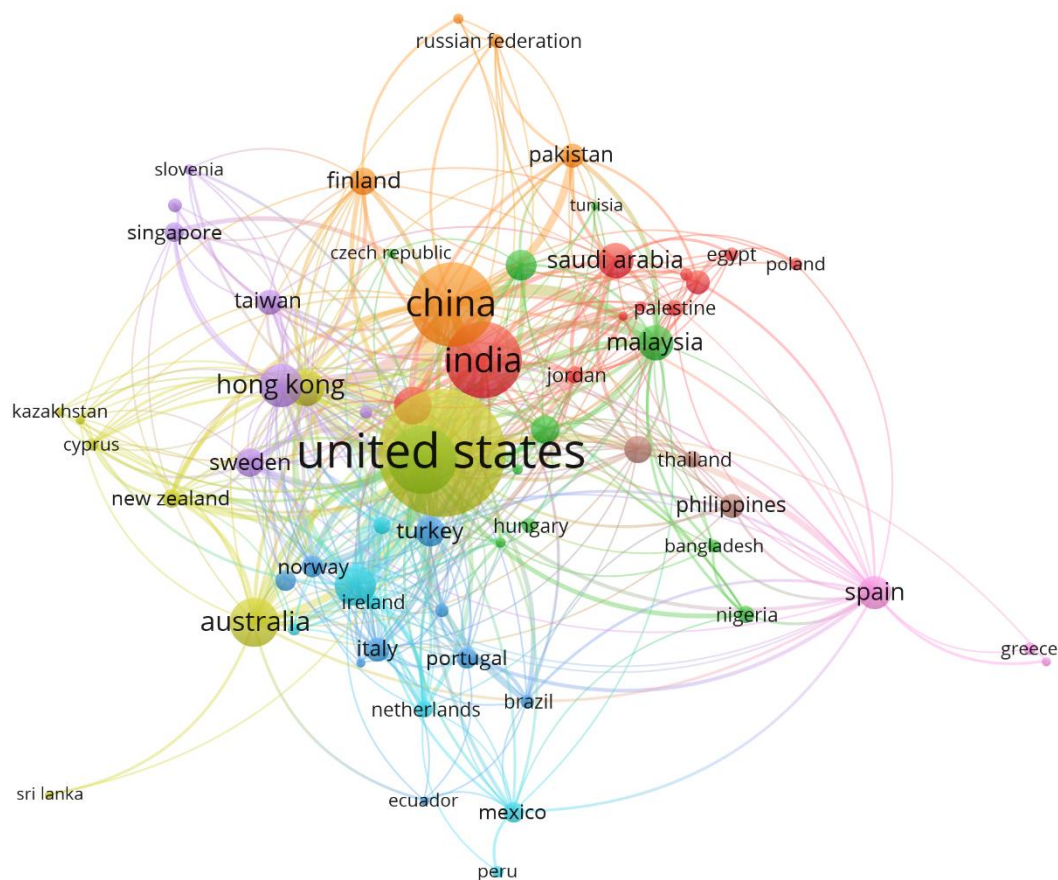

Figure 4: The Co-Authorship by Countries Collaboration

Conclusion

This study aimed to explore and map the research landscape surrounding AI in higher education through a bibliometric analysis, focusing on publication trends, influential authors, collaborative networks, and key thematic directions. The findings demonstrate a marked increase in scholarly output from 2023 onwards, with the highest concentration of publications occurring in 2024, reflecting growing academic interest in generative AI tools like ChatGPT. The analysis identified the U.S., China, and India as the most productive countries. At the same time, collaborative efforts among institutions from Asia, Europe, and the Middle East revealed a strong global engagement. Prominent keywords such as *"artificial intelligence,"* "*higher education*," and "*teaching and learning*" underscore the emphasis on AI's integration into academic environments.

Additionally, co-authorship and citation analyses highlighted the leading contributors to the emergence of ethical and pedagogical concerns as central research themes. This research contributes to the academic field by providing a systematic overview of developments and shifts in AI-related educational studies, thereby informing future inquiries and institutional policies. From a practical standpoint, the outcomes support evidence-based decision-making for stakeholders seeking to implement AI in learning environments. However, the study is limited by its reliance on a single database and a defined timeframe, suggesting that future research could expand the scope to include multidisciplinary perspectives or longitudinal trends beyond 2025. Ultimately, the value of bibliometric analysis lies in its capacity to illuminate scholarly activity, guide research priorities, and foster collaborative advancement in understanding the evolving role of AI in higher education.

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