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EXPLORING BIBLIOSHINY FOR MAPPING ARTIFICIAL INTELLIGENCE RESEARCH IN EDUCATION

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Abstract

This study critically analyzes the development of artificial intelligence (AI) research in education using a bibliometric approach, leveraging data from 191 Scopus-indexed documents during the 2015-2024 period. Employing Biblioshiny software, the study identifies an annual publication growth rate of 44.22% and an average of 11.88 citations per document. The analysis maps five key clusters: AI-based adaptive learning, automated assessment systems, predictive learning analytics, intelligent pedagogical agents, and personalized learning content. Dominant contributions are observed from countries such as the United States, China, and India, supported by substantial international collaboration. The findings also highlight dominant keywords like "Artificial Intelligence" and "Education Technology," reflecting a global research focus. While emphasizing AI's strategic potential in transforming education systems, this study critically underscores ethical and data privacy challenges that require further attention in advancing educational technology.

Keywords: Artificial Intelligence, Bibliometrics, Biblioshiny, Education, Research Trends

Introduction

Globalization has become a defining feature of the 21st century, leading to substantial changes in societal and individual life patterns relative to the previous century (Purwanto et al., 2024; Utami et al., 2022) . The rapid development of artificial intelligence (AI) has significantly reformed technology and education in recent years (Alam, 2022; Lamri & Lubart, 2023). This change has been further accelerated by the COVID-19 pandemic (Grinin et al., 2022; Neto et al., 2020), which has driven massive adoption of technology in learning (Nurhayati & Wijayanti, 2023; Rahmiyanti, 2024). Bibliometric analysis related to AI in education shows exponential growth, both in research and implementation, especially during the period 2020-2024 (Hossein Mohand et al., 2025). This highlights the urgent need to understand the patterns, trends, and strategic impacts of AI on the evolving global education system (Guo et al., 2024; Paek & Kim, 2021).

A study shows a significant surge of 312% in publications related to AI in education since 2020. This rise is mostly due to contributions from East Asian and North American countries (Hossein Mohand et al., 2025; Liengpunsakul, 2021). This shows that these two areas play a key role in driving innovation in educational technology (Dwivedi et al., 2022). Systematic mapping of the literature using the bibliometric analysis identified several dominant research clusters in the development of AI for education (Maphosa & Maphosa, 2023; Wang et al., 2024). In the analysis of 1,223 articles indexed by Scopus, five main focus areas were found, namely AI-based adaptive learning, automated assessment systems, predictive learning analytics, intelligent pedagogical agents, and personalization of learning content (Hwang & Tu, 2021; Wink & Bonivento, 2023).

This finding is supported by a meta-analysis study that showed the significant effectiveness of AI implementation in improving learning outcomes compared to conventional methods (Thong, Chou, Chew, & Ying, 2023). The AI technology revolution in education has also driven the emergence of a new paradigm in the development of learning systems (Charles et al., 2023; Siska et al., 2023). where the integration of deep learning and natural language processing now allows the development of tutorial systems that are more responsive and adaptive to the individual needs of students (Kamalov et al., 2023; Rane et al., 2023). In addition, this is reinforced by a longitudinal study that revealed an average increase of 42% in student engagement and understanding of the material through the implementation of AI-based learning systems (Wu et al., 2024).

However, the implementation of AI in education also presents complex challenges that need to be addressed (Akgun & Greenhow, 2022; Kuleto et al., 2021). It is important to consider ethical and fair aspects in the development of AI systems for education(Eden et al., 2024), especially related to data privacy and bias (Lin, Huang, & Lu, 2023). In line with this, there is a need to develop an in-depth evaluation framework to assess the impact and sustainability of AI technologies in diverse learning contexts (Jing et al., 2024). Research mapping with the terminology "AI for education" will focus more on the strategy or technique of implementing AI in education, so that later, with bibliometric analysis mapping, more specific research areas will be identified. In addition, this study will utilize the Scopus database with an initial time limit to ensure that the literature used is still relevant. The selection of Scopus as a data collection database is a trusted reputation and completeness (Gusenbauer, 2022). Biblioshiny as the software used allows for broader and more comprehensive data mapping because it supports the needs of bibliometric analysis by providing identification of research trends, collaboration patterns between authors, and distribution of publications from geographical areas to relationships between keywords (Moral-Muñoz et al., 2020).

