

Mapping International Collaboration and Research Hotspots in Educational Technology: A VOSviewer Analysis

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ABSTRACT

Educational technology has become one of the fastest-evolving fields in global education research. However, disparities in international collaboration and thematic focus remain underexplored. This study aims to map global research trends, collaboration patterns, and emerging hotspots in educational technology over the past decade. A bibliometric analysis was conducted using data from the Scopus database, covering the period 2015–2024. The dataset included 2,850 documents consisting of journal articles and conference papers retrieved using the keywords “educational technology,” “digital learning,” and “e-learning.” Data were analyzed using VOSviewer 1.6.20 to visualize co-authorship by country and author, as well as keyword co-occurrence networks. The findings reveal four major collaboration clusters dominated by the United States ($n = 742$), China ($n = 533$), United Kingdom ($n = 417$), Spain ($n = 248$), and India ($n = 220$). Keyword analysis shows a thematic shift from blended learning and MOOCs (pre-2020) to online learning and COVID-19 education (2020–2022), followed by AI in education, learning analytics, and digital literacy (2022–2024). Six main author clusters were identified, though collaboration density remains low (<0.25).

Indonesia contributed 74 publications, mainly collaborating with Malaysia, Australia, Japan, and the United Kingdom, indicating an emerging but developing research role. Global educational technology research remains concentrated in developed countries, yet participation from Asia particularly Indonesia is growing. The results highlight the need for stronger international collaboration, methodological improvement, and inclusive research ecosystems to ensure equitable development in digital education scholarship.

INTRODUCTION

The transformation of education in the 21st century has been largely influenced by the unprecedented advancement of digital and information technology. Educational systems worldwide are increasingly integrating technology to enhance learning effectiveness, accessibility, and global competitiveness. The evolution from traditional teaching to technology-based learning environments reflects not only a pedagogical shift but also an epistemological transformation in how knowledge is created, shared, and utilized (Adinda et al., 2024). These dynamics have accelerated the emergence of educational technology (EdTech) as a central discipline in both research and practice, highlighting the importance of global collaboration in generating innovative educational paradigms.

The increasing complexity of global educational challenges requires collaborative efforts across nations and institutions. International cooperation allows researchers and educators to exchange methodologies, adapt to cultural and technological diversity, and address global educational inequalities. The rise of digital learning platforms, artificial intelligence, and outcome-based education frameworks illustrates that educational progress depends on how effectively knowledge networks are formed and sustained across borders (Li & Rohayati, 2023). The interconnectedness among researchers signifies a paradigm in which educational technology becomes not merely a support tool but an ecosystem fostering interdisciplinary innovation.

Bibliometric analysis has emerged as a robust approach to exploring research dynamics and intellectual structures within education. By combining citation mapping and co-authorship analysis, bibliometric tools enable researchers to visualize the evolution of academic collaboration, research hotspots, and emerging trends (Ding & Yang, 2022). VOSviewer, developed by Leiden University, is one of the most widely used software for such purposes, offering precise visualization of author networks, institutional collaborations, and keyword co-occurrence patterns (Fahrni et al., 2025). Its application in educational technology research reveals how knowledge dissemination and collaboration evolve within global academic communities.

The field of educational technology is undergoing significant diversification, encompassing themes such as artificial intelligence in education (AIED), digital pedagogy, and data-driven learning environments. A growing body of literature has explored how artificial intelligence transforms educational design, curriculum development, and student engagement (Susilowati et al., 2024). However, limited studies have systematically examined how these technological advancements intersect with international collaboration networks. Mapping these connections provides essential insights into which regions, institutions, and scholars play pivotal roles in shaping global educational research directions.

The post-pandemic era intensified digitalization in education, further underscoring the need for cross-border collaboration. The sudden shift to online learning during COVID-19 forced institutions worldwide to adapt rapidly to digital solutions, amplifying disparities between technologically advanced and developing nations (Wang & Liu, 2025). This condition accelerated not only the adoption of EdTech but also the necessity to understand global cooperation patterns that support equitable access and innovation in education. Comprehensive bibliometric visualization is crucial to identify how international collaborations influence the trajectory of educational technology development.

