

Artificial Intelligence Transforming Higher Education: A Bibliometric Review of Intellectual Progress and Future Pathways

Murali S^{1*}  and Jagadish M. H² 
Lokesha Gadigeppa Angadi³ 

¹ Associate Professor, Kristu Jayanti Institute of Management, Kristu Jayanti (Deemed to be University), India

² Associate Professor, Department of Commerce & Management, Surana College (Autonomous), India

³ Assistant Professor, Department of commerce and Management, Surana College (Autonomous), India
murali.s@kristujayanti.com

Abstract. This study provides a comprehensive assessment of research on the application of Artificial Intelligence (AI) in higher education by mapping the evolution of the field, identifying influential contributors, highly cited publications, collaboration networks, thematic developments, and emerging research trends between 2017 and 2026. To achieve these objectives, the study integrates bibliometric techniques with quantitative descriptive analysis to evaluate the most impactful scholarly publications. Bibliographic data were retrieved from the Scopus database, and after eliminating duplicate records, a final dataset comprising 7,085 documents was analysed. The analytical framework incorporated citation analysis, co-authorship analysis, co-word analysis, and bibliographic coupling, while VOSviewer software was employed to visualize the intellectual structure and research networks within the field. The findings indicate that China, India, and the United Kingdom are the leading contributors to AI-related higher education research. Furthermore, Lecture Notes in Education and Communications in Computer and Information Science emerged as the most influential publication sources. The co-authorship analysis highlights strong collaborative research networks, particularly among developed countries, whereas the co-word analysis identifies adaptive learning, predictive analytics, and ChatGPT as the dominant and rapidly evolving research themes. Overall, the review demonstrates the transformative role of AI in enhancing teaching and learning processes, improving institutional management and administrative efficiency, and fostering educational innovation. The findings offer valuable theoretical, managerial, and practical implications for policymakers, universities, educators, and students seeking to promote the effective adoption of AI technologies in higher education. Despite these contributions, the study acknowledges certain limitations, which provide opportunities for future research to further expand knowledge in this evolving domain.

Keywords: Artificial Intelligence, Higher Education, Bibliometric Analysis, VOS viewer

1. Introduction

Artificial intelligence (AI) has become one of the most influential technological innovations shaping the future of higher education. In earlier decades, discussions on technological advancement were primarily centred on computers and the Internet because of their significant contributions to social and economic development [4]. During that period, AI was rarely considered a central component of technological transformation. However, rapid digitalization has broadened the technological landscape to include digital transformation, digital signatures, the metaverse, virtual avatars, and AI-driven applications. These developments have fundamentally altered the way educational institutions, businesses, and governments operate, demonstrating the transformative potential of emerging technologies across multiple sectors [1].

Within higher education, AI offers unprecedented opportunities to improve teaching, learning, research, and institutional administration. By reducing traditional barriers and encouraging innovation, AI enables universities to create more adaptive and student-centred learning environments [2]. The automation of routine administrative activities, including student registration, grading, scheduling, and resource management, significantly reduces the workload of educators and administrators. Consequently, academic staff are able to devote greater attention to curriculum development, research activities, mentoring, and other strategic educational responsibilities. Such improvements not only enhance institutional efficiency but also contribute to a richer and more engaging learning experience for students [3].

The increasing adoption of AI technologies—including machine learning, natural language processing, and predictive analytics—has introduced innovative approaches to teaching, assessment, and learner engagement. These technologies support personalized learning pathways, intelligent tutoring systems, and data-driven educational decision-making, thereby improving both academic performance and institutional effectiveness. As AI continues to evolve, higher education institutions must develop sustainable implementation strategies that

maximize its educational benefits while effectively addressing technical, ethical, organizational, and governance challenges [5]. Continuous research and technological innovation therefore remain essential for ensuring the responsible and effective integration of AI into higher education systems.

Recent empirical investigations have considerably expanded the understanding of AI implementation within higher education. For example, research employing structural equation modelling has examined the transformational potential of AI for educational institutions [6]. Other studies have explored both the opportunities and the challenges associated with implementing artificial intelligence and machine learning technologies in higher education institutions [7, 08]. The rapid growth of scholarly publications in this area reflects increasing global interest in understanding the educational, managerial, and technological implications of AI adoption.

Given the expanding volume of research, comprehensive literature reviews are essential for synthesizing existing knowledge and identifying emerging research directions. Bibliometric analysis provides a systematic approach for evaluating the intellectual development of a research field by examining publication patterns, influential contributors, citation structures, and thematic evolution. Previous investigations have analysed AI research in higher education to identify publication trends, leading authors, prominent journals, and major thematic areas during the period 2017–2023. Similarly, Hinojo-Lucena et al. [09] conducted a bibliometric study examining the scientific impact of artificial intelligence within higher education.