Research Methods

This study applies the bibliometric analysis method, which utilizes scientific article metadata as the main data source (Budianto, 2022). The metadata includes important elements such as title, author, affiliation, abstract, keywords, number of citations, and other relevant information. This

data is used to identify patterns, trends, and evaluations in the scope of science systematically and measurably. The research process is described through the flowchart shown in Figure 1.

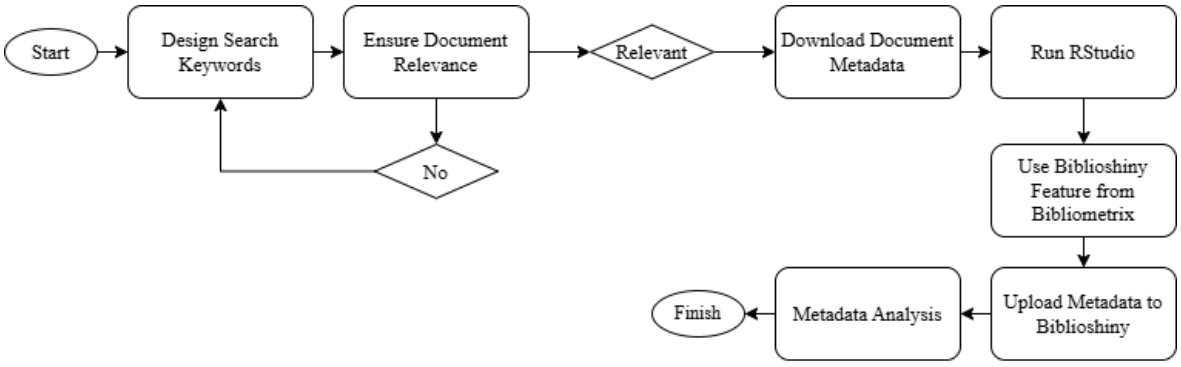

Figure 1. Research Flowchart

The purpose of this study is to conduct a critical analysis of publications on the theme of "Artificial Intelligence" that have been published and indexed in the Scopus database, in order to evaluate their quality, relevance, and contribution to scientific development (Majidah & Rullyana, 2024). In the early stages of the study, the Scopus database was used to conduct a search using the keyword "Artificial Intelligence" in the search column that includes the article title, abstract, and keywords. The result was 191 documents. The next stage was to export the document metadata in CSV format, which was then accessed via Microsoft Excel. The exported metadata includes various information, such as citation data, bibliographic information, abstracts and keywords, funding details, and other additional information. After that, the researcher verified the CSV file and ensured that the number of documents collected remained at 191. This data was then further analyzed using Biblioshiny software.

Research Results and Discussion

We conducted this study using data covering the period 2015-2024, providing an overview of almost a decade of information development from a variety of diverse sources. This study aims to explore the trends and growth of literature reflected in the documents analyzed, as well as to map the significant contribution indicated by the high annual growth rate (Mustofa, 2022). This information is summarized in Table 1, which presents details about the time span, number of sources, documents, and annual growth rates to illustrate the development of the literature during the analysis period.

Table 1. Main Information

DESCRIPTION	RESULTS
Timespan	2015:2024
Sources (Journals, Books, etc)	144
Documents	191
Annual Growth Rate %	44.22
Document Average Age	1.75

DESCRIPTION	RESULTS
Average citations per doc	11.88
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	879
Author's Keywords (DE)	574
AUTHORS	
Authors	564
Authors of single-authored docs	42
AUTHORS COLLABORATION	
Single-authored docs	50
Co-Authors per Doc	3.16
International co-authorships %	21.47
DOCUMENT TYPES	
articles	81
book	7
book chapter	16
conference paper	63
conference papers conference papers	1
conference review	8
editorial	1
letter	2
review	12

Table 1 presents the results of a biblioshiny analysis of bibliometric research focused on the theme of Artificial Intelligence in Scopus-indexed publications, with document metadata showing a total of 191 documents divided into 9 types of publications. The types of publications include 81 journal articles, 7 books, 16 collections of scientific papers, 63 conference papers, 1 advanced conference paper, 8 conference reviews, 1 editorial, 2 letters, and 12 reviews. The research conducted in the period from 2015 to 2024 involved 564 authors, with a publication trend showing a significant increase, namely from 2 documents in 2015 to 54 documents in 2024. The annual growth rate of 44.22% and the average age of documents of 1.75 years reflect the rapid

development in this field, while the high interest in Artificial Intelligence research can be seen from the average number of citations per document reaching 11.88.