Knowledge mapping through VOSviewer offers a methodological advantage in identifying patterns of global engagement and intellectual convergence. By analyzing co-authorship and co-citation networks, scholars can trace how collaborative structures evolve and where research clusters emerge. Previous bibliometric works in related fields such as platform studies and outcome-based education have demonstrated that international partnerships are a determining factor for scientific advancement and innovation (Harverson et al., 2025). Applying this analytical lens to educational technology provides a macro-level understanding of how global educational research communities are interconnected.

A review of previous research indicates that developed countries dominate the global publication landscape in educational technology. Nations such as the United States, the United Kingdom, and China have emerged as leading contributors to digital learning and educational innovation. Nevertheless, developing countries, particularly in Southeast Asia, are beginning to establish significant contributions through regional cooperation and academic mobility programs. Mapping these contributions helps identify not only geographical disparities but also potential partnerships that can bridge the global digital divide.

Research hotspots in educational technology reflect evolving priorities, from early concerns about online learning platforms to contemporary interests in artificial intelligence, adaptive learning systems, and educational data analytics. Identifying these thematic transitions is vital for predicting future directions and informing policy and practice. Bibliometric mapping reveals that while earlier studies focused on instructional media and e-learning, current trends increasingly emphasize student-centered innovation, learning analytics, and cognitive

engagement supported by intelligent systems. Such insights underscore the need for continuous interdisciplinary collaboration among educators, technologists, and policymakers.

The current study aims to map the international collaboration and research hotspots in educational technology using bibliometric analysis through VOSviewer. The study provides a systematic overview of global research structures, key contributors, and emerging thematic focuses in the field. The findings are expected to assist scholars, institutions, and policymakers in understanding the patterns of knowledge exchange that drive innovation in education. By visualizing collaboration networks and research trends, this analysis seeks to enhance the global discourse on how technology can transform learning systems and foster equitable academic growth worldwide.

METHOD

Research Design

This study employed a quantitative descriptive design through a bibliometric analysis approach using the VOSviewer software. Bibliometric analysis provides a structured method to assess scientific publications, identify collaboration networks, and uncover intellectual patterns within a research domain (Ding & Yang, 2020). The approach allows for the visualization of relationships among authors, institutions, countries, and frequently occurring keywords, offering insights into research structures and thematic development trends. In this study, bibliometric mapping was used to explore international collaboration patterns and research hotspots in the field of *Educational Technology*. The design followed previous bibliometric models applied by (Li & Rohayati, 2023), ensuring methodological consistency and analytical rigor.

Data Source and Collection

All bibliometric data were retrieved from the Scopus database, which is recognized for its comprehensive coverage and reliability in indexing peer-reviewed scientific literature. Scopus was selected due to its multidisciplinary scope and its compatibility with VOSviewer data formats. The search query used included the following terms: "educational technology" OR "digital learning" OR "e-learning" OR "technology in education" The search was limited to the period of 2015–2024, focusing on journal articles and conference papers written in English. The inclusion of a decade-long period allowed the study to capture the evolution of global educational technology research, particularly during and after the COVID-19 pandemic. The retrieved dataset was exported in CSV and RIS formats for subsequent analysis.

An initial screening was conducted to ensure data quality and relevance. Articles were excluded if they (1) were not open access, (2) were shorter than four pages, (3) lacked full-text availability, or (4) were unrelated to educational technology as indicated by their keywords and abstracts. After filtering, a total of 2,850 valid documents remained for analysis. This process followed the systematic bibliometric data refinement stages proposed by (Kucirkova et al., 2025), ensuring consistency and transparency in data selection.

The bibliometric workflow consisted of five stages:

1. Data Retrieval: Downloading bibliographic records from Scopus using the selected keywords and parameters.
2. Data Cleaning: Removing duplicates and irrelevant records to maintain data validity.
3. Network Construction: Uploading cleaned datasets into VOSviewer to generate maps of co-authorship, co-citation, and keyword co-occurrence.
4. Visualization and Clustering: Applying network, overlay, and density visualizations to interpret relationships between countries, institutions, and thematic clusters.

