Curricula: Journal of Curriculum Development *- e-ISSN 2830-7917 & p-ISSN 2964-7339*
Volume 4 No 1 (2025) 609-632

Curricula:
Journal of Curriculum Development
https://ejournal.upi.edu/index.php/CURRICULA/

Artificial Intelligence (AI) trends in higher education learning: Bibliometric analysis

Ai Pemi Priandani[1], Cepi Riyana[2], Asep Herry Hernawan[3], Laksmi Dewi[4], Mario Emilzoli[5], Gema Rullyana[6]
[1,2,3,4,5,]Universitas Pendidikan Indonesia, Kota Bandung, Indonesia
femyprian@upi.edu[1], cepi@upi.edu[2], asepherry@upi.edu[3], laksmi@upi.edu[4], emilzoli@upi.edu[5], gemarullyana@upi.edu[6]

ABSTRACT
The development of artificial intelligence (AI) technology has driven significant transformations in higher education. The integration of AI in learning offers the potential to increase the effectiveness, efficiency, and personalization of data-driven learning. This study aims to conduct a comprehensive bibliometric analysis of AI research trends in higher education learning, tracing publication patterns, source distribution, geographic distribution, and emerging themes in academic literature. The study uses a quantitative descriptive method with bibliometric analysis of Scopus publication data 2018-2023. The analysis was conducted using VOSviewer to map bibliographic relationships between publications, sources, authors, countries, and keywords. The results show that AI publications in higher education have increased rapidly, especially in 2023. The dominant themes are "artificial intelligence" and "higher education", with the latest trend towards "generative AI" and "ChatGPT". Publications appear in many interdisciplinary journals of social and computer sciences, with the United States, China, Australia, and the United Kingdom dominating research contributions. The findings provide a systematic overview of the development of AI research in higher education and serve as a strategic basis for educators, researchers, and policymakers in designing effective and sustainable AI integration in higher education.

ARTICLE INFO
Article History:
Received: 15 Mar 2025
Revised: 5 Jun 2025
Accepted: 10 Jun 2025
Available online: 22 Jun 2025
Publish: 27 Jun 2025
Keywords:
artificial intelligence; bibliometric analysis learning; higher education; instructional design
Open access
Curricula: Journal of Curriculum Development is a peer-reviewed open-access journal.

ABSTRAK
Perkembangan teknologi kecerdasan buatan (AI) telah mendorong transformasi signifikan dalam pendidikan tinggi. Integrasi AI dalam pembelajaran menawarkan potensi peningkatan efektivitas, efisiensi, dan personalisasi pembelajaran berbasis data. Penelitian ini bertujuan melakukan analisis bibliometrik komprehensif terhadap tren penelitian AI dalam pembelajaran pendidikan tinggi, menelusuri pola publikasi, distribusi sumber, persebaran geografis, dan tema yang muncul dalam literatur akademik. Penelitian menggunakan metode deskriptif kuantitatif dengan analisis bibliometrik data publikasi Scopus 2018-2023. Analisis dilakukan menggunakan VOSviewer untuk memetakan hubungan bibliografis antara publikasi, sumber, penulis, negara, dan kata kunci. Hasil menunjukkan publikasi AI dalam pendidikan tinggi mengalami peningkatan pesat, terutama tahun 2023. Tema dominan adalah "artificial intelligence" dan "higher education", dengan tren terkini mengarah pada "generative AI" dan "ChatGPT". Publikasi banyak muncul di jurnal interdisipliner ilmu sosial dan komputer, dengan Amerika Serikat, Tiongkok, Australia, dan Inggris mendominasi kontribusi penelitian. Temuan memberikan gambaran sistematis perkembangan penelitian AI dalam pendidikan tinggi dan menjadi dasar strategis bagi pendidik, peneliti, dan pembuat kebijakan dalam merancang integrasi AI yang efektif dan berkelanjutan di perguruan tinggi.
Kata Kunci: *analisis bibliometrik; desain pembelajaran; kecerdasan buatan; pembelajaran; pendidikan tinggi*

How to cite (APA 7)
Priandani, A. P., Riyana, C., Hernawan, A. H., Dewi, L., Emilzoli, M., & Rullyana, G. (2025). Artificial Intelligence (AI) trends in higher education learning: Bibliometric analysis. *Curricula: Journal of Curriculum Development, 4*(1), 609-632.
Peer review
This article has been peer-reviewed through the journal's standard double-blind peer review, where both the reviewers and authors are anonymised during review.

https://doi.org/10.17509/curricula.v4i1.86165

INTRODUCTION

Higher education represents one of the most dynamic educational levels, characterized by rapid changes and continuous adaptation to contemporary developments (Kovalenko et al., 2021; Petrychenko et al., 2023). The digital transformation era has fundamentally altered educational paradigms, making technological integration not merely an option but a necessary imperative for institutional survival and excellence. Within this context, artificial intelligence (AI) has emerged as a transformative force with unprecedented potential to revolutionize teaching and learning processes in higher education institutions worldwide (Singh, 2023). The significance of AI integration in higher education extends beyond technological novelty. Current educational challenges include increasing student diversity, the demand for personalized learning, resource constraints, and the need for scalable and high-quality education delivery. Traditional pedagogical approaches often struggle to address these multifaceted challenges effectively, creating a substantial gap between educational aspirations and actual outcomes (Beikian & Derakhshideh, 2024). Statistical data indicate that over 40% of higher education institutions globally face challenges in providing personalized learning experiences, while 60% struggle with resource optimization for diverse student populations (Govea et al., 2023). Consequently, educational transformation through the implementation of AI has become an essential strategy for addressing these systemic challenges while enhancing learning effectiveness and institutional efficiency.

Recent scholarly investigations have demonstrated AI's transformative potential across various dimensions of higher education. A comprehensive analysis of AI applications in educational contexts identified key areas where artificial intelligence can enhance learning outcomes through data-driven personalization and adaptive learning systems (Sumathy & Navamani, 2024). These findings established foundational frameworks for understanding AI's role in educational transformation, with a particular emphasis on the importance of learner-centered approaches in the implementation of technology. Building upon this foundation, the discourse has expanded to include specific AI applications in higher education settings, with a focus on intelligent tutoring systems and automated assessment tools (Khan et al., 2022). Research revealed that AI-powered educational technologies could improve learning efficiency by up to 35% while reducing instructional workload by approximately 25%. Similarly, the integration of AI in learning management systems has demonstrated how machine learning algorithms can predict student performance and provide timely interventions to prevent academic failure (Chen et al., 2020).

The application of AI in instructional design has been extensively explored, showing how artificial intelligence can automate and personalize the development of learning experiences (Davis et al., 2024). This research highlighted the potential for AI to analyze individual learning styles and generate customized content delivery mechanisms, significantly enhancing student engagement and learning outcomes. AI’s capacity to create inclusive learning environments that accommodate diverse student needs and learning preferences has also been demonstrated (Bahroun et al., 2023). Contemporary implementations of AI in higher education have been systematically analyzed in recent literature. Early insights into AI's transformative potential were provided in previous studies (Jarrahi, 2018), while more recent perspectives addressed adoption patterns and implementation challenges (Hassani et

https://doi.org/10.17509/curricula.v4i1.86165

al., 2020; Jiang et al., 2022). These studies collectively indicate that AI technologies, including intelligent learning management systems, virtual assistants, and predictive analytics, have become increasingly prevalent in higher education settings (Bates et al., 2020).

Practical applications of AI technologies have been documented across various institutional contexts. The effectiveness of AI-powered learning management systems in personalizing educational content and improving student engagement has been confirmed (Chen et al., 2020; Kuleto et al., 2021). Virtual assistant technologies have shown significant improvements in student service delivery and administrative efficiency (Belda-Medina & Calvo-Ferrer, 2022; Essel et al., 2022). Predictive analytics applications have revealed substantial potential for improving student retention and academic success through early intervention strategies (Ang et al., 2020; Akçapınar et al., 2019; Ashaari et al., 2021; Yağcı, 2022).

However, the implementation of AI in higher education faces significant challenges that have been systematically documented in the literature. Primary obstacles include data privacy concerns, technological infrastructure limitations, and stakeholder resistance (Bobrytska et al., 2024). Other studies emphasized the critical importance of data security and privacy protection in AI implementation (Aldoseri et al., 2023; Price & Cohen, 2019). While infrastructure requirements and associated costs were also highlighted (Javaid et al., 2022). Challenges related to stakeholder acceptance have been addressed, underscoring the need for comprehensive training and change management strategies (Bates et al., 2020; Strohm et al., 2020). While existing literature provides valuable insights into AI applications in higher education, significant gaps remain in comprehensive trend analysis and systematic evaluation of research development patterns. Previous studies have primarily focused on specific AI applications or implementation challenges within limited institutional contexts, lacking broader perspectives on global research trends and emerging patterns in the field.