Figure 2 illustrates the growth trend of publications on the theme of "Artificial Intelligence" during the period, which generally shows a consistent increase. The year 2023 was the peak of productivity with 54 publications, marking the most active year in research on the theme of "Artificial Intelligence". In the last three years (2021–2024), this theme has experienced a significant increase, indicating an increasingly relevant and in-demand trend.

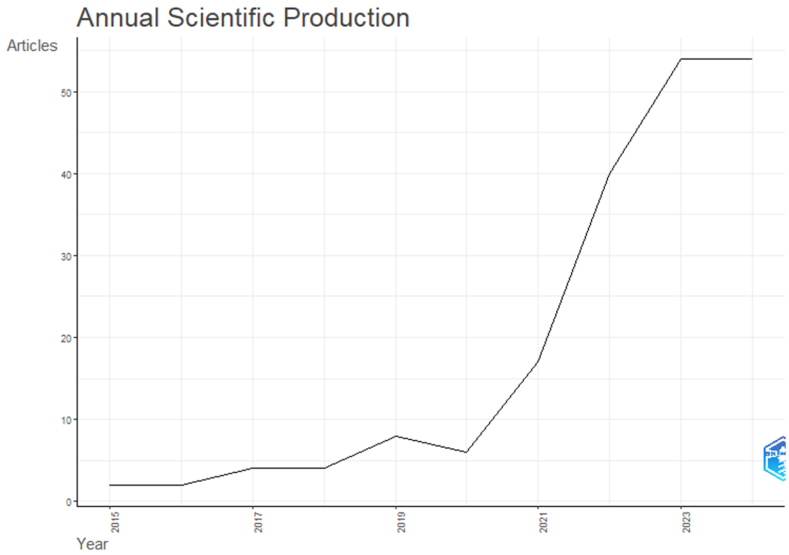

Figure 2. Increase in Publications 2015-2024

Figure 3 below presents a visualization of the Three-Fields Plot, which systematically depicts the relationship between 3 main elements, namely the author's country of origin (AU_CO), author's name (AU), and research topic (DE) (Rachmawati et al., 2021). These three elements are connected by gray lines, which represent the relationship or relationships between the elements. This diagram is designed to provide an in-depth understanding of the authors' collaboration patterns, geographic distribution, and the main focus of the research. Thus, the Three-Fields Plot becomes an effective analytical tool in identifying interconnections between research dimensions.

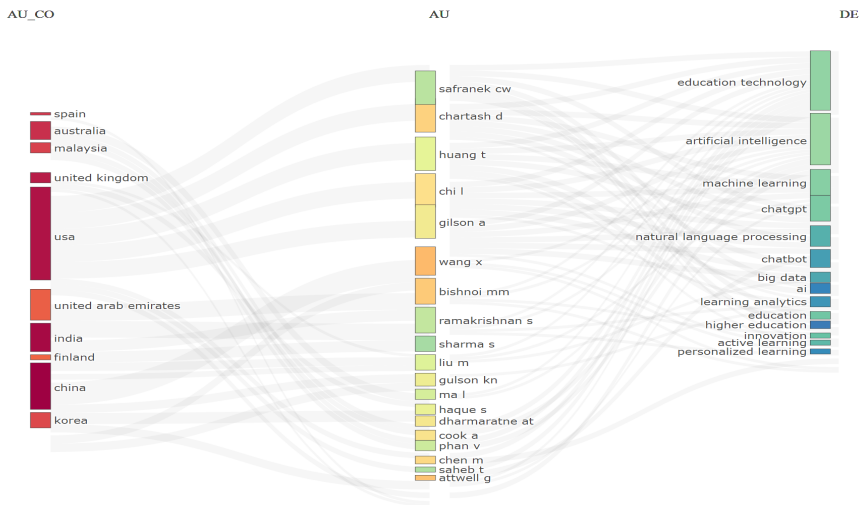

Figure 3. Three-Fields Plot

In the first column (AU_CO) or the left column in Figure 3, it can be seen that countries such as the United States, China, and India have significant dominance in contributing to this research theme, as indicated by the length of their bars. This dominance indicates that these 3 countries have advantages in terms of greater research resources and capacity compared to other countries, such as Malaysia, Finland, or Spain, whose contributions are relatively smaller. This phenomenon can be linked to the high investment allocation made by these countries in developing research infrastructure, which is strengthened by comprehensive access to advanced technology (Sulaeman et al., 2024). Therefore, the availability of superior resources and mastery of cutting-edge technology are the main factors that drive their dominance in this sector.