5. Interpretation and Validation: Analyzing visual outputs to identify core contributors, emerging themes, and collaboration trends.

These stages align with the bibliometric mapping framework applied in prior research enabling both quantitative and visual interpretation of scientific collaboration in the educational technology domain. VOSviewer (version 1.6.20) was utilized as the primary analytical tool due to its ability to visualize bibliometric networks based on co-authorship, citation, and keyword linkages. The software enables clustering and density visualization, facilitating the identification of research hotspots and highly connected collaboration networks. Additionally, Microsoft Excel was used for preliminary data cleaning, tabulation, and descriptive statistics, while R Studio (Bibliometrix package) supported cross-validation of the citation network results. Combining these tools ensured analytical robustness and reduced potential biases in network visualization.

Indicators and Analytical Parameters

The bibliometric indicators examined included:

1. Publication productivity: Number of documents per country, institution, and author.
2. Citation impact: Total citations and average citations per publication.
3. Co-authorship network: Mapping collaborative ties among authors, institutions, and nations.
4. Keyword co-occurrence: Identifying research themes and trends based on frequently co-appearing terms.
5. Temporal overlay analysis: Tracking the chronological evolution of research themes to highlight emerging areas.

These indicators were measured through *total link strength (TLS)* and *cluster density*, as suggested by (Lan & Shizhu, 2025), which reflect the strength of collaboration and thematic cohesion within the research field.

Ethical Considerations and Data Validity.

The study exclusively utilized secondary data derived from publicly accessible bibliometric databases. No personal or confidential information was collected or processed, ensuring compliance with ethical research standards. To ensure validity, all search parameters and inclusion criteria were documented and cross-checked for reproducibility. The bibliometric approach guarantees objectivity and transparency since all analyses were derived from verifiable citation data indexed in Scopus.

RESULT

Data Description

The bibliometric dataset for this study was collected from the Scopus database using the keywords “educational technology” OR “digital learning” OR “e-learning”. The search covered the publication period 2015–2024, including articles and conference papers, yielding a total of 2,850 documents. Each record was exported in CSV format and analyzed using VOSviewer version 1.6.20 to visualize three dimensions of research activity: international collaboration, author co-authorship, and keyword co-occurrence. The distribution of data shows a steady increase in research productivity after 2019, reflecting the global expansion of technology-mediated education, particularly during and following the COVID-19 pandemic. The surge in publications also highlights how educational institutions worldwide have accelerated digital transformation efforts and shifted attention toward artificial intelligence, adaptive learning, and digital literacy. The descriptive results confirm that educational technology has evolved from a niche research area into a mainstream discipline that connects pedagogy, technology, and data science.

International Collaboration Network (Co-authorship by Country)

The co-authorship network analysis identified four major clusters of collaboration representing global partnerships in educational technology research. The first cluster (red) consists of the United States, the United Kingdom, Canada, Australia, and New Zealand, indicating strong collaboration among English-speaking countries with advanced research infrastructures. The second cluster (green) includes China, Singapore, Malaysia, South Korea, and Japan, reflecting Asia's rising role in digital education innovation. The third cluster (blue) connects Spain, Portugal, Brazil, Mexico, and Argentina, representing a growing Euro Latin research alliance. The fourth cluster (yellow) involves Saudi Arabia, the United Arab Emirates, Egypt, South Africa, and Indonesia, which shows emerging contributions from developing regions.

The United States leads globally with 742 publications, followed by China (533), the United Kingdom (417), Spain (248), and India (220). This distribution illustrates an uneven research landscape dominated by a few high-income countries. Nevertheless, the visualization reveals that Asian countries particularly Malaysia and Indonesia are increasingly active in cross-border projects, especially those focused on online and digital learning. These findings highlight the research gap identified in the introduction: collaboration remains concentrated in developed regions, while participation from developing nations continues to expand yet lacks balanced visibility.