Earlier bibliometric studies primarily investigated AI research published between 2007 and 2017 using the Web of Science and Scopus databases to understand the initial development of this emerging field. Their analyses mainly adopted descriptive approaches to examine publication growth, research productivity, and scientific output. While these studies provided valuable foundational insights, they offered relatively limited examination of collaboration networks, intellectual structures, conceptual development, and emerging research themes.

Building upon previous research, the present study adopts a more comprehensive bibliometric framework by integrating descriptive analysis, network analysis, and content analysis. This multidimensional approach provides a deeper understanding of the evolution of AI research within higher education while identifying knowledge gaps and future research opportunities. Specifically, the study addresses the following research questions:

RQ1: What are the current publication trends in artificial intelligence research within higher education?

RQ2: Who are the most influential authors, institutions, journals, and countries contributing to artificial intelligence research in higher education?

RQ3: Which publications represent the most highly cited contributions to artificial intelligence in higher education?

RQ4: What are the dominant research themes and conceptual structures characterizing the literature on artificial intelligence in higher education?

RQ5: Which countries demonstrate the strongest collaborative relationships in artificial intelligence research related to higher education?

RQ6: What future research opportunities emerge from the existing literature on artificial intelligence in higher education?

The primary objective of this study is to examine the intellectual development and knowledge structure of AI research in higher education by analysing publication productivity across journals, authors, institutions, countries, and individual documents. In addition, the study investigates the principal research themes that define the intellectual landscape of this field while identifying influential publications, international collaboration patterns, and emerging directions for future scholarly investigation.

This research contributes to the existing literature in several important ways. First, it provides a comprehensive bibliometric assessment of the relationship between artificial intelligence and higher education, offering an updated overview of scientific developments within this rapidly expanding research domain. Second, the study evaluates research performance through indicators such as annual publication trends, leading institutions, influential authors, productive countries, and highly cited publications. Third, it maps the intellectual structure of the field using citation analysis, co-authorship analysis, bibliographic coupling, and thematic analysis to reveal conceptual relationships among existing studies.

Finally, the findings provide a valuable foundation for future investigations by integrating previous research with emerging scholarly developments. The study identifies important knowledge gaps requiring further exploration while proposing a future research agenda that supports continued advancement of AI applications in higher education. Beyond its academic contributions, the findings also offer practical guidance for students, educators, university administrators, policymakers, and governments seeking to develop evidence-based strategies for the effective adoption and governance of artificial intelligence in higher education.

2 Research methodology

A bibliometric analysis and content analysis (hybrid review) were used to identify best practices in scientific knowledge sharing, specifically for artificial intelligence in higher education [09]. This approach combines quantitative bibliometric tools with qualitative content analysis to track scientific advancements in a certain topic. Review [10]. The study analyzed the literature on AI in higher education using quantitative and qualitative methodologies using Scopus data for disclosure.

2.1 Data collection method

This bibliometric research study utilized Scopus, a well-known scientific database with a comprehensive collection of peer-reviewed publications [11]. Scopus is a comprehensive database that indexes peer-reviewed journals from various areas. It also has good citation metrics, making it a useful tool for bibliometric analysis. The tight editorial criteria ensure only renowned journals are included, decreasing the likelihood of low-quality sources [12]. Scopus was chosen above other databases because of its vast coverage of peer-reviewed publications across different disciplines, resulting in a more comprehensive dataset

Scopus provides advanced citation analysis tools, full author profiles, and structured metadata to improve research tracking and bibliometric studies. Unlike Google Scholar, which includes non-peer-reviewed sources, Scopus' data is more curated and credible. While the Web of Science is reputable, its journal selection is relatively limited, notably in non-English publications [13]. On January 5, 2026, a search using the terms "Artificial Intelligence," "AI," and "Higher Education" yielded 7089 articles published between 2017 and 2026 After deleting duplicates and excluding editorials, notes, and reports.

2.2 Data analysis method

This research utilized two bibliometric analysis methods: descriptive (publication trend, contributing countries, affiliations, authors, and journals) and network analysis (co-word, citation, co-authorship, and bibliographic coupling analysis) [14]. Additionally, the top ten most cited articles in AI in higher education were analyzed for content. This study investigates performance using descriptive analysis of publishing patterns, top contributing nations, authors, journals, and affiliations. This study analyzes the top five most cited articles in AI in higher education using science mapping techniques, including co-word analysis, citation analysis, co-authorship analysis, bibliographic coupling analysis, and content analysis. We use VOSviewer software for data processing and visualization. VOSviewer is a powerful visualization tool that utilizes a distance-based mapping strategy for displaying things [15]. The results are visualized as colored networks and clusters, indicating links, link strength, and total link strength among articles [16] (Fig.1).