This research addresses previous limitations by conducting a comprehensive bibliometric analysis of AI trends in higher education learning, utilizing Scopus-indexed publications from 2018 to 2023. Unlike earlier studies focused on specific AI applications or limited regions, this study offers a systematic global overview of research development, publication trends, and emerging themes in AI-enhanced higher education. Its scientific contribution lies in a thorough methodology that analyzes global research trends, identifies clusters, and maps the evolution of AI applications over a five-year period. This enables the detection of research gaps, emerging trends, and future directions that have not been previously explored. Additionally, by examining geographical and source-based distribution, the study reveals new insights into global collaboration networks and knowledge dissemination in AI education research. Despite the growing literature, a comprehensive understanding of global research trends and development patterns remains lacking due to the fragmentation of studies and rapid technological changes, posing challenges for researchers, practitioners, and policymakers in grasping the current state and future of AI in higher education learning.

The primary research problem addressed in this study is: "How do artificial intelligence trends manifest in higher education learning research, and what patterns emerge from global scholarly publications in this field?" This overarching question encompasses several specific research challenges that require systematic investigation in order to develop a

https://doi.org/10.17509/curricula.v4i1.86165

comprehensive understanding of the field's development. In line with the identified research gaps and the dynamic nature of AI research within higher education, this study formulates the following hypotheses: 1) AI research in higher education learning has experienced significant growth between 2018 and 2023, with accelerated publication rates in recent years; 2) research publications exhibit geographical clustering patterns, with certain regions showing higher concentrations of AI-enhanced education research; 3) source-based publication patterns reveal emerging themes and areas of scholarly focus that reflect both technological advancement and evolving educational needs; and 4) regional distribution patterns indicate varying levels of AI adoption and research intensity across different geographical contexts. These hypotheses guide the analytical direction of the study and provide a structured framework for interpreting the bibliometric evidence.

The purpose of this study is to conduct a comprehensive bibliometric analysis of artificial intelligence (AI) trends in higher education learning, aiming to provide systematic insights into the development patterns of research, publication trends, and emerging themes in the field. To accomplish this, the research focuses on four interconnected dimensions: 1) analyzing the growth of AI-related publications in higher education from 2018 to 2023 in the Scopus database to identify development patterns and research trajectories; 2) examining the distribution of publications by source to highlight key journals, conferences, and publication venues; 3) investigating publication patterns by country to map geographic concentrations and international collaborations; and 4) assessing regional publication distributions to reveal broader spatial trends and disparities. By addressing these dimensions, this study offers valuable insights for educators, researchers, and policymakers regarding the potential and challenges of AI in enhancing learning quality, supporting evidence-based decision-making, and informing strategic frameworks for its integration into higher education.

LITERATURE REVIEW

The use of artificial intelligence (AI) in higher education has become a growing concern in recent years (Bates et al., 2020). The theories and concepts behind the use of AI in higher education can be categorized into four main areas: personalized learning, adaptive learning systems, learning analytics, and automated assessment. Each of these aspects offers different insights into how AI can be applied to improve the teaching and learning process.

Personalized Learning

One of the most significant contributions of AI in education is its ability to personalize learning (Chen et al., 2022; Nobanee et al., 2021; Zhai et al., 2021). Personalized learning refers to a teaching approach that is tailored to an individual's needs, pace, and learning preferences. Personalized learning systems utilize student data to make relevant recommendations and deliver the appropriate learning content at the right time (Shemshack and Spector, 2020). AI technologies, such as machine learning algorithms, enable these systems to analyze students' learning behaviors and provide targeted and useful feedback (Chen et al., 2020).

https://doi.org/10.17509/curricula.v4i1.86165

Personalized learning systems often utilize data collected from various sources, including students' academic records, usage patterns on e-learning platforms, and assessment results (Murtaza et al., 2022). By utilizing this data, AI can identify students' strengths and weaknesses, providing additional materials or customized learning strategies that, in turn, improve student engagement and academic outcomes by offering personalized attention and support tailored to individual needs (Chen et al., 2020).

Adaptive Learning System

Adaptive learning systems are another implementation of AI in higher education that is growing in popularity. This system utilizes algorithms to dynamically adjust difficulty levels and content types in real-time based on students' performance (Sari et al., 2024). For example, if a student is having difficulty with a particular concept, the system can provide additional exercises or explanations to help understand the material (Kasneci et al., 2023).

Adaptive learning systems continuously collect data on students' interactions with learning content and analyze it to determine the optimal approach for delivering subsequent material. This process not only enhances learning effectiveness but also enables teachers to identify and address learning challenges more promptly and accurately (Cheung et al., 2021).

Learning Analytics

Learning analytics, a rapidly evolving approach, uses AI to collect, analyze, and report data about students and the learning environment. Its goal is to understand and optimize both learning processes and contexts (Salas-Pilco et al., 2022). By employing learning analytics tools, higher education institutions can detect patterns in student data that traditional methods might miss, such as identifying students at risk of failing and facilitating timely interventions. This evidence-based approach supports better decision-making in educational settings (Romero & Ventura, 2020).

Automated Grading

Automated grading, a widely used AI application in higher education, can assess various types of student work, from multiple-choice tests to complex essays. It improves assessment efficiency, consistency, reduces teacher workload, and delivers prompt feedback (Cavalcanti et al., 2021; Rudolph et al., 2023). Natural language processing (NLP), a key technology in automated assessment, enables systems to analyze the structure, grammar, and content of student writing. Studies indicate that automated grading can achieve accuracy levels comparable to those of human graders, particularly in formative assessments where timely and specific feedback is crucial (Ramesh & Sanampudi, 2022; Somers et al., 2021).

https://doi.org/10.17509/curricula.v4i1.86165

Collaboration and Social Learning

AI also enhances collaboration and social learning by providing intelligent discussion platforms and study group recommendation systems. These tools help students engage more effectively with peers and instructors. Social learning, defined as learning through social interaction and cooperation, benefits from AI's ability to match students with similar interests or challenges, fostering group formation that strengthens both understanding and collaborative skills (Erbil, 2020; Kew & Tasir, 2020). Additionally, social learning analytics offer insights into group dynamics and student interactions, supporting the design of more effective teaching strategies (Kew & Tasir, 2020).

Instructional Design in the Context of AI

Instructional design (ID) is a systematic process for creating effective and efficient learning experiences. In the context of AI, ID gains importance as AI provides detailed data and analytics on student behavior and learning needs. ID focuses on identifying learning needs, setting objectives, and designing appropriate teaching strategies (Weng et al., 2024). AI supports instructional designers by offering real-time data that informs decisions, such as identifying learning patterns and recommending effective strategies (Ayeni et al., 2024). Furthermore, through adaptive learning systems and learning analytics, designers can continuously update and improve materials based on AI-collected feedback (Yongli & Zhipeng, 2024). AI also facilitates the creation of immersive, interactive learning environments by integrating technologies such as virtual reality (VR) and augmented reality (AR), enabling personalized and contextual learning experiences (Scavarelli et al., 2021).

Ethical Challenges and Issues

Despite AI's benefits, ethical concerns persist, notably algorithmic bias, which may reinforce existing inequalities in assessments and recommendations. Ensuring diversity and inclusivity in AI design and training is crucial (Christyodetaputri & Marwa, 2024). Additionally, data privacy and security issues are significant concerns. The data collected and analyzed by AI systems often includes sensitive personal information of students. Educational institutions must have robust privacy policies and effective data protection mechanisms in place to prevent the misuse of information. Transparency in the use of data and giving students control over their data are important steps in maintaining trust and protecting privacy (Jones et al., 2020).

The Future of AI in Higher Education

The future of AI in higher education promises ongoing innovation and transformation. Emerging developments include more interactive and responsive AI that functions as personalized learning assistants, capable of understanding students' unique contexts and needs to enhance the depth and richness of learning (Mahmoud & Sørensen, 2024).

https://doi.org/10.17509/curricula.v4i1.86165

Furthermore, the integration of AI with other technologies, such as virtual reality (VR) and augmented reality (AR), can create new opportunities for immersive and contextual learning (Scavarelli et al., 2021). VR and AR enable students to learn through hands-on experiences and simulations, which can be further enhanced with AI to provide real-time feedback and tailor content to individual student performance.

METHODS

The method used in this study is a descriptive approach with a bibliometric component, employing quantitative techniques based on bibliometric analysis guidelines (Donthu et al., 2021). As shown in Figure 1, the research commenced by searching for keywords in the Scopus database, specifically "artificial intelligence" and "university." It then continued by locking the initial search results for cluster identification, which were subsequently entered into the VOSviewer application.