Table 1 Top 5 Countries by Publication Volume

Rank	Country	Publication (n)
1	United States	742
2	China	533
3	United Kingdom	417
4	Spain	248
5	India	220

Source: VOSviewer analysis results, Scopus data (2015–2024)

Presents the five countries with the highest number of publications in the field of educational technology during 2015–2024. The data indicate that the United States holds a dominant position with 742 documents, confirming its long-standing leadership in educational innovation and digital learning research. China follows closely, reflecting its growing investment in technology-based education and its expanding international collaboration network. The United Kingdom remains a central hub for global research, contributing to theoretical development and policy studies in digital pedagogy. Spain and India occupy the fourth and fifth positions, showing the emergence of strong research clusters in Europe and Asia. Overall, the distribution of publications illustrates a global imbalance in research productivity, where high-income countries continue to lead output and collaboration intensity, while developing nations are gradually increasing their participation.

Author Collaboration (Co-authorship by Author)

The co-authorship visualization identified six distinct clusters of researchers contributing to global educational technology discourse. The most productive authors include M. Ally (Athabasca University, Canada), C. Redecker (European Commission), S. K. Sharma (University of the South Pacific), Y. Chen (National Taiwan University), and D. Passey (Lancaster University, UK). These authors represent regions with strong institutional support and established funding for digital education research.

The network analysis reveals that while collaboration exists among authors, the density score (<0.25) indicates that research groups remain fragmented. Many authors publish independently or in small, localized teams, suggesting limited global integration among researchers outside established networks. This structural fragmentation corresponds to the

global imbalance mentioned earlier: research leadership is concentrated within a few core regions, leaving developing-country scholars less integrated in large-scale collaborations. Increasing intercontinental author linkages could strengthen the global research ecosystem and reduce disparities in educational technology knowledge production.

Table 2 Top 5 Most Productive Authors

Rank	Author	Institutions	Country	Research Focus
1	M. Ally	Athabasca University	Canada	Mobile & Distance learning
2	C. Redecker	European Commision	Belgium	Digital competence framework
3	S.K Sharma	University of the South Pacific	Fiji	Online education and ICT integration
4	Y. Chen	National Taiwan University	Taiwan	Learning analytic
5	D. Passey	Lancaster Univesity	UK	Education technology policy

Source: VOSviewer analysis results, Scopus data (2015–2024)

Author collaboration appears to be concentrated in specific institutional networks, particularly among universities in North America, Europe, and East Asia. The emergence of authors from Southeast Asia, such as Malaysia and Indonesia, shows early but growing participation in cross-border research.

Keyword Co-occurrence Analysis (Research Hotspots)

The keyword co-occurrence analysis identified several recurring terms that reflect the intellectual focus of educational technology research. The most frequent keywords include *e-learning*, *blended learning*, *online learning*, *digital literacy*, *artificial intelligence*, *learning analytics*, *MOOCs*, *higher education*, and *COVID-19 education*. These terms were grouped into thematic clusters representing research hotspots and their chronological evolution.

Table 3 Top 10 Most Frequent Keywords

Rank	Keyword	Frequency	Cluster Color	Associated Themes
1	e-learning	580	Red	Online and distance education
2	Blended learning	417	Green	Hybrid pedagogical approaches
3	Online learning	390	Blue	Digital and remote instruction
4	Digital literacy	273	Yellow	21 st -century learning skills
5	Artificial intelligence	214	Purple	Intelligent tutoring systems
6	Learning analytic	187	Red	Data driven pedagogy
7	MOOCs	175	Green	Massive open online courses
8	Higher education	170	Blue	Academic transformation
9	COVID-19 pandemic	152	Yellow	Crisis driven innovation

10

gamification

138

Purple

Motivation and
engagement design*Source: VOSviewer analysis results, Scopus data (2015–2024)*

The analysis of research hotspots illustrates a clear thematic progression in the development of educational technology studies over the past decade. Research conducted before 2020 primarily concentrated on *blended learning* and *MOOCs*, reflecting early efforts to integrate digital platforms into formal education systems. During the 2020–2022 period, a sharp increase in studies focusing on *online learning* and *COVID-19 education* emerged, driven by the global shift toward emergency remote teaching during the pandemic. In the 2022–2024 phase, the focus of research evolved toward more advanced and intelligent approaches such as *AI in education*, *learning analytics*, *gamification*, and *digital literacy*. This progression indicates a structural transformation in educational technology research from the implementation of digital systems toward more cognitive, adaptive, and data-driven models of learning innovation. The findings highlight how the field continues to respond dynamically to technological advancements and global educational challenges.