3 Result and discussion

3.1 Descriptive analysis

This section presents a descriptive study of characteristics such as the ten-year publication chronology, top journals, authors, research institutes, and nations. Figure 2 depicts the amount of publications between 2017 and 2026. Artificial intelligence studies in higher education have grown steadily since 2021 and will continue until 2025. In recent years, 2025 had the most noteworthy publications, with 152. There is growing interest in artificial intelligence in higher education, both in the education sector and academic context, as evidenced by literature.

A Total 7053, articles, and conference paper from Scopus database were collected and filtered.

1- Descriptive analysis (Publication trends, Top Contributing Countries, Affiliations, Journals and Authors

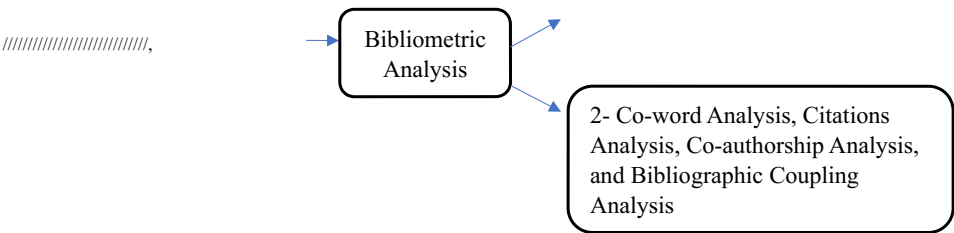


Fig. 1 Research Design. Source: Author

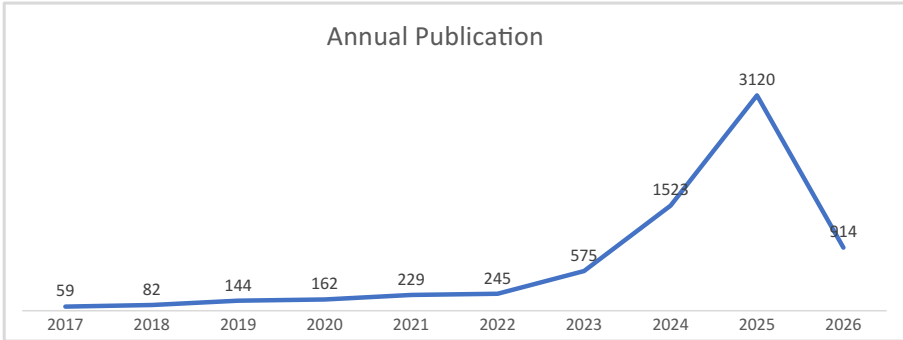


Fig.2 Annual Publication. Source: Author (Scopus Database)

The rapid advancement of digital technologies has contributed to a substantial increase in scholarly publications examining the application of artificial intelligence (AI) within higher education. AI has become an integral component of both academic and administrative functions, transforming how educational institutions deliver instruction and manage operational activities. Innovative AI-driven technologies, including intelligent tutoring systems, adaptive learning environments, and predictive analytics, have significantly reshaped contemporary educational practices. These technologies support personalized learning experiences, automate assessment processes, and provide immediate feedback to learners, thereby enhancing both instructional effectiveness and student learning outcomes [17].

A growing body of research has investigated the influence of AI on various dimensions of higher education, including student engagement, academic achievement, institutional performance, and educational quality [18]. In addition to its instructional applications, AI has attracted considerable attention for its capacity to improve administrative decision-making through functions such as student enrolment forecasting, resource allocation, automated grading, and institutional planning [19]. As AI technologies continue to mature, scholarly interest has expanded beyond implementation issues to encompass broader questions concerning ethical governance, responsible adoption, and the long-term implications of AI for teaching, learning, and institutional sustainability [20].

The widespread adoption of AI accelerated considerably with the expansion of digital learning environments, leading to the increased use of AI-powered online teaching platforms, intelligent tutoring systems, and adaptive educational technologies. Consequently, researchers have devoted increasing attention to understanding how these technologies influence student engagement, personalized learning pathways, and overall educational experiences [21]. Simultaneously, governments, higher education institutions, and international organizations have made substantial investments in AI research and innovation, recognising its strategic importance for improving educational quality, supporting academic research, and strengthening evidence-based decision-making within universities [22].