The second column (AU) serves to identify authors who have a significant role in the research topic being studied. Based on Figure 3, authors such as Safranek CW and Gilson A, who are from the United States, are listed as the main contributors with the largest number of studies. Meanwhile, from China, Wang X is an author who makes important contributions to the research topic. Meanwhile, Ramakrishnan S from India is also listed as the author with the largest contribution in the related research field. This finding indicates the existence of certain centers of expertise that play an important role in the development of science, especially in the fields of Artificial Intelligence and Education Technology (Muhammad Wali et al., 2023).

The third column (DE) containing keywords indicates the main focus of the research. Topics such as Artificial Intelligence, Machine Learning, and Education Technology dominate. It confirms that research in this period tends to focus on the integration of intelligent technology in education. The close relationship between authors and keywords reflects the global research direction that focuses on innovation and technology-based learning (Tamrin & Masykuri, 2024). Overall, this diagram reveals a logical and systematic pattern, where countries with high research capacity produce individuals who make significant contributions to emerging topics. This shows the importance of investing in research and development to generate substantial contributions in academic and technological fields.

Figure 4 below shows the 10 sources of articles with the most publications on the related topic. "Most Relevant Sources" which illustrate the distribution of the main and most frequently cited sources in the analyzed research, are marked with a circle at the right end of the horizontal axis diagram (X-axis) (Rahmani et al., 2024). The circles represent the number of documents published by a particular source and indicate its relevance to the research analyzed. This visualization provides a clear picture of the contribution of each source to the research topic analyzed.

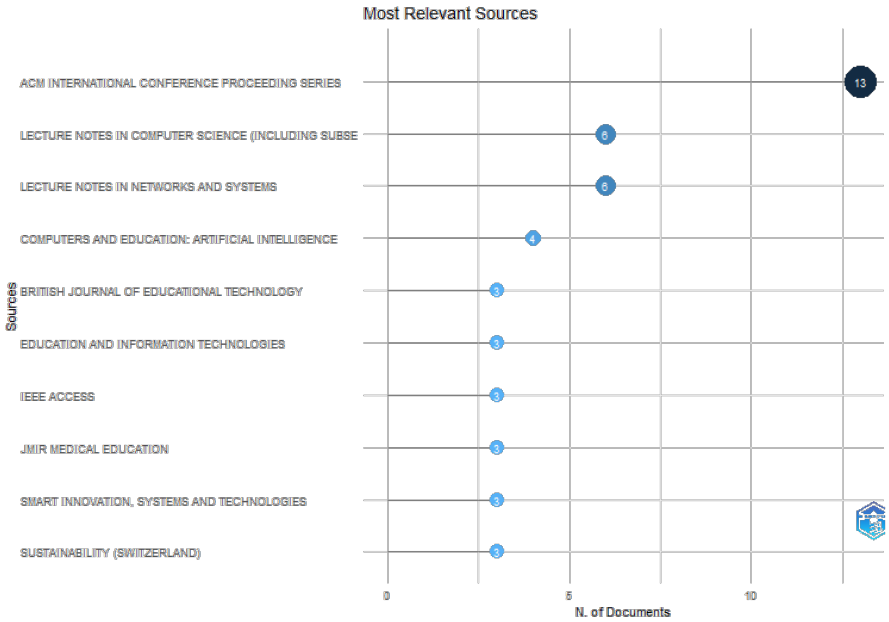

Figure 4. Number of Publications per Journal

Based on the data presented in Figure 4, the ACM International Conference Proceeding Series is the main contributor with 13 published documents. This confirms its role as a significant reference source and publication platform for related research. This conference serves not only as a means of disseminating high-quality research results but also as a major catalyst in the development of science in its field. In second place, Lecture Notes in Computer Science and Lecture Notes in Networks and Systems, which each contributed 6 documents, show strong relevance to the research theme, especially in the application of technology and information systems in education. In addition, Computers and Education Artificial Intelligence, with 4 documents, stands out for its focus on the integration of artificial intelligence in education and reflects the trend of technology-based learning innovation. Other sources, such as IEEE Access and Advances in Medical Education, which each contributed 3 documents, also make important contributions to enriching research, especially in the field of technology-based education in specific contexts.