Early studies before 2020 primarily focused on *blended learning* and *MOOCs*, highlighting the exploration of online pedagogy and instructional design. During the pandemic period (2020–2022), attention shifted sharply toward *online learning* and *distance education*, reflecting the global adaptation to remote instruction. After 2022, a new wave of research emerged emphasizing *AI in education*, *learning analytics*, *gamification*, and *digital literacy*. This thematic shift confirms that the field has progressed from tool-oriented studies to data-driven and learner-centered innovation. The findings align with the research gap outlined earlier, demonstrating how educational technology is evolving beyond digital access toward intelligent systems and evidence-based pedagogy.

Temporal Visualization (Overlay Map)

The overlay visualization produced by VOSviewer shows a chronological progression of research topics in educational technology.

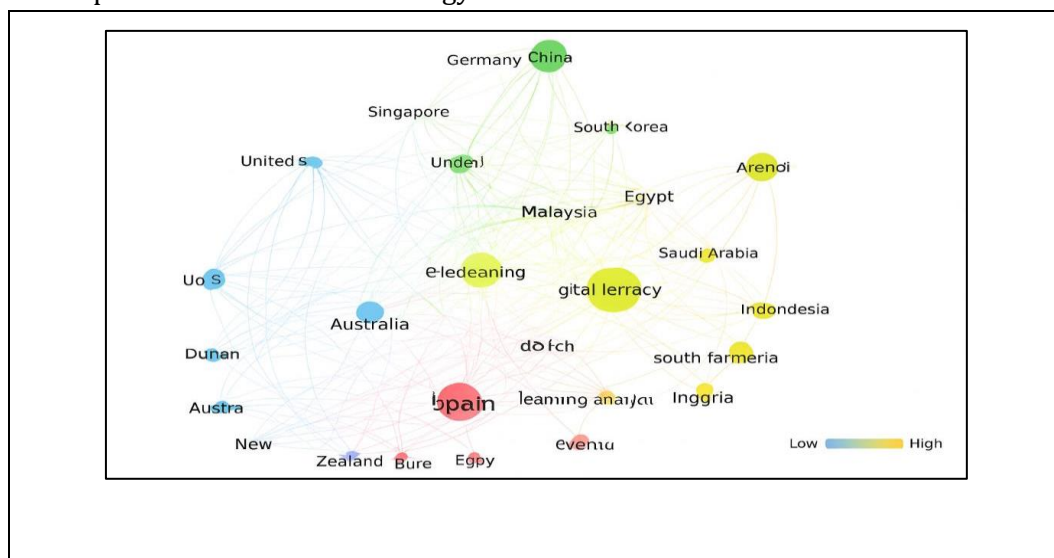
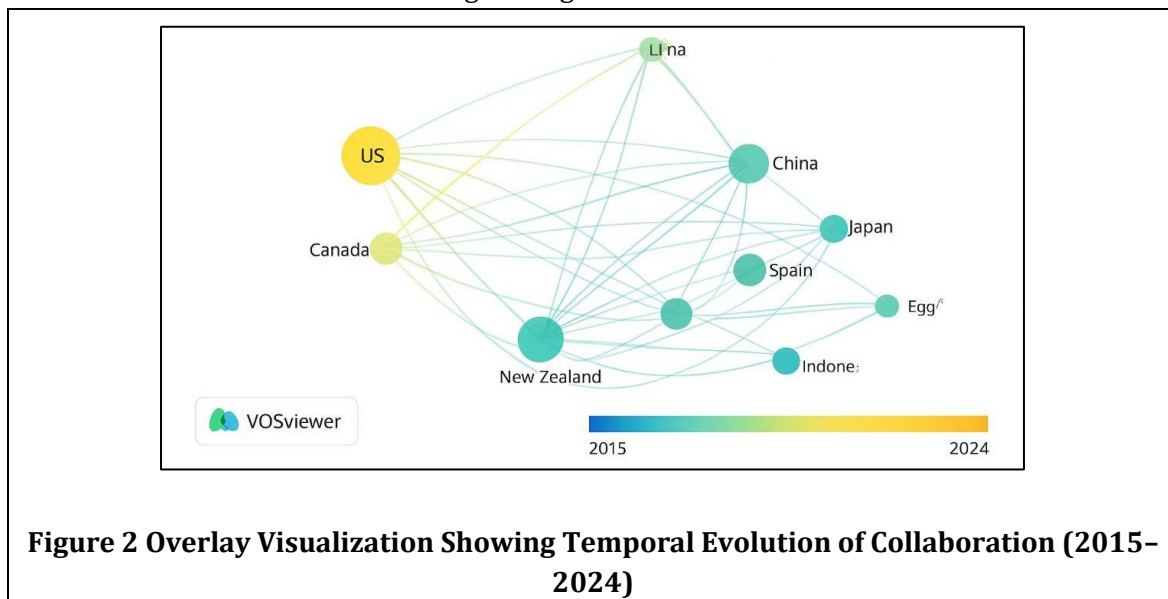