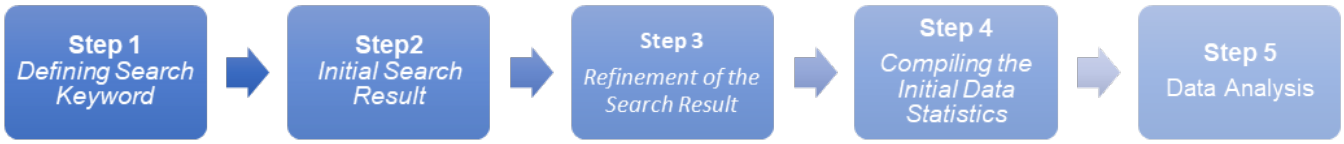

Figure 1. Bibliometric Analysis Procedure
Source: Donthu et al., 2021

Step 1: Defining Search Keyword

The first step in **Figure 1** involves a keyword search in the Scopus database, with options for searching by 'title', 'article', 'abstract', and 'keyword'. A literature search is to be conducted. The keywords used are "aritificial intellgence" OR "AI" and "higher education".

Step 2: Initial Search Results

In the initial search, 1,516 documents were found in the Scopus database for the keyword "artificial intelligence (AI) in universities." This document does not use a time range setting and is sourced from Articles, Conference Papers, Book Chapters, Conference Reviews, Reviews, Books, Editorials, Erratums, and all languages.

Step 3: Refinement of the Search Result

In this stage, a series of restrictions were applied to refine the search results and ensure greater relevance and specificity of the data. First, the publication period was limited to the years 2018-2023. This timeframe was selected to capture the most recent developments and emerging trends in the application of artificial intelligence in higher education learning, ensuring the analysis reflects the current state of research.

Second, the field of study was narrowed to Social Sciences. This decision was based on the understanding that the integration of AI into educational settings often intersects with pedagogical, psychological, and sociocultural dimensions, all of which are central to the social sciences domain.

https://doi.org/10.17509/curricula.v4i1.86165

Third, the search was limited to journal articles only, excluding other types of documents such as conference proceedings, book chapters, and reviews. This criterion was applied to focus on peer-reviewed academic works, which are generally regarded as having higher methodological rigor and scholarly credibility.

Fourth, a geographical restriction was applied to include only documents published in the United Kingdom. This decision was motivated by the interest in examining how AI research in higher education is situated within the context of a specific region with strong educational infrastructure and technological innovation, allowing for a more focused regional analysis.

The refinement process aligns with the PRISMA framework, consisting of four systematic stages: 1) identification; 2) screening; 3) eligibility; and 4) inclusion (Donthu et al., 2021). **Figure 2** below illustrates the document selection process according to these inclusion criteria.

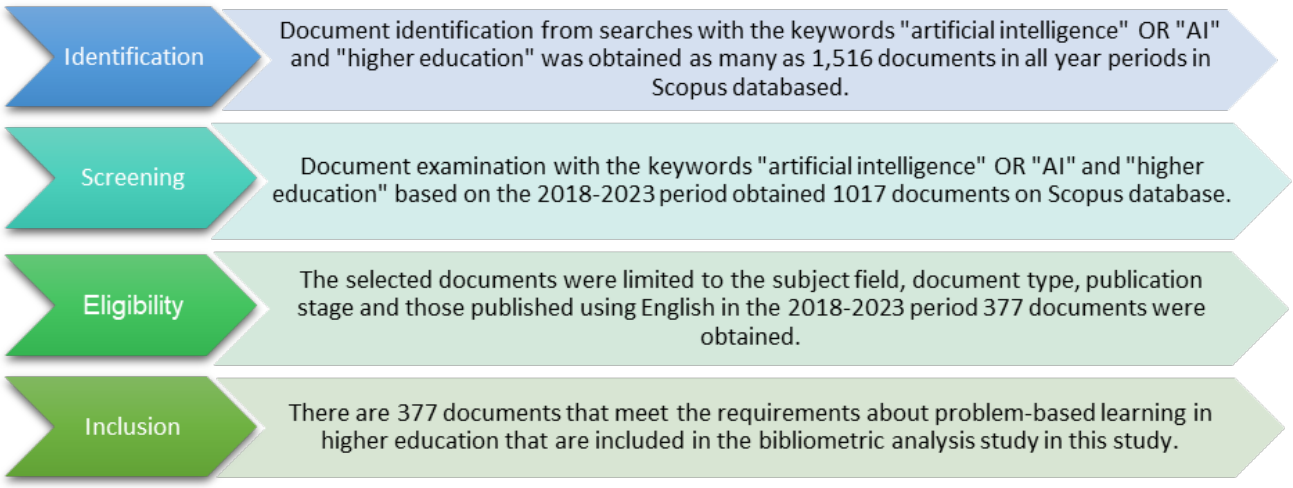

Figure 2. Steps in refining the search result of bibliometric analysis related to "Artificial Intelligence (AI) in Higher Education"
Source: Author's construction 2024.

Step 4: Compiling the Initial Data Statistics

This stage involves an initial statistical analysis of bibliometric data, divided into two main components. First, the mapping of publication growth trends is conducted to observe the development of research productivity over time. This mapping includes the number of publications per year and highlights significant shifts or increases in scholarly interest related to artificial intelligence in higher education.

Second, the performance analysis focuses on identifying key contributors to the field based on country, institution, and author productivity. This includes analyzing the number of publications and citation counts to determine which countries, universities, and authors have had the most significant influence on the development of the research area, using an analytical framework that emphasizes both productivity and impact metrics (Cucari,2023).

Additionally, a narrative synthesis of keyword clusters is conducted to interpret the emerging research themes. This process involves identifying dominant topics, theoretical frameworks, and methodological patterns within the literature. The goal is to provide a structured

https://doi.org/10.17509/curricula.v4i1.86165

summary of thematic areas identified through bibliometric clustering, offering insight into the intellectual landscape of the field.

Step 5: Data Analysis

The data were analyzed using two main approaches: science mapping and performance analysis, with the aid of VOSviewer software. VOSviewer was chosen due to its ability to visualize relationships between entities, such as authors, institutions, countries, and keywords, in the form of network maps, density maps, and temporal graphs. The analysis includes co-occurrence keywords, citations, and bibliographic coupling to identify emerging themes, research trends, and key actors in the field of artificial intelligence in higher education. The results of this analysis are directly linked to the research objectives, specifically mapping the development of publications, the distribution of sources, and the distribution by country and region, as well as identifying collaboration patterns and research development directions. Thus, this bibliometric analysis provides an empirical basis for strategic decision-making in the integration of AI in higher education.

RESULTS AND DISCUSSION

This chapter presents the findings based on bibliometric analysis using the Scopus database and VOSviewer software. The data is described descriptively based on visualizations in the form of graphs and network maps, without interpretation of meaning or impact.

Number of Publications Per Year

Figure 3 illustrates the number of documents published each year from 2018 to 2023 related to the topic of Artificial Intelligence (AI) in higher education, based on the Scopus database. The results of the analysis of publication development from 2018 to 2023 are presented as follows.

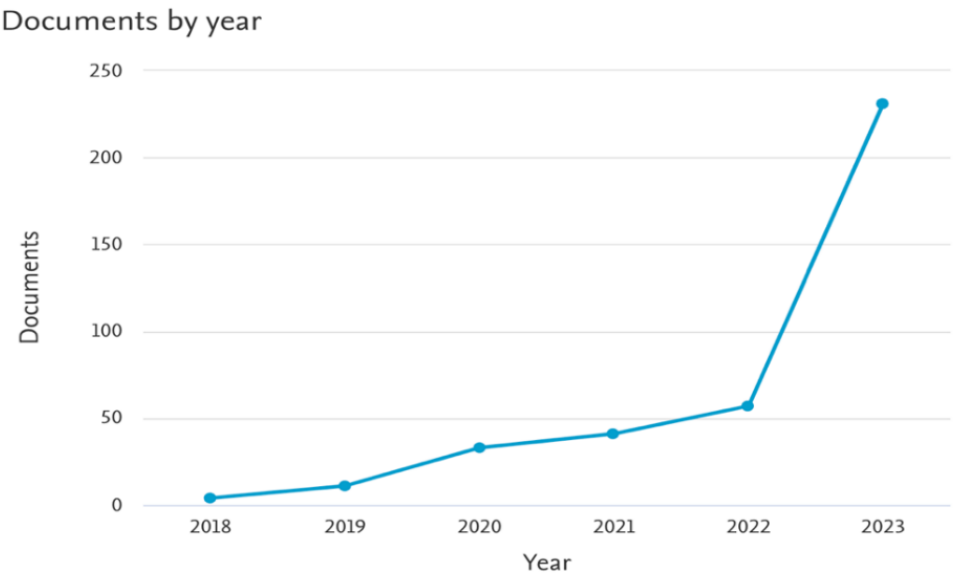

Figure 3. Number of Publications per Year (2018-2023)
Source: Scopus Database, 2024

https://doi.org/10.17509/curricula.v4i1.86165

Figure 3 shows a steady increase in the number of AI-related publications in higher education from 2018 to 2022, followed by a significant surge in 2023. In 2018, only 4 documents were published, indicating limited attention to this topic. A modest rise occurred in 2019, with 12 documents, and a more noticeable growth in 2020, reaching 33 documents. The upward trend continued with 41 publications in 2021 and 57 in 2022. However, the most dramatic increase occurred in 2023, with the number of documents soaring to 233. This sharp rise signals a substantial expansion of academic interest and research output on AI in higher education, possibly driven by advancements in technology and the growing integration of AI tools in educational practices.