This study also produced findings regarding the "Most Relevant Words," which represent the keywords that appear most frequently in the analyzed literature. A total of 10 primary keywords were identified as being the most dominant and relevant within the context of artificial intelligence in education. The data is visualized in the form of a graph presented in Figure 5. This graph provides an in-depth overview of the distribution and frequency of keywords across all documents included in the bibliometric analysis. On the horizontal axis (X-axis), the graph displays the number of occurrences or frequency with which each keyword appears. Meanwhile, the circle-shaped elements aligned with the vertical axis (Y-axis) represent individual keywords, with their size indicating the relative prominence or impact within the dataset.

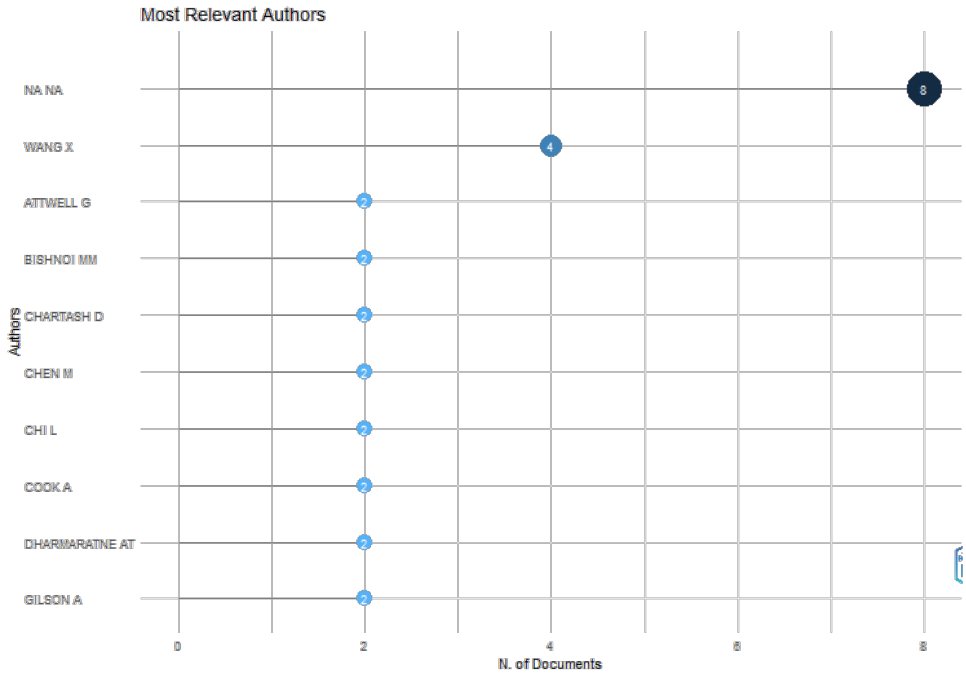

Figure 5. Most Relevant Words

Figure 5 presents a graph showing the distribution of the 10 most relevant and frequently used keywords in the topic being analyzed. This graph serves as a visual illustration to show the frequency of occurrence of these words while emphasizing their level of relevance to data analysis on the topic being studied (Saputra & Budianto, 2022). The keyword "artificial intelligence" is in first place with a frequency of occurrence of 65 times, followed by "education technology" which is in second place with a small margin, namely 63 times. Furthermore, "engineering education" is recorded as a keyword with a frequency of occurrence of 42 times, occupying the third position,

and followed by "student" which appears 37 times, reflecting a still significant level of relevance. The word "e-learning" is in fifth place with a frequency of occurrence of 20 times, followed by two other terms, namely "education computing" and "teaching", which each appear 19 times. Furthermore, keywords such as "artificial intelligence technologies", "machine learning", and "learning systems" are recorded as appearing 16, 15, and 14 times respectively. The frequency of occurrence of these words reflects their relevance and contribution in the context of the topic being analyzed. Meanwhile, the "Most Cited Document" in a research topic describes the level of influence, quality, and relevance of the article to the theme being discussed, which will be explained in Figure 6.