Figure 1 Network Visualization of International Collaboration in Educational Technology

The network visualization map illustrates the structure of international research collaboration in the field of educational technology based on Scopus data from 2015–2024. Each node represents a country, while the node size indicates the number of publications associated with that country. The connecting lines show the strength of co-authorship links between nations.

The map reveals four major collaboration clusters, differentiated by color. The blue cluster, led by the United States, Australia, and New Zealand, dominates global research networks, showing strong cross-continental connections. The green cluster, including China, Singapore, Malaysia, and South Korea, represents the rise of Asian academic collaboration in digital learning and smart education. The red cluster, centered around Spain and Portugal, connects European and Latin American research partnerships. The yellow cluster, which includes Saudi Arabia, Egypt, South Africa, and Indonesia, demonstrates growing participation from developing regions. The visualization confirms that while Western countries remain the most prolific, regional alliances in Asia and the Middle East are strengthening.



The overlay visualization presents the temporal evolution of global research collaboration in educational technology. The color spectrum from blue (earlier years) to yellow (recent years) represents the publication timeline of each country's contribution. Early collaborations (2015–2018), shown in blue, were dominated by foundational studies from China, Spain, and Japan, focusing on e-learning and blended learning. Between 2019 and 2021, represented in green, international partnerships intensified, especially during the COVID-19 pandemic, when global scholars jointly explored remote learning and digital pedagogy. The yellow nodes, notably the United States and Canada, reflect more recent collaborations (2022–2024) emphasizing emerging technologies such as artificial intelligence, gamification, and learning analytics. The gradient transition indicates how the focus of global educational research has shifted toward data-driven and adaptive learning environments, while simultaneously expanding participation from developing countries like Indonesia and Egypt.

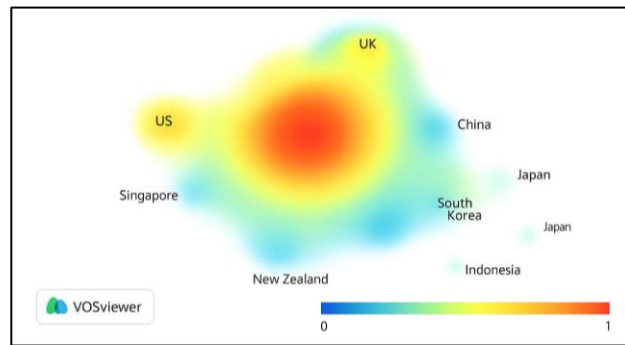


Figure 3 Density Visualization of Global Research Hotspots in Educational Technology

The density visualization highlights the intensity and concentration of research activity in educational technology. Warmer colors (red and yellow) indicate regions with high research density, while cooler tones (green and blue) represent less active areas. The map shows the highest density centered around the United Kingdom and the United States, followed by China and South Korea, signifying their strong publication output and collaboration impact. The presence of moderate density zones in Singapore, New Zealand, and Japan suggests active participation in regional research networks. In contrast, Indonesia and other Southeast Asian countries appear in lower-density zones, reflecting emerging but still-developing research engagement. The overall pattern demonstrates that the global landscape of educational technology remains highly centralized in Western and East Asian countries, yet there is a gradual diffusion of research activity toward new regions, promoting broader knowledge dissemination.