The continued expansion of AI research suggests that its role in higher education extends well beyond the temporary demands created by the global pandemic. Instead, AI is increasingly recognised as a fundamental

component of modern educational systems and institutional management. Its growing integration into teaching, assessment, student support, and administrative processes reflects a long-term transformation towards data-driven, intelligent, and technology-enhanced higher education environments [23]. Collectively, these developments highlight the considerable potential of AI to personalise learning, improve institutional efficiency, strengthen academic decision-making, and support innovative pedagogical practices across higher education institutions.

Table 1 Top Contributing Country. Source: Author (Scopus Database)

Ranking	Country/Territory	Publications	Average
1	China	1078	12%
2	United States	772	8%
3	India	418	4%
4	United Kingdom	397	4%
5	Spain	383	4%
6	Mexico	288	3%
7	Australia	284	3%
8	Malaysia	260	3%
9	Indonesia	256	3%
10	Saudi Arabia	229	2%

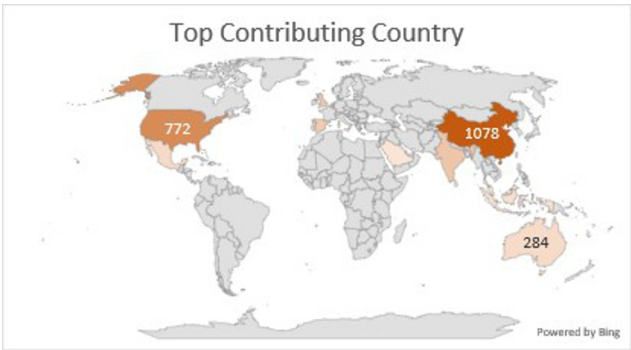


Fig 3 Top Contributing Country. Source: Author (Scopus Database)

Table 1 and Figure 3 illustrate the geographical distribution of research output on artificial intelligence in higher education. China emerged as the leading contributor, producing 1,078 publications, followed by the United States with 772 publications. India ranked third with 418 publications, while the United Kingdom and Spain contributed 397 and 383 publications, respectively. Among the remaining leading contributors, Mexico, Australia, Malaysia, and Indonesia each recorded publication outputs ranging from 256 to 288 articles. Saudi Arabia completed the list of the top ten productive countries with 229 publications.

The distribution of publications demonstrates that scholarly research in artificial intelligence and higher education is concentrated primarily within a limited number of countries. China and the United States have established themselves as the dominant contributors, reflecting their substantial investments in artificial intelligence research, technological innovation, and higher education development. At the same time, the increasing publication output from emerging economies such as India, Malaysia, Indonesia, and Saudi Arabia indicates that research activity is expanding beyond traditionally dominant research nations. This broader participation suggests that artificial intelligence in higher education has evolved into a globally significant research area, attracting increasing scholarly attention from both developed and developing countries. The findings further indicate a growing international commitment to advancing AI-driven educational research and promoting innovation across diverse higher education systems.

Table 2 Top Contributing Journal. Source: Author (Scopus Database)

Ranking	Journal	Publication	Average
1	Lecture Notes in Networks and Systems	189	3%
2	Communications in Computer and Information Science	144	2%
3	Education Sciences	110	2%
4	Education and Information Technologies	103	1%
5	Sustainability Switzerland	95	1%
6	ACM International Conference Proceeding Series	91	1%
7	Frontiers in Education	85	1%
8	Computers and Education Artificial Intelligence	77	1%
9	Lecture Notes in Computer Science	64	1%
10	Ceur Workshop Proceedings	63	1%

From the above table2 - The findings suggest that Lecture Notes in Networks and Systems has the most publications, followed by Communications in Computer and Information Science and Education Sciences, demonstrating a significant contribution to AI research in higher education. Journals such as Education and Information Technologies and Computers and Education Artificial Intelligence emphasize the rising use of AI in teaching and learning.Overall, the inclusion of both journals and conference proceedings indicates that the discipline is interdisciplinary and fast growing, with a focus on technological and educational developments.

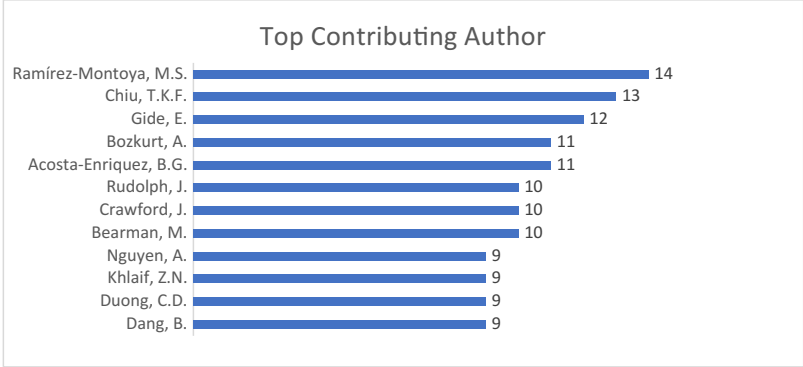


Fig 4 Top Contributing Author. Source: Author (Scopus Database)

From the above fig 4. The chart shows that Ramírez-Montoya is the leading contributor with the highest number of publications, followed by Chiu and Gide. Several authors such as Bozkurt and Acosta-Enriquez also have strong contributions, while others show moderate but consistent research output. Overall, the distribution indicates a mix of leading and emerging researchers contributing to the field of AI in higher education.