Distribution of Publications by Source

Figure 4 presents a longitudinal analysis of the number of documents published annually across five key scholarly sources between 2020 and 2023. The visualization enables the identification of trends and patterns in publication output within the domains of education, learning technology, and sustainability.

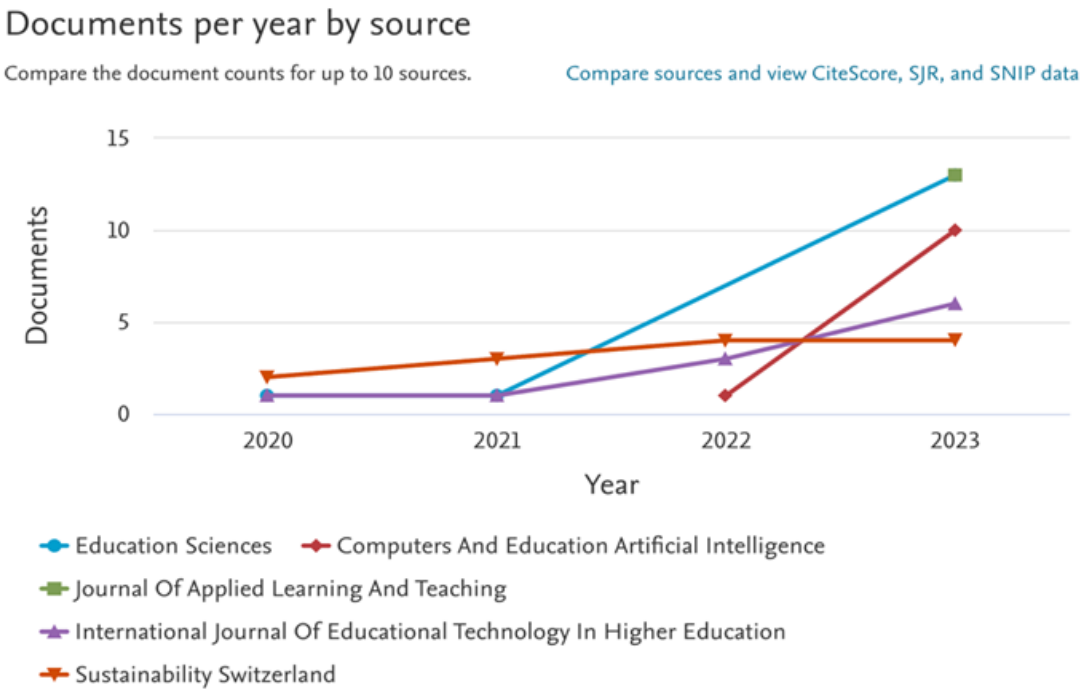

Figure 4. Distribution of Publications by Journal Source
Source: Scopus Database, 2024

Figure 4 shows the distribution of the number of documents published each year by five major journal sources during the period 2020 to 2023. In general, there was an increase in the number of publications across most sources, reflecting the dynamics and trends in research on education, technology, and sustainability. The source with the most significant growth was Education Sciences, which did not publish any documents in 2020 and 2021 but experienced a sharp spike in 2022 (6 documents) and reached its peak in 2023 with 15

https://doi.org/10.17509/curricula.v4i1.86165

documents. This phenomenon shows an increase in researchers' interest in the education issues published in the journal. The Journal of Applied Learning and Teaching also showed a striking trend. However, it only appeared in 2023, it immediately recorded 13 documents, indicating increasing relevance and visibility in the field of applied learning. The same thing happened to Computers and Education Artificial Intelligence, which after no publications for the first two years, increased sharply from only 1 document in 2022 to 10 documents in 2023. This reflects the growing attention to integrating artificial intelligence in education. Meanwhile, the International Journal of Educational Technology in Higher Education shows a steady upward trend from 2020 (1 document) to 2023 (6 documents), indicating the consistency and sustainability of research in educational technology at the higher education level. Unlike the others, Sustainability Switzerland maintains a relatively stable trend, from 2 documents in 2020 to 4 documents in 2023. Overall, the data in Figure 4 depict a non-uniform growth pattern, reflecting the development of cross-disciplinary themes related to education, digital technology, and sustainability in the scientific publication landscape over recent years.

Distribution of Publications by Country or Territory

The Scopus database provides a geographical overview of the distribution of publications related to artificial intelligence (AI). This analysis aims to identify which countries are leading in AI research publications, as reflected in Scopus-indexed journals. **Figure 5** visualizes this distribution by comparing the number of documents published across various countries and regions.

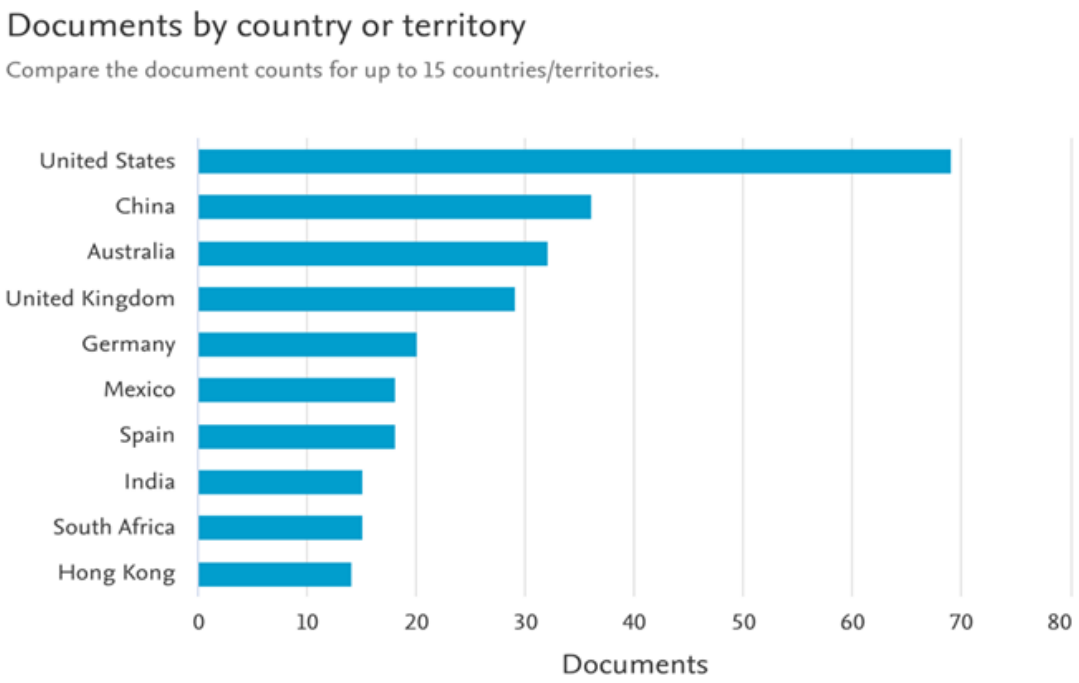

Figure 5. Distribution of Publications by Country
Source: Scopus Database, 2024

https://doi.org/10.17509/curricula.v4i1.86165

Figure 5 shows that the United States emerges as the most dominant contributor to AI-related publications, with a total of 69 documents. This number is significantly higher than that of other countries and reflects the country's consistent investment in AI research and innovation. The United States has long maintained a leadership role in technological development, supported by both academic institutions and private industry.

Following this, China ranks second with 36 documents. This finding underscores China's strategic commitment to AI advancement as a national priority, which is further reinforced by the rapid growth in technological infrastructure and scholarly output. In the third position, Australia contributed 32 documents, demonstrating not only its strong research capacity but also its active engagement in international AI collaboration. Closely behind, the United Kingdom records 29 documents, reaffirming its reputation as a key academic center for AI research, particularly within the European region.

Moving further, Germany contributes 20 documents, a number that aligns with its role as a prominent leader in European scientific and industrial innovation. Meanwhile, several other countries, including Mexico, Spain, India, South Africa, and Hong Kong, each contributed between 13 and 18 documents. Although their numbers are lower, their inclusion indicates a significant and growing global interest in AI development and scholarship.

Notably, the participation of countries from Latin America, South Asia, and Sub-Saharan Africa reveals a positive trend toward the internationalization of AI research. These contributions suggest that the global research community is becoming increasingly inclusive, with a broader array of nations engaging in AI discourse and experimentation.

In summary, while AI research continues to be concentrated in technologically advanced countries, particularly the United States and China, the gradual rise in contributions from various other regions signifies a shift toward a more distributed and global research landscape. This trend supports the notion that artificial intelligence is not only a scientific frontier for industrialized nations but also a shared research priority with widespread academic and societal implications.