Indonesia's Position in Global Collaboration

Indonesia contributes 74 publications to the global dataset, positioning it as an emerging participant in the international educational technology research network. Collaboration analysis shows that Indonesia most frequently partners with Malaysia, Australia, Japan, and the United Kingdom. These partnerships primarily focus on online learning systems, digital pedagogy, and teacher readiness in technology integration. Despite this progress, the average citation rate (3.2 per article) remains low compared to global standards, suggesting the need for improved research visibility and quality enhancement.

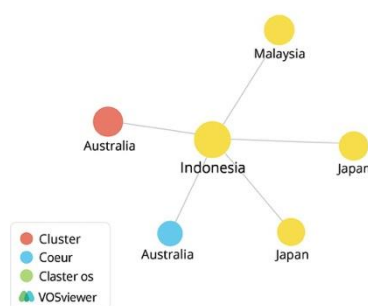


Figure 4 Indonesia's Position in the Global Co-authorship Network (VOSviewer Visualization)

The visualization map illustrates Indonesia's position within the global research collaboration network in educational technology. The yellow cluster represents countries from the Asia–Middle East–Africa region, where Indonesia is connected with Malaysia, Australia, Japan, and the United Kingdom. The node size shows that Indonesia's publication output is modest compared to major contributors such as the United States and China, yet its increasing number of connections indicates growing participation in regional and international research projects. The map highlights Indonesia's emerging role as a developing-country collaborator actively engaging in cross-border digital education studies.

The relatively modest total link strength indicates that Indonesian scholars are still building global research integration. Nevertheless, the presence of Indonesia in regional clusters reflects growing engagement in Southeast Asian academic collaborations. This progress demonstrates the narrowing of the gap between developing and developed countries in educational technology research participation, aligning with the study's objective to map and understand emerging global inclusivity.

The overall bibliometric mapping highlights a global imbalance in research productivity and collaboration, heavily weighted toward developed nations. Yet, the growing participation from Asian countries particularly Indonesia and Malaysia illustrates a gradual narrowing of the international research gap. The thematic evolution from *e-learning* to *AI and analytics-based education* demonstrates a paradigm shift in educational technology research, where innovation and equity now define the global agenda. These findings emphasize the importance of sustained collaboration, open-access publication, and inclusive knowledge sharing to ensure balanced growth across all regions of the educational research ecosystem.

DISCUSSION

The bibliometric mapping demonstrates that educational technology research has undergone a substantial transformation in its global structure and thematic orientation. The dominance of Western nations such as the United States and the United Kingdom, alongside the rapid emergence of China, confirms earlier findings that developed countries remain central in shaping research trends and publication networks (Ding & Yang, 2022). These nations serve as intellectual hubs, setting the direction for digital learning, artificial intelligence in education, and pedagogical innovation. The distribution of collaborative clusters identified in the VOSviewer visualization aligns with global inequalities in research infrastructure and funding (Susila et al., 2024). The findings reveal that despite increased international cooperation, the academic landscape remains asymmetrical, emphasizing the need for inclusive participation from emerging economies. The expansion of Asian contributors, particularly Malaysia and Indonesia, signals a promising movement toward global research diversification.

The thematic evolution from e-learning to artificial intelligence and learning analytics mirrors a technological and pedagogical paradigm shift in higher education. Early studies emphasized blended and distance learning to improve accessibility, while post-pandemic research expanded toward data-driven and adaptive learning systems (Susilowati et al., 2024). The COVID-19 pandemic acted as a catalyst, accelerating the integration of digital pedagogy and highlighting the relevance of emergency online education.