Table 3 Co-Occurrence of Keyword. Source: Author (Scopus Database & VOS viewer Software)

Number	Keyword	Occurrence	Total Link Strength
1	Artificial Intelligence	4,353	14500
2	Higher Education	2,884	10000
3	Students	2,080	9800
4	High Educations	2,059	6000
5	Education Computing	1,235	5800
6	Teaching	1,226	5700
7	Engineering Education	1,210	3800
8	ChatGPT	808	3500
9	Curricula	738	3400
10	Learning Systems	732	3000

Table 3 says that the keyword “Higher Education” shows the highest occurrence and estimated link strength, indicating its central role in the research network. Keywords such as “Students,” “Teaching,” and “Engineering Education” also demonstrate strong connectivity, reflecting their importance in AI-driven educational research. Emerging keywords like “ChatGPT” and “Generative Artificial Intelligence” show moderate link strength, indicating growing research interest in recent years.

3.2 Citation analysis

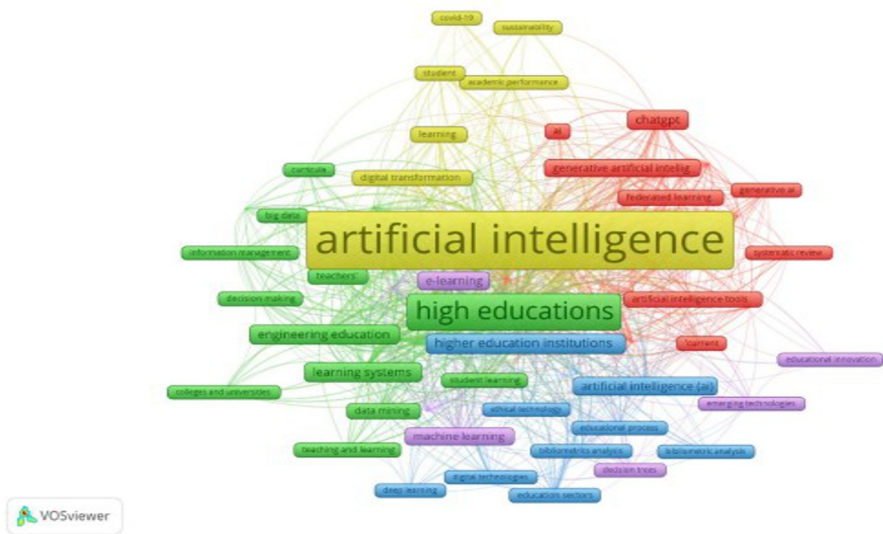


Fig. 5 Network Visualization of highest cited articles. Source: Author (Scopus Database & VOS viewer Software)

The above fig 5 says : The keyword co-occurrence network reveals that artificial intelligence is the major theme, with a strong link to higher education, showing extensive study on AI integration in academic contexts. The map identifies numerous critical clusters One cluster focuses on developing AI technologies, such as generative AI and ChatGPT, demonstrating a renewed interest in sophisticated tools. Another cluster focuses on educational applications, including learning systems, data mining, and decision-making. A third cluster focuses on student learning and academic performance, demonstrating the influence of AI on outcomes. Furthermore, machine learning and learning analytics are key themes, indicating data-driven education, whilst e-learning and digital transformation represent the shift toward technology-enabled learning settings.

Overall, the network represents a highly integrated and interdisciplinary field that combines education, technology, and management. The findings indicate an increasing trend toward data-driven and AI-supported learning systems, with an emerging emphasis on generative AI, while topics such as ethics and long-term impact remain underexplored.