Distribution by Subject Category

The analysis of scientific publication trends retrieved from the Scopus database reveals important insights into the interdisciplinary landscape of artificial intelligence (AI) research through the distribution of documents by subject area. **Figure 6** presents a breakdown of publication proportions across various fields of study, offering a clearer view of which academic domains are most actively engaged in AI-related discourse. This analysis is critical for understanding the thematic orientations and scholarly interests that drive the evolution of AI as a multidisciplinary phenomenon.

https://doi.org/10.17509/curricula.v4i1.86165

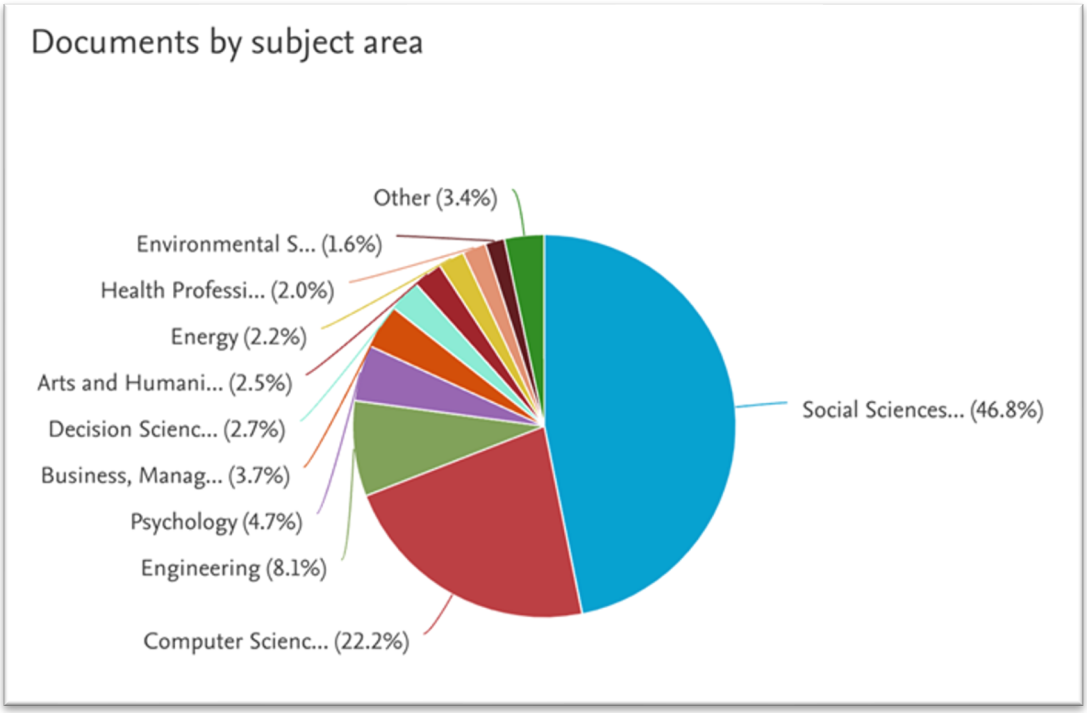

Figure 6. Distribution of Publications by Subject Area
Source: Scopus Database, 2024

Figure 6 shows the distribution of publications by subject area, indicating that the Social Sciences dominates AI-related research output, accounting for 46.8% of total documents. This significant share highlights the growing importance of AI in addressing societal, behavioral, educational, and ethical dimensions, which are central to social science inquiry. The prominence of this field suggests an increased scholarly focus on the human, institutional, and cultural implications of AI technologies. Following this, Computer Science emerges as the second most represented subject area, with 22.2% of the publications. This reflects the foundational role of computational disciplines in the development of AI algorithms, machine learning frameworks, and intelligent systems. The high percentage confirms that technical innovation remains a core component of AI research.

Engineering ranks third with 8.1%, highlighting the integration of AI into hardware systems, robotics, automation, and industrial applications. Psychology, contributing 4.7%, signals growing interest in cognitive modeling, human-computer interaction, and the psychological effects of intelligent technologies. Business, Management and Accounting (3.7%), Decision Sciences (2.7%), and Arts and Humanities (2.5%) also contributed, emphasizing the relevance of AI in organizational decision-making, ethics, and digital culture. Other areas, such as Energy (2.2%), Health Professions (2.0%), and Environmental Science (1.6%) contribute smaller but meaningful proportions, indicating the broadening application of AI in sustainable development, healthcare, and environmental monitoring. The "Other" category (3.4%) encapsulates additional interdisciplinary engagements that further demonstrate the versatility of AI across academic fields.

https://doi.org/10.17509/curricula.v4i1.86165

Keyword Network Visualization

This section presents the results of bibliometric keyword analysis using VOSviewer software. The visualizations aim to illustrate the structural and temporal relationships between frequently occurring terms within the literature on artificial intelligence in higher education. This analysis covers three dimensions: the co-occurrence of keywords (**Figure 7**), the chronological overlay of keyword emergence (**Figure 8**), and the density of keyword usage (**Figure 9**). All three visualizations have been combined into one comprehensive figure to provide a holistic understanding of keyword distribution.

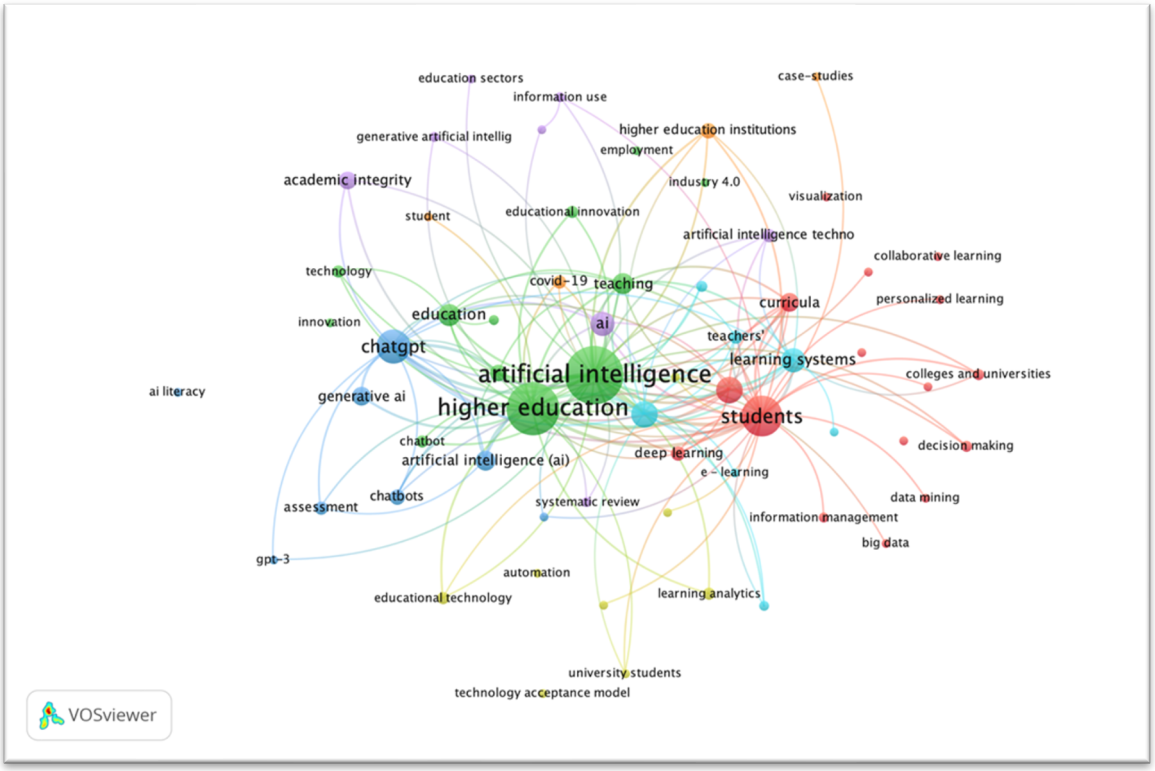

Figure 7. Composite Visualization of Keyword Networks: Co-occurrence
Source: VOSviewer Analysis Result, 2024

The first part of the composite **Figure 7**, the co-occurrence network, reveals the main thematic structure within the AI in higher education literature. At the center of this network are two dominant and closely related concepts: "artificial intelligence" and "higher education." These terms serve as hubs connected to various subthemes, including "students," "learning systems," "collaborative learning," and "personalized learning." These relationships suggest that AI is deeply embedded in efforts to enhance educational delivery, support student-centered approaches, and optimize learning management. Additional keywords such as "information management" and "virtual assistants" also appear, reflecting the growing application of AI in both administrative and instructional contexts. The visualization underlines the multidimensional nature of AI integration, encompassing technological tools, pedagogical strategies, and learner engagement.