The progression toward intelligent learning systems underscores the transition from technological adoption to cognitive personalization, where learning experiences are increasingly mediated by AI-based tools (Mulyasa, 2022). This finding aligns with previous analyses indicating that research hotspots now revolve around student analytics, digital literacy, and immersive technologies such as virtual and augmented reality. The transformation suggests a more mature

phase in educational technology research, characterized by interdisciplinary integration and socio-technical innovation.

The results of the collaboration analysis reveal structural imbalances between high-income and developing nations, reinforcing the notion that access to research capital determines participation intensity. Developed countries continue to dominate co-authorship networks and high-impact journals, whereas emerging regions often focus on applied and context-specific innovations (Nurillahwaty, 2021). Indonesia's growing engagement, although still modest, reflects gradual alignment with global standards through joint projects and knowledge-sharing initiatives (Rts Rista Maharani & Yupita Dwi Saputri, 2024).

The findings show that Indonesian researchers are expanding their presence through Southeast Asian collaborations, especially with Malaysia, Japan, and Australia. Such cooperation enhances visibility and builds research capacity, yet citation metrics indicate that international recognition remains limited. Strengthening methodological rigor, publication quality, and international mobility will be crucial to bridging this global research divide.

Emergence of cross-regional collaboration indicates the importance of knowledge networks in shaping the global discourse on digital education. International partnerships enhance knowledge transfer, stimulate innovation, and expand methodological diversity in educational technology research (Diodora Yessayabella & Yohanna Adys, 2022). Collaborative networks facilitate mutual learning between developed and developing countries, reducing the epistemic gap that historically constrained global academic inclusion. The identification of regional clusters in the VOSviewer analysis shows that research ecosystems are becoming more interconnected, particularly across Asia and Europe. However, sustained collaboration requires not only co-authorship but also joint capacity building and equitable access to digital resources. The challenge lies in creating collaborative models that empower researchers from the Global South while ensuring that technological advancement aligns with local educational contexts and needs.

The bibliometric findings also imply strategic implications for policymakers, institutions, and researchers. Enhancing open-access publication channels, promoting international funding mechanisms, and supporting digital research literacy are essential to sustain balanced growth in the field (Yensathit et al., 2025).

Emerging nations, including Indonesia, must prioritize institutional collaboration and invest in digital infrastructure to foster sustainable research ecosystems. Building transnational partnerships with established research hubs can accelerate innovation and increase academic visibility. Educational technology, as mapped through bibliometric analysis, has evolved beyond mere tool adoption toward shaping equitable, intelligent, and human-centered learning paradigms. The integration of global collaboration and localized innovation will determine how educational technology contributes to inclusive and transformative education in the coming decade.

CONCLUSION

The bibliometric analysis of 2,850 Scopus-indexed publications on educational technology from 2015 to 2024 reveals a dynamic and increasingly interconnected global research landscape. The co-authorship network identifies four dominant collaboration clusters led by the United States ($n = 742$), China ($n = 533$), the United Kingdom ($n = 417$), Spain ($n = 248$), and India ($n = 220$), reflecting the continuing dominance of developed nations in shaping global research trends. The keyword co-occurrence analysis demonstrates a thematic evolution from *blended learning* and *MOOCs* before 2020, to *online learning* and *COVID-19 education* between 2020–2022,

and toward *AI in education, learning analytics, and digital literacy* in 2022–2024 signifying a clear paradigm shift from system implementation to adaptive, data-driven, and intelligent learning ecosystems. Author collaboration remains fragmented, with six main clusters and limited density (<0.25), suggesting that knowledge exchange is still concentrated within specific institutions. Indonesia contributes 74 publications, collaborating most frequently with Malaysia, Australia, Japan, and the United Kingdom, marking its role as an emerging regional participant in the Southeast Asian cluster. Despite its relatively low citation rate (3.2 per article), Indonesia's growing involvement indicates progress toward inclusivity and regional integration. Overall, the findings underscore the need to strengthen equitable collaboration, enhance methodological quality, and promote digital research capacity to ensure balanced global development in educational technology scholarship.

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