Table 4 Highest Cited Articles. Source: Author (Scopus Database & VOS viewer Software)

Author and Title	Citations Number	Total Strength link
Cotton, Debby R. E . Chatting and cheating: Ensuring academic integrity in the era of ChatGPT	1661	95
Rudolph J		87

ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	1387	
Popenici S.A.D Exploring the impact of artificial intelligence on teaching and learning in higher education	1291	85
Crompton H and Burke D. Artificial intelligence in higher education: the state of the field	1124	78

Table 4 shows Cotton (1661 citations) recorded the highest total link strength, indicating strong influence and connectivity with other studies in the field. This is followed by Rudolph (1387 citations) and Popenici (1291 citations), which also show high link strength, reflecting their significant contribution to artificial intelligence research in higher education. Crompton and Burke (1124 citations) demonstrate comparatively lower but still strong connectivity. The results indicate that highly cited articles play a crucial role in shaping the research network and are strongly linked with multiple studies in the domain.

3.3 Co-authorship analysis

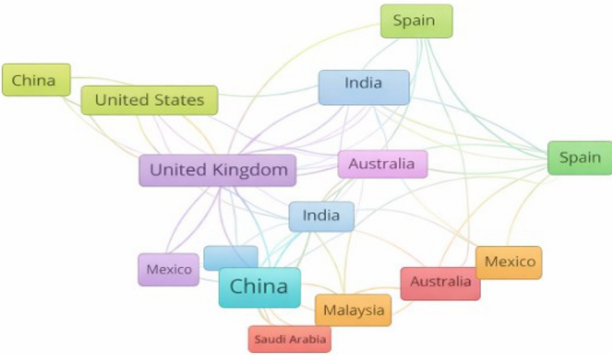


Fig. 6 Network Visualization of the Co-authorship of the countries. Source: Author (Scopus Database & VOS viewer Software)

The figure 6 shows the co-authorship network among countries in AI research in higher education. China, the United States, the United Kingdom, and India are the main hubs with strong collaborations. Other countries like Spain, Australia, and Mexico show moderate links, while Malaysia, Indonesia, and Saudi Arabia are emerging contributors. Overall, the network indicates growing global collaboration in this research area.

3.4 Bibliographic coupling analysis

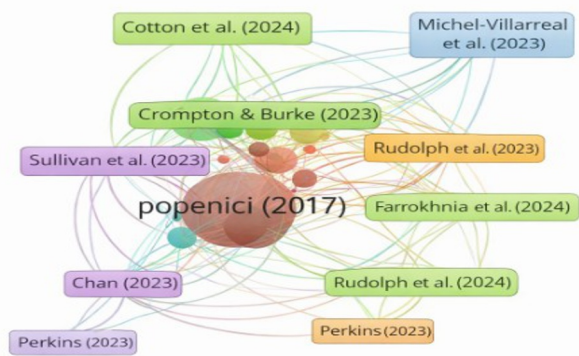


Fig. 8 Network Visualization of the Bibliographic Coupling of Articles. Source: Author (Scopus Database & VOS viewer Software)

The figure 8 shows that authors like Popenici, Crompton, and Ouyang are key contributors with strong collaboration links. Recent authors such as Cotton and Rudolph indicate growing research trends. Overall, the network reflects increasing collaboration and expansion in AI research in higher education.

Table 5 Bibliographic Coupling. Source: Author (Scopus Database & VOS viewer Software)

Author and title	Title Citation	Direction for Future Research
Cotton D.R.E. Chatting and cheating: Ensuring academic integrity in the era of ChatGPT	1661	- Future research should focus on ethical use of AI in education, development of AI-proof assessments, effectiveness of detection tools, and the impact of AI on student learning. - Studies can also explore personalized learning and cross-country comparisons to better understand AI adoption in higher education
Rudolph J ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	1387	Future research should examine the impact of ChatGPT on teaching, learning, and assessment practices in higher education. It should also focus on developing ethical guidelines and effective policies to ensure responsible use of AI tools while maintaining academic integrity.
Popenici S.A.D and Kerr S. Exploring the impact of artificial intelligence on teaching and learning in higher education	1294	Future research should focus on ethical issues, data privacy, and the governance of AI in higher education. It should also explore the evolving role of educators and the effectiveness of AI-driven personalized learning systems.

4 Managerial recommendation

The present bibliometric investigation provides a comprehensive understanding of the development and intellectual evolution of research on artificial intelligence (AI) in higher education. Given the rapid expansion of AI applications across teaching, learning, research, and institutional management, synthesizing the existing body of literature is essential for identifying current research patterns and informing future scholarly investigations. The first objective of this study was achieved through descriptive bibliometric analysis, which offers an overview of the research landscape by examining publication growth, leading journals, prolific authors, contributing countries, and scientific productivity. These descriptive indicators provide valuable reference points for researchers, educators, policymakers, and postgraduate students seeking to understand the progression of AI research within higher education.