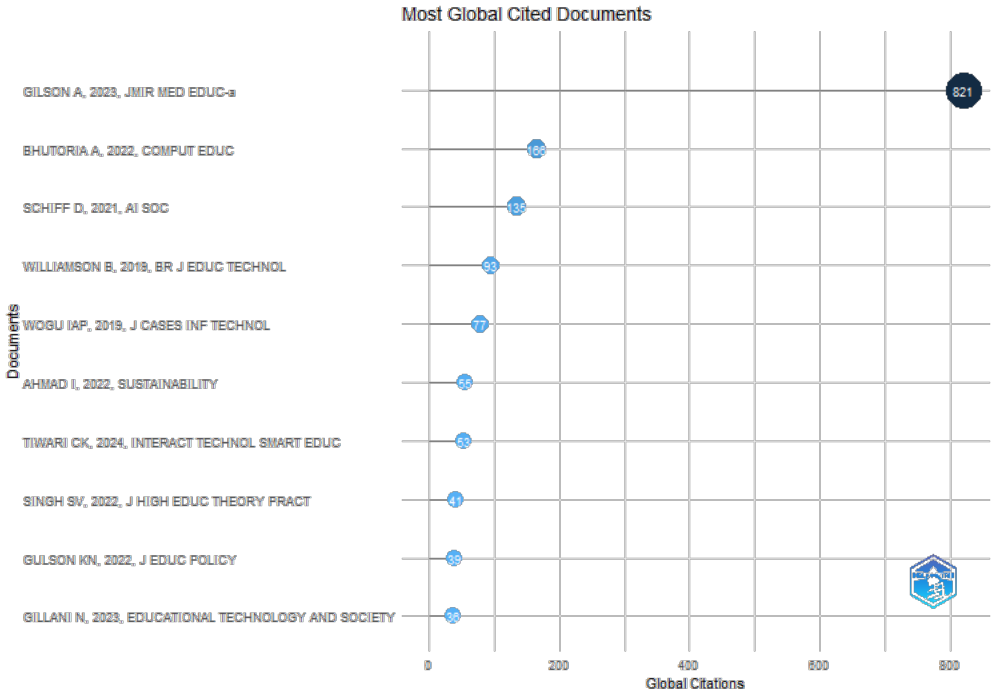

Figure 6. Most Cited Documents

In the graph shown in Figure 6, the vertical axis (Y) contains information about the author, year of publication, and journal where the article was published, while the horizontal axis (X) shows the number of citations received by each article. The top position is occupied by Gilson A. (2023), who received 821 citations, indicating that this research has a significant influence and high contribution in the field. In second place is Bhutoria A. (2022) with 166 citations, followed by the article by Schiff D. (2021) with 135 citations in third place. The fourth position is filled by Williamson B. (2019) with 93 citations, while Wogu IAP (2019) is in fifth place with 77 citations. Furthermore, the sixth to tenth ranks show the number of citations that are relatively close to each other, namely 65, 53, 41, 39, and 30 citations for each article. This shows that even though there are differences in the number of citations, these articles still have a significant influence on the same research topic. To further understand the key themes within these highly cited articles, Figure 7 presents a keyword co-occurrence treemap that highlights the most frequently used terms, providing insight into dominant research topics and emerging trends in the field.