https://doi.org/10.17509/curricula.v4i1.86165

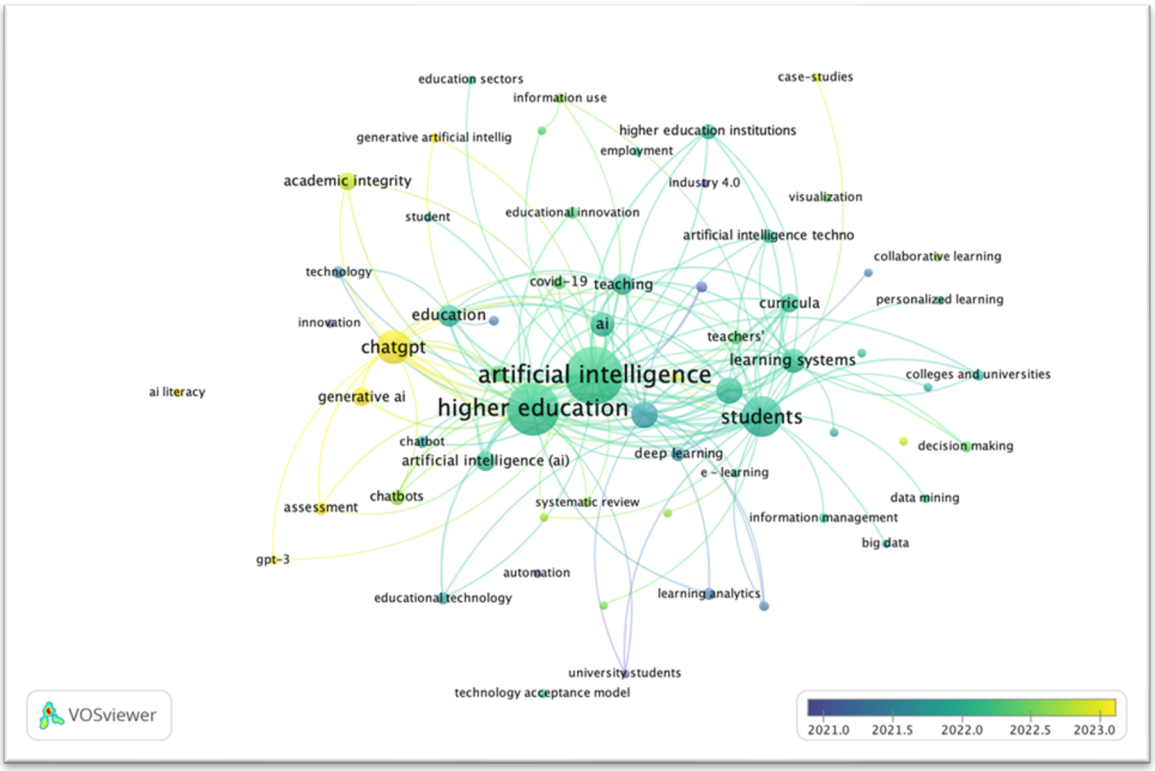

Figure 8. Composite Visualization of Keyword Networks: Co-occurrence, Overlay by Year, and Density Map
Source: VOSviewer Analysis Result, 2024

The second part (**Figure 8**), the overlay visualization, adds a temporal dimension by showing the average year of appearance for each keyword. A gradient color scheme, ranging from blue (older) to yellow (newer), is used to indicate this progression. Notably, yellow nodes highlight the emergence of recent terms, such as "ChatGPT," "generative AI," and "assessment," which experienced a surge in usage between 2022 and 2023. These keywords highlight the impact of recent technological advancements and educational needs on shaping research directions. In contrast, older terms like "learning analytics" and "technology," shown in blue, have maintained a foundational presence since 2018. Cluster groupings in this overlay map further categorize keywords into thematic areas: green clusters represent innovation in education and AI applications, yellow clusters highlight academic integrity and chatbot usage, and blue and purple clusters focus on e-learning systems and information technology. Together, the overlay view illustrates a dynamic evolution of focus in AI and higher education research over the past five years.

https://doi.org/10.17509/curricula.v4i1.86165

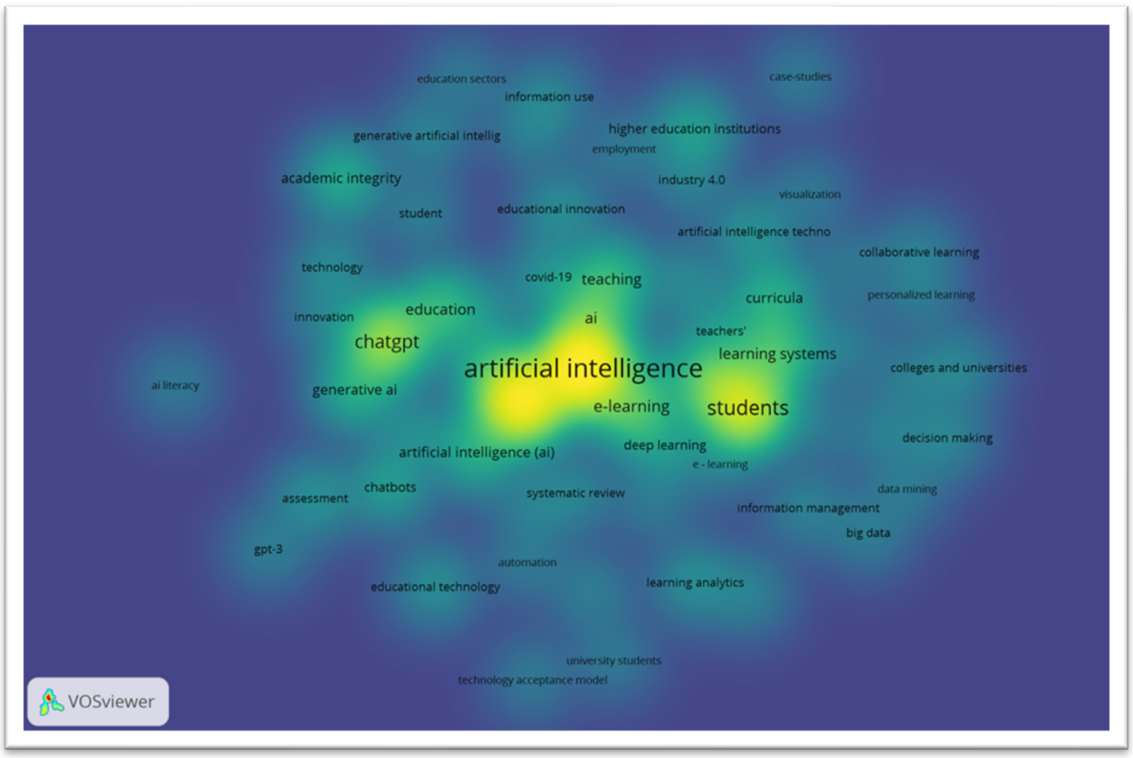

Figure 9. Composite Visualization of Keyword Networks: Co-occurrence, Overlay by Year, and Density Map
Source: VOSviewer Analysis Result, 2024

The third component, the density map (**Figure 9**), visualizes the concentration of keyword occurrences to highlight the areas that are most intensively studied. In this map, bright yellow and green colors indicate regions of high keyword density, with "artificial intelligence," "higher education," "students," and "learning systems" again appearing as central topics. This high density confirms their importance and consistent attention in scholarly discussions. Keywords such as "ChatGPT," "generative AI," "deep learning," and "chatbots" are also shown with significant density, reflecting their rising prominence as research interests. Although slightly less intense, terms like "academic integrity," "AI literacy," and "COVID-19 teaching" still display noticeable density, emphasizing the expanding concern for ethical and contextual implications of AI use. The density map thus complements the co-occurrence and overlay results by confirming the frequency and centrality of emerging and core concepts within the field.

Discussion

The dramatic surge in publications in 2023 can be interpreted as an academic response to the launch and mass adoption of ChatGPT in late 2022. This phenomenon illustrates how technological breakthroughs can rapidly alter research agendas and generate new momentum in academic disciplines. The dominance of Social Sciences in the subject area distribution reflects the awareness that AI implementation in education is not only a technical challenge but also requires deep understanding of social, cultural, and pedagogical aspects.

https://doi.org/10.17509/curricula.v4i1.86165

The emergence of keywords such as "ChatGPT" and "generative AI" as the latest trends indicates a shift in focus from rule-based AI toward more sophisticated generative AI. Meanwhile, the emergence of "academic integrity" as a theme highlights academic concerns about the ethical implications and new challenges posed by generative AI technology. This pattern indicates that the academic community is not only enthusiastic about adopting new technologies but also proactive in identifying and addressing accompanying risks.

The results of this analysis reveal patterns consistent with previous bibliometric research, which enables researchers to detect emerging trends and map intellectual structures within a research field (Donthu et al., 2021). This study confirms the utility of such an approach by identifying a thematic progression from foundational terms, such as "learning analytics," toward more application-based concepts, including "ChatGPT" and "assessment." These developments align with findings that AI in education is evolving from data analysis tools to interactive and generative systems (Guleria & Kaur, 2021).