The second objective was addressed through network analysis, which explores the intellectual and collaborative relationships among publications within the field. Techniques such as co-word analysis, citation analysis, bibliographic coupling, and co-authorship analysis were employed to identify dominant research themes, influential publications, conceptual relationships, and patterns of international scientific collaboration. Together, these analytical approaches reveal the intellectual structure of AI research in higher education while highlighting emerging areas that warrant further investigation.

The co-word analysis identified several frequently occurring keywords, including artificial intelligence, higher education, higher education institutions, students, ChatGPT, engineering education, learning systems, and teaching. The prominence of these terms reflects the principal areas of contemporary research and demonstrates that AI applications are increasingly transforming educational practices, institutional operations, and student learning experiences. These thematic patterns provide a useful foundation for future empirical studies by assisting researchers in developing theoretical frameworks, formulating research hypotheses, and identifying relationships among emerging concepts. Furthermore, educators can utilise these findings to refine curriculum design, strengthen research agendas, and integrate emerging AI technologies into teaching practices. Students may also benefit by identifying current research trends, developing innovative academic projects, and preparing for careers in technology-driven educational environments.

The findings further emphasise the importance of strengthening international collaboration among researchers from both established and emerging research economies. Expanding collaborative networks can facilitate knowledge sharing, encourage interdisciplinary research, and accelerate innovation within the field of AI in higher education. Greater cooperation among institutions and countries is likely to enhance the overall quality and global impact of future research while contributing to the development of more comprehensive theoretical and practical perspectives on AI adoption in higher education.

Finally, the bibliometric evidence identifies several influential authors whose contributions have significantly shaped the intellectual development of AI research in higher education. Their work has established important theoretical foundations, methodological approaches, and practical frameworks that continue to guide subsequent investigations. University faculty members, researchers, and policymakers can build upon these established contributions to develop improved guidelines, governance frameworks, ethical standards, and institutional strategies for the effective and responsible implementation of artificial intelligence within higher education systems.

5 Practical recommendation

The integration of artificial intelligence (AI) into higher education has significant implications for multiple stakeholder groups, including students, faculty members, university administrators, and policymakers. Although AI offers considerable opportunities to improve educational quality and institutional effectiveness, its implementation also introduces several ethical, technical, and governance challenges that require careful consideration.

For students, AI technologies have transformed learning by enabling personalized educational experiences through adaptive learning platforms, intelligent tutoring systems, and predictive analytics. These technologies customize instructional content according to individual learning needs, thereby enhancing student engagement, academic performance, and learning efficiency [24]. Despite these benefits, the widespread use of AI raises important concerns regarding fairness, data privacy, and continuous digital surveillance. AI-supported assessment systems, remote proctoring, and learning analytics may generate ethical issues related to student autonomy, privacy protection, and responsible data management. Consequently, universities must ensure transparency in AI applications while implementing robust data protection measures to maintain student confidence and safeguard personal information.

Faculty members also benefit from AI through automated grading systems, intelligent content recommendations, and AI-assisted teaching tools that reduce routine administrative responsibilities. By minimizing repetitive tasks, educators are able to dedicate more time to research, curriculum development, mentoring, and meaningful student interaction. Furthermore, AI-generated analytical insights assist faculty in identifying learning deficiencies and refining instructional strategies to improve educational outcomes [25]. Nevertheless, the successful adoption of AI remains challenging for many educators because of limited technical expertise, insufficient professional training, and concerns regarding the potential replacement of traditional teaching roles through automation. Some faculty members perceive AI as a threat to conventional pedagogical practices and worry that excessive reliance on automated technologies may diminish the human dimension of education [26]. Addressing these concerns requires universities to invest in comprehensive AI literacy initiatives and continuous professional development programmes that equip educators with the competencies needed to integrate AI effectively into teaching and learning processes.

University administrators increasingly rely on AI to support strategic planning, resource optimization, and institutional decision-making. Predictive analytics enables institutions to identify students who may be at risk of academic failure or withdrawal, allowing timely intervention strategies to improve retention and student success. AI applications also enhance operational efficiency by automating admissions processes, scheduling, financial planning, and resource allocation [27]. However, the growing reliance on algorithmic decision-making has generated concerns regarding algorithmic bias, transparency, and accountability. Decisions derived from AI systems may inadvertently reinforce existing inequalities or create impersonal administrative processes if adequate oversight mechanisms are not established [28]. Therefore, universities should implement appropriate governance frameworks that ensure fairness, ethical accountability, and transparency in AI-supported institutional decision-making.