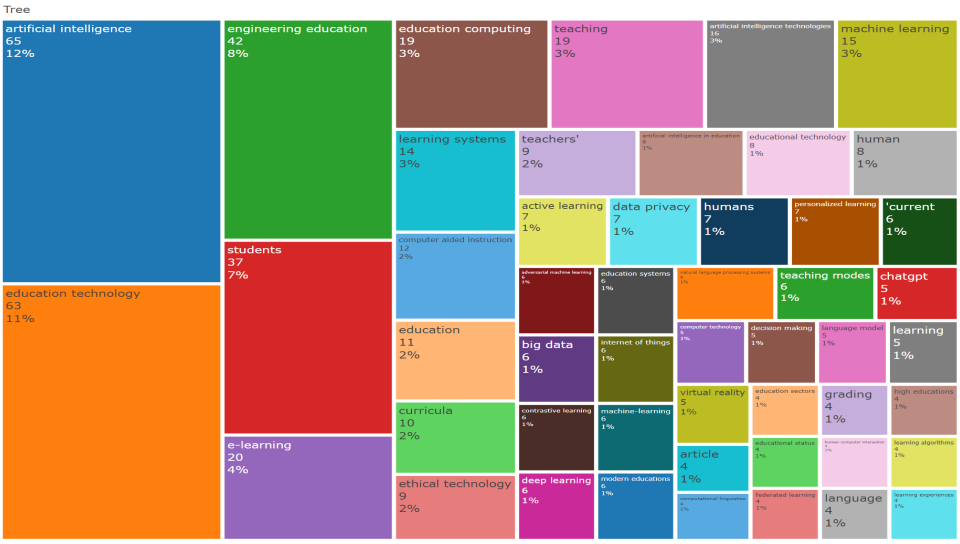

Figure 7. Treemap

A treemap presents a visualization of the distribution of topics or keywords based on their level of relevance or frequency in a particular context (Athoillah et al., 2022; Atzberger et al., 2021) with the size of the box representing the relative proportion of each topic to the overall data. In this visualization, the topic of "artificial intelligence" appears to be the most dominant theme with a proportion of 12%, followed by "education technology" at 11%, reflecting the importance of both themes in the analysis conducted. In addition, other topics such as "engineering education" (8%), "students" (7%), and "e-learning" (4%) also showed significant representation, illustrating concerns about the application of technology in education and its impact on teaching and learning. Meanwhile, themes with smaller proportions, such as "data privacy," "ChatGPT," and "personalized learning," highlighted specific issues that are part of educational technology, such as data security, personalization of learning, and the contribution of advanced language models in supporting learning (Kurniawan et al., 2024).

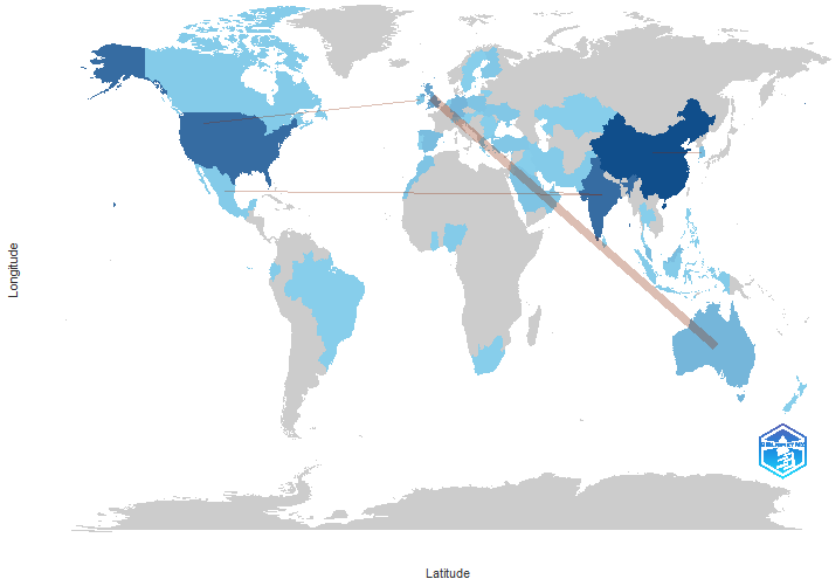

Figure 8. Country Collaboration Map

The world map in Figure 8 represents the distribution of a phenomenon, such as scientific publications, research collaborations, or other data dissemination, represented by the intensity of the blue color. Regions with darker blue colors indicate higher contributions, while lighter blue colors indicate lower contributions (Judijanto, 2024). In addition, the dominance of author collaborations in the United States, China, and several European countries such as Germany has darker blue color intensities, indicating their dominance of both authors and collaborations, and has a large contribution to the related research topic. Other regions, such as Australia, India, and some Southeast Asian countries, also contribute but with lower intensity, this can be seen from the lighter blue color. Additionally, there are connecting lines between regions, which likely indicate international collaboration or data connections between countries (Agbo et al., 2021). For example, there are clear connections between the United States and countries in Asia and Europe.