The findings regarding the dominance of certain countries in research contributions also align with the argument that global research on AI in education is driven by both technological readiness and institutional agendas (Cucari, 2023). The widespread geographical distribution, as reflected in the contributions of various countries, confirms this perspective, where countries with advanced technological infrastructure tend to lead in research productivity. These results also align with findings that emphasize the importance of temporal mapping in identifying shifts in academic focus (Moral-Muñoz et al., 2020).

The emergence of terms related to "academic integrity" and "AI literacy" in the keyword analysis supports findings about the need for ethical frameworks and digital competence in the adoption of AI (Christyodetaputri & Marwa, 2024). This also confirms research showing that new topics such as "generative AI" and "chatbots" have begun to gain greater attention in recent years, signaling a shift in research focus toward more sophisticated and applicable AI technologies (Schöbel et al., 2024). Meanwhile, the challenges of AI implementation in higher education identified in this study align with findings regarding data privacy and security issues, technological infrastructure readiness, and resistance from staff and students (Bobrytska et al., 2024).

These findings confirm and extend Rogers' diffusion of innovation theory in the context of educational technology, where AI adoption in higher education has entered the early majority phase, marked by accelerated publication and diversified applications (Chen, 2024). The dominance of Social Sciences in AI higher education research supports the social constructivist theory, which emphasizes the importance of social and cultural contexts in the implementation of technology (Chang, 2025). The emergence of different thematic clusters also supports the application of complexity theory in educational systems, where AI integration creates nonlinear interactions between various educational system components (Ouyang et al., 2023).

For higher education practitioners, these findings indicate the need to develop comprehensive AI literacy competencies, focusing not only on technical aspects but also understanding social and ethical implications (Al-Zahrani & Alasmari, 2024). The emergence of ChatGPT and generative AI as dominant trends necessitates that higher education institutions develop clear usage frameworks, including guidelines for academic integrity and best practices for integrating AI into learning and research processes (Batista et al., 2024).

https://doi.org/10.17509/curricula.v4i1.86165

This aligns with findings emphasizing the need for significant investment in technological infrastructure and staff training for effective AI adoption (Chan, 2023).

Higher education institutions also need to develop internal capacity for interdisciplinary AI research, given the dominance of Social Sciences and Computer Science in publications. This implies the need for cross-disciplinary collaboration and investment in research infrastructure supporting interdisciplinary approaches (Farooq et al., 2023). This research also confirms the perspective that with the right approach, AI has great potential to create a more inclusive, personalized, and effective learning environment, driving positive transformation in higher education in the future (Aithal & Maiya, 2023).

From a national policy perspective, the concentration of research in developed countries indicates a digital divide in AI higher education research capacity. This requires governments in developing countries to develop national strategies that include investment in research infrastructure, human resource training, and international partnerships to avoid inequality in access and utilization of AI technology (Aderibigbe et al., 2023). The emergence of academic integrity issues as a significant theme also implies the need to develop regulations and standards governing the use of AI in academic contexts. These policies must strike a balance between encouraging innovation and maintaining academic integrity, while considering the ethical and legal aspects related to the use of generative AI (Fowler, 2023).

The findings about generative AI trends also necessitate the development of adaptive and responsive policies to keep pace with rapid technological developments. This requires effective monitoring and evaluation mechanisms to identify emerging trends and anticipate their impact on higher education systems. Additionally, policy frameworks that support interdisciplinary research and international collaboration are needed to maximize the potential of AI in sustainable and inclusive higher education transformation.

CONCLUSION

This study aims to conduct a comprehensive bibliometric analysis of artificial intelligence (AI) research in higher education learning by investigating publication trends, source distributions, geographical patterns, and thematic developments between 2018 and 2023. The findings address the research problem concerning the lack of systematic mapping of AI integration in the higher education context. The analysis of publication growth reveals a significant upward trend, particularly in 2023, which aligns with the growing interest in AI technologies, such as ChatGPT and generative AI. This development reflects the expanding role of AI in education, both as a research topic and a practical solution in post-pandemic learning environments.

Furthermore, the source-based distribution shows that the majority of influential research appears in interdisciplinary journals, particularly those focused on education and sustainability. This finding supports the objective of identifying key publication venues and highlights the cross-sectoral nature of AI-related scholarship. Additionally, the study maps the global distribution of research activity, revealing that countries like the United States, China, Australia, and the United Kingdom are leading contributors. These findings fulfill the objective of identifying regional publication concentrations and demonstrate the international dimension of AI development in higher education.

https://doi.org/10.17509/curricula.v4i1.86165

Keyword network visualization reveals dominant themes, including "higher education," "students," and "learning systems," as well as emerging terms such as "generative AI," "ChatGPT," and "AI literacy." These reflect both continuity and innovation within the research landscape, fulfilling the objective of tracing thematic shifts. Taken together, the findings align with both the problem formulation and the research objectives by offering a structured overview of how AI research in higher education has evolved, where it is published, who contributes to it, and what themes dominate the field.

Future studies should incorporate citation analysis and author co-authorship networks to identify the most influential scholars and collaborative hubs in the AI and education domain. Moreover, comparative bibliometric studies across regions or disciplines could offer a deeper understanding of contextual differences in AI implementation in higher education. Expanding the data source beyond Scopus, such as including Web of Science or Dimensions, would also improve the robustness of future bibliometric insights.

REFERENCES

Aderibigbe, A. O., Ohenhen, P. E., Nwaobia, N. K., Gidiagba, J. O., & Ani, E. C. (2023). Artificial intelligence in developing countries: Bridging the gap between potential and implementation. *Computer Science and IT Research Journal*, *4*(3), 185-199.

Aithal, P. S., & Maiya, A. K. (2023). Innovations in higher education industry-shaping the future. *International Journal of Case Studies in Business, IT, and Education (IJCSBE)*, *7*(4), 283-311.

Akçapınar, G., Altun, A., & Aşkar, P. (2019). Using learning analytics to develop early-warning system for at-risk students. *International Journal of Educational Technology in Higher Education*, *16*(1), 1-20.

Aldoseri, A., Al-Khalifa, K. N., & Hamouda, A. M. (2023). Re-thinking data strategy and integration for artificial intelligence: Concepts, opportunities, and challenges. *Applied Sciences*, *13*(12), 1-33.

Al-Zahrani, A. M., & Alasmari, T. M. (2024). Exploring the impact of artificial intelligence on higher education: The dynamics of ethical, social, and educational implications. *Humanities and Social Sciences Communications*, *11*(1), 1-12.

Ang, K. L. M., Ge, F. L., & Seng, K. P. (2020). Big educational data & analytics: Survey, architecture and challenges. *IEEE access*, *8*(2020), 116392-116414.

Ashaari, M. A., Singh, K. S. D., Abbasi, G. A., Amran, A., & Liebana-Cabanillas, F. J. (2021). Big data analytics capability for improved performance of higher education institutions in the Era of IR 4.0: A multi-analytical SEM & ANN perspective. *Technological Forecasting and Social Change*, *173*(2021), 1-16.

https://doi.org/10.17509/curricula.v4i1.86165

Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalized learning and educational technology. *GSC Advanced Research and Reviews*, *18*(2), 261-271.

Bahroun, Z., Anane, C., Ahmed, V., & Zacca, A. (2023). Transforming education: A comprehensive review of generative artificial intelligence in educational settings through bibliometric and content analysis. *Sustainability*, *15*(17), 1-40.

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education?. *International Journal of Educational Technology in Higher Education*, *17*(42), 1-12.

Batista, J., Mesquita, A., & Carnaz, G. (2024). Generative AI and higher education: Trends, challenges, and future directions from a systematic literature review. *Information*, *15*(11), 1-27.

Beikian, A., & Derakhshideh, M. K. (2024). Multifaceted challenges in English language education: Perspectives from secondary school teachers and students in Baluchistan, Iran. *Journal of English Language Teaching and Learning*, *16*(34), 443-462.

Belda-Medina, J., & Calvo-Ferrer, J. R. (2022). Using chatbots as AI conversational partners in language learning. *Applied Sciences*, *12*(17), 1-16.

Bobrytska, V. I., Krasylnykova, H. V., Beseda, N. A., Krasylnykov, S. R., & Skyrda, T. S. (2024). Artificial Intelligence (AI) in Ukrainian higher education: A comprehensive study of stakeholder attitudes, expectations and concerns. *International Journal of Learning, Teaching and Educational Research*, *23*(1), 400-426.

Cavalcanti, A. P., Barbosa, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Mello, R. F. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, *2*(2021), 1-17.

Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, *20*(38), 1-25.

Chang, H. (2025). The research direction of emerging human enhancement technology from the perspective of social constructivism. *Studies on Religion and Philosophy*, *1*(1), 95-108.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*(2020), 75264-75278.