Policymakers play a fundamental role in facilitating the responsible adoption of AI within higher education through the development of supportive regulatory frameworks and strategic policies. AI technologies provide valuable analytical capabilities that assist policymakers in evaluating large-scale educational data, monitoring student performance, identifying curriculum improvement opportunities, and forecasting future educational requirements [29]. Despite these advantages, significant disparities remain in access to AI technologies across different socioeconomic and geographical contexts. Higher

education institutions located in developing countries often encounter financial limitations, inadequate digital infrastructure, and shortages of technical expertise that restrict effective AI implementation. Overcoming these barriers requires sustained public investment in digital infrastructure, institutional AI capacity building, equitable technology access, and harmonized regulatory policies that encourage responsible innovation.

To ensure the sustainable and ethical integration of AI within higher education, universities should establish comprehensive governance frameworks that address issues of fairness, bias mitigation, accountability, and transparency in AI-driven decision-making. Professional development programmes should incorporate AI literacy and digital competency training to prepare faculty members for technology-enhanced teaching environments. In addition, higher education institutions must adopt rigorous data governance policies that comply with internationally recognized privacy and security standards to safeguard sensitive student information. Policymakers should promote standardized ethical guidelines while encouraging collaborative partnerships among universities, industry, and research organizations to support responsible AI innovation. Future research should continue examining the long-term effects of AI on student learning outcomes, academic roles, institutional governance, and decision-making processes, with particular emphasis on developing scalable and cost-effective AI solutions suitable for resource-constrained higher education institutions.

6 Conclusion

Artificial intelligence (AI) has become one of the most influential technological developments shaping the future of higher education. Using a combination of bibliometric techniques and qualitative content analysis, this study systematically examined the evolution of AI-related research within higher education. The findings demonstrate a substantial expansion of scholarly output over the study period, with research activity accelerating markedly after 2021. This growth reflects the increasing adoption of AI technologies in teaching, learning, research, and institutional management, further reinforced by the digital transformation triggered by the COVID-19 pandemic. China, India, the United States, and the United Kingdom emerged as the leading contributors, while several universities and research institutions played a prominent role in advancing knowledge in this field.

The bibliometric findings identified from table 5 four dominant research streams that characterize the current intellectual structure of AI in higher education: adaptive learning technologies, intelligent tutoring systems, predictive analytics, and AI-enabled administrative management. Network and co-word analyses further revealed strong conceptual relationships among topics such as ethics, e-learning, engineering education, learning analytics, and emerging generative AI applications, including ChatGPT. These patterns indicate that AI research has evolved beyond technology adoption toward broader discussions concerning pedagogical innovation, institutional transformation, and responsible implementation.

The study also highlights the increasing level of international collaboration among researchers from both developed and developing countries, demonstrating the global importance of AI in transforming educational systems. Such collaborative efforts have accelerated knowledge sharing and facilitated interdisciplinary research, thereby strengthening the overall development of this rapidly expanding field.

Despite the considerable benefits associated with AI adoption, including enhanced learning experiences, improved teaching effectiveness, and greater institutional efficiency, the findings emphasize that significant challenges remain. Ethical considerations, algorithmic bias, data privacy, transparency, and the need to preserve meaningful human interaction in educational environments continue to require careful attention. Addressing these issues is essential to ensure that AI technologies are implemented responsibly and in ways that support inclusive, equitable, and student-centred education.

Overall, this study provides a comprehensive overview of the intellectual development of AI research in higher education and offers valuable insights for researchers, educators, institutional leaders, and policymakers. The findings suggest that the successful integration of AI depends not only on technological advancement but also on effective governance, ethical frameworks, continuous professional development, and policies that align AI applications with broader educational objectives. As AI technologies continue to evolve, future research should focus on evaluating their long-term educational impact, promoting responsible innovation, and developing sustainable strategies that maximize the benefits of AI while minimizing potential risks across diverse higher education contexts.

7 Limitations and future research directions

This study has limitations that may affect the generalizability of its findings.

1. Scopus Database Limitation: We acknowledge that relying entirely on Scopus may exclude relevant studies from other databases like Web of Science and Google Scholar. This selection ensures high-quality peer-reviewed sources may induce selection bias. Future study should use multiple databases to gain a more thorough understanding of AI use in higher education.
2. Exclusion of Non-English Publications: Limiting the investigation to English-language articles may exclude relevant studies

from non-English speaking locations. To further comprehend the impact of AI on higher education, future studies should include multilingual sources.

3 Methodological Constraints: Although bibliometric and content analysis can highlight patterns and major topics, they may not fully reflect the intricacies of AI integration in real-world educational contexts. As per table 5 To further understand teachers, future study should incorporate qualitative methods like case studies, surveys, or interviews. perspectives, institutional problems and students' experiences with artificial intelligence.

4. Limited Source Types: Exclusion of books, book chapters, and review papers may have limited the scope of our findings. To acquire a greater understanding of AI applications in education, future studies should include more academic and institutional sources.

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