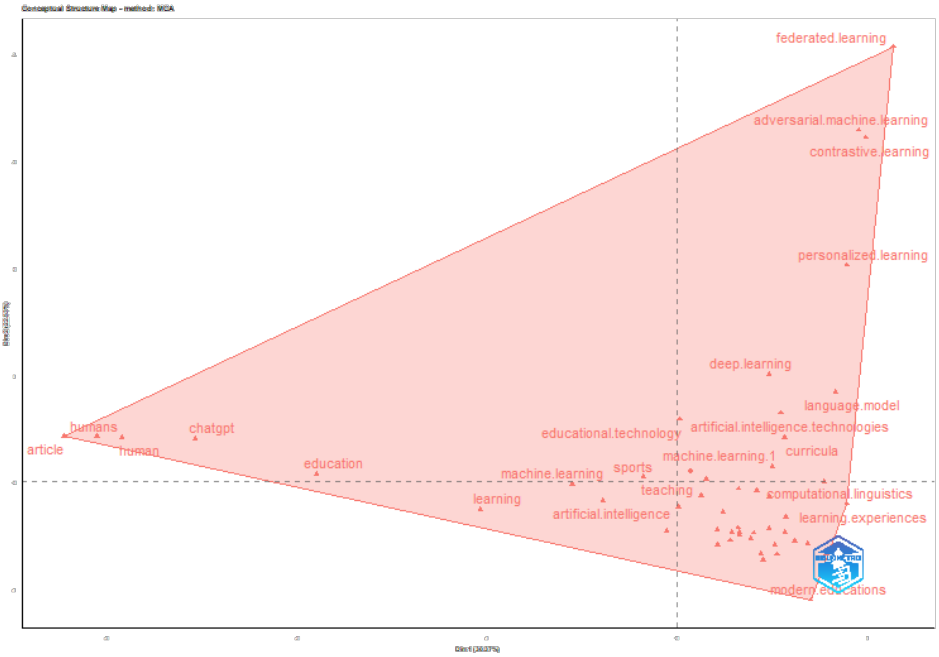

Figure 9. Keyword Plus Factorial Analysis using Multiple Correspondence Analysis

As shown in Figure 9, mapping of the Conceptual Structure Map generated through the Multiple Correspondence Analysis (MCA) method using analysis tools such as Biblioshiny. This visualization aims to identify clustering of research themes that are relevant to the research topic (Amiri et al., 2023). In this case, the MCA method is used to map the relationship between keywords based on the relationship of concepts that often appear in the literature. The concept map displays one main cluster that stretches across the entire area, starting from the top right side to the bottom left side. This cluster is marked with a shaded area using pink, reflecting the distribution of interrelated research themes in the visualization (Slavinski et al., 2023). This area not only illustrates the interrelationships between themes but also shows the scope of topics that cover various dimensions of related research. To make it easier to read, the large cluster is divided into two parts, namely the first cluster in the top right and the second cluster in the bottom left.

The first cluster is the top right section with a scope of themes such as "federated learning", "adversarial machine learning", "contrastive learning", and "personalized learning". These themes reflect the research orientation that focuses on the development of more advanced and specific artificial intelligence (AI)-based learning methods. The main focus of this cluster is on the aspects of personalization, increasing security, and optimizing efficiency in the implementation of AI-based learning technology. This shows a research trend that is directed at creating more adaptive and secure learning solutions. In contrast, the second cluster located at the bottom left includes themes such as “ChatGPT”, “education”, “teaching”, and “artificial intelligence”. The themes in

this cluster are more oriented towards the practical application of AI technology in education. Research in this cluster focuses on the use of technology such as chatbots to support learning, the application of AI in the teaching process, and the development of technology-based curricula. The approach taken is more applicative, targeting direct solutions to challenges in education through technology.

In addition, the distribution of keywords on the graph shows varying relationships between themes (Mejia et al., 2021). The position of keywords on the graph provides an idea of the level of relationship or proximity between concepts, where adjacent themes tend to appear together more often in the literature. For example, deep learning is close to artificial intelligence technologies and curricula, indicating a strong connection between AI research and educational curriculum development.

Conclusion

This study successfully maps the trends and developments of artificial intelligence (AI) research in education using a bibliometric approach based on an analysis of 191 Scopus-indexed documents in the period 2015-2024. The results of the study show significant growth in the number of publications, reflected in an annual growth rate of 44.22% and an average of 11.88 citations per document. In the analysis process, this study identified five main clusters of AI applications in education, namely AI-based adaptive learning, automated assessment systems, predictive learning analytics, intelligent pedagogical agents, and personalization of learning content, which collectively reflect the main focus of the development of this technology. In addition, the study also shows that the dominance of publications comes from countries such as the United States, China, and India, whose contributions are supported by substantial levels of international collaboration. By identifying dominant keywords such as "Artificial Intelligence" and "Education Technology," the study provides insight into the global direction of AI research that continues to evolve in a way that is relevant to the needs of modern education.

Overall, this study confirms the strategic potential of AI in revolutionizing the global education system, both through increasing learning efficiency and personalizing teaching. However, challenges related to data ethics and privacy must be of primary concern to ensure that the implementation of AI in education is not only innovative but also equitable, safe, and sustainable in the future.

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