Chen, R. (2024). A study applying rogers' innovation diffusion theory on the adoption process of new teaching methods in secondary education. *Research and Advances in Education*, *3*(2), 6-10.

https://doi.org/10.17509/curricula.v4i1.86165

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two decades of artificial intelligence in education. *Educational Technology and Society*, *25*(1), 28-47.

Cheung, S. K., Kwok, L. F., Phusavat, K., & Yang, H. H. (2021). Shaping the future learning environments with smart elements: Challenges and opportunities. *International Journal of Educational Technology in Higher Education*, *18*(16), 1-9.

Christyodetaputri, J. H., & Marwa, N. (2024). Realizing ethical and equitable assessment in global education through artificial intelligence. *Sinergi International Journal of Education*, *2*(3), 170-186.

Cucari, N., Tutore, I., Montera, R., & Profita, S. (2023). A bibliometric performance analysis of publication productivity in the corporate social responsibility field: Outcomes of SciVal analytics. *Corporate Social Responsibility and Environmental Management*, *30*(1), 1-16.

Davis, C., Bush, T., & Wood, S. (2024). Artificial intelligence in education: Enhancing learning experiences through personalized adaptation. *International Journal of Cyber and IT Service Management*, *4*(1), 26-32.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*(1), 285-296.

Erbil, D. G. (2020). A review of flipped classroom and cooperative learning method within the context of Vygotsky theory. *Frontiers in Psychology*, *11*(1157), 1-9.

Essel, H. B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E. E., & Baah, P. K. (2022). The impact of a virtual teaching assistant (chatbot) on students' learning in Ghanaian higher education. *International Journal of Educational Technology in Higher Education*, *19*(1), 1-19.

Farooq, M., Buzdar, H. Q., & Muhammad, S. (2023). AI-Enhanced Social Sciences: A systematic literature review and bibliographic analysis of web of science published research papers. *Pakistan Journal of Society, Education and Language (PJSEL)*, *10*(1), 250-267.

Fowler, D. S. (2023). AI in higher education: academic integrity, harmony of insights, and recommendations. *Journal of Ethics in Higher Education*, (3), 127-143.

Govea, J., Ocampo Edye, E., Revelo-Tapia, S., & Villegas-Ch, W. (2023). Optimization and scalability of educational platforms: Integration of artificial intelligence and cloud computing. *Computers*, *12*(11), 1-20.

Guleria, D., & Kaur, G. (2021). Bibliometric analysis of ecopreneurship using VOSviewer and RStudio Bibliometrix, 1989-2019. *Library Hi Tech*, *39*(4), 1001-1024.

https://doi.org/10.17509/curricula.v4i1.86165

Hassani, H., Silva, E. S., Unger, S., TajMazinani, M., & Mac Feely, S. (2020). Artificial Intelligence (AI) or Intelligence Augmentation (IA): What is the future?. *AI*, *1*(2), 143-155.

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, *61*(4), 577-586.

Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2022). Artificial intelligence applications for industry 4.0: A literature-based study. *Journal of Industrial Integration and Management*, *7*(1), 83-111.

Jiang, Y., Li, X., Luo, H., Yin, S., & Kaynak, O. (2022). Quo vadis artificial intelligence?. *Discover Artificial Intelligence*, *2*(1), 1-19.

Jones, K. M., Asher, A., Goben, A., Perry, M. R., Salo, D., Briney, K. A., & Robertshaw, M. B. (2020). "We're being tracked at all times": Student perspectives of their privacy in relation to learning analytics in higher education. *Journal of the Association for Information Science and Technology*, *71*(9), 1044-1059.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*(2023), 102274-102286.

Kew, S. N., & Tasir, Z. (2022). Learning analytics in online learning environment: A systematic review on the focuses and the types of student-related analytics data. *Technology, Knowledge and Learning*, *27*(2), 405-427.

Khan, M. A., Khojah, M., & Vivek. (2022). Artificial intelligence and big data: The advent of new pedagogy in the adaptive e-learning system in the higher educational institutions of Saudi Arabia. *Education Research International*, *2022*(1), 1-10.

Kovalenko, M., Lomonosova, O., & Rusnak, A. (2021). Strategies and technologies of adaptive management of higher education institutions in a rapidly changing external environment. *Baltic Journal of Economic Studies*, *7*(2), 118-128.

Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O. M., Păun, D., & Mihoreanu, L. (2021). Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. *Sustainability*, *13*(18), 1-16.

Mahmoud, C. F., & Sørensen, J. T. (2024). Artificial intelligence in personalized learning with a focus on current developments and future prospects. *Research and Advances in Education*, *3*(8), 25-31.

Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *Profesional de la Información*, *29*(1),1-20.

https://doi.org/10.17509/curricula.v4i1.86165

Murtaza, M., Ahmed, Y., Shamsi, J. A., Sherwani, F., & Usman, M. (2022). AI-based personalized e-learning systems: Issues, challenges, and solutions. *IEEE Access*, *10*(2022), 81323-81342.

Nobanee, H., Al Hamadi, F. Y., Abdulaziz, F. A., Abukarsh, L. S., Alqahtani, A. F., AlSubaey, S. K., ... & Almansoori, H. A. (2021). A bibliometric analysis of sustainability and risk management. *Sustainability*, *13*(6), 1-16.

Ouyang, F., Xu, W., & Cukurova, M. (2023). An artificial intelligence-driven learning analytics method to examine the collaborative problem-solving process from the complex adaptive systems perspective. *International Journal of Computer-Supported Collaborative Learning*, *18*(1), 39-66.

Petrychenko, O., Petrichenko, I., Burmaka, I., & Vynohradova, A. (2023). Changes in modern university: Challenges of today and development trends. *Transport Systems and Technologies*, *41*(2023), 74-83.

Price, W. N., & Cohen, I. G. (2019). Privacy in the age of medical big data. *Nature Medicine*, *25*(1), 37-43.

Ramesh, D., & Sanampudi, S. K. (2022). An automated essay scoring systems: A systematic literature review. *Artificial Intelligence Review*, *55*(3), 2495-2527.

Romero, C., & Ventura, S. (2020). Educational data mining and learning analytics: An updated survey. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *10*(3), 1-21.

Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?. *Journal of Applied Learning and Teaching*, *6*(1), 342-363.

Salas-Pilco, S. Z., Xiao, K., & Hu, X. (2022). Artificial intelligence and learning analytics in teacher education: A systematic review. *Education Sciences*, *12*(8), 1-18.

Sari, H. E., Tumanggor, B., & Efron, D. (2024). Improving educational outcomes through adaptive learning systems using AI. *International Transactions on Artificial Intelligence*, *3*(1), 21-31.

Scavarelli, A., Arya, A., & Teather, R. J. (2021). Virtual reality and augmented reality in social learning spaces: A literature review. *Virtual Reality*, *25*(1), 257-277.

Schöbel, S., Schmitt, A., Benner, D., Saqr, M., Janson, A., & Leimeister, J. M. (2024). Charting the evolution and future of conversational agents: A research agenda along five waves and new frontiers. *Information Systems Frontiers*, *26*(2), 729-754.

Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, *7*(1), 1-20.

https://doi.org/10.17509/curricula.v4i1.86165

Singh, R. J. (2023). Transforming higher education: The power of artificial intelligence. *International Journal of Multidisciplinary Research in Arts, Science and Technology*, *1*(3), 13-18.

Somers, R., Cunningham-Nelson, S., & Boles, W. (2021). Applying natural language processing to automatically assess student conceptual understanding from textual responses. *Australasian Journal of Educational Technology*, *37*(5), 98-115.

Strohm, L., Hehakaya, C., Ranschaert, E. R., Boon, W. P., & Moors, E. H. (2020). Implementation of Artificial Intelligence (AI) applications in radiology: Hindering and facilitating factors. *European radiology*, *30*(2020), 5525-5532.

Sumathy, V., & Navamani, G. (2024). AI-Driven personalized learning: enhancing student success through adaptive technologies. *Library of Progress-Library Science, Information Technology & Computer*, *44*(3), 1-5.

Weng, X., Ye, H., Dai, Y., & Ng, O. L. (2024). Integrating artificial intelligence and computational thinking in educational contexts: A systematic review of instructional design and student learning outcomes. *Journal of Educational Computing Research*, *62*(6), 1640-1670.

Yağcı, M. (2022). Educational data mining: prediction of students' academic performance using machine learning algorithms. *Smart Learning Environments*, *9*(1), 1-19.

Yongli, G., Qi, D., & Zhipeng, C. (2024). Leveraging the synergy of ipv6, generative AI, and web engineering to create a big data-driven education platform. *Journal of Web Engineering*, *23*(2), 197-226.

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y. (2021). A Review of Artificial Intelligence (AI) in education from 2010 to 2020. *Complexity*, *2021*(1), 1-18.

https://doi.org/10.17509/curricula.v4i1.86165