

# Technological Trends in Indonesian Educational Research: A Bibliometric Analysis

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## ABSTRACT

This study aims to analyze the development of research on the use of technology in education in Indonesia through a bibliometric approach. Using predefined keywords, a total of 50,563 publications were retrieved and then filtered using the PRISMA method, resulting in a final selection of 381 documents. After the screening and validation process, the documents were analyzed using the R Program to examine publication trends, three-field plot, word cloud, keyword evolution, and keyword novelty. The conclusion of this analysis is that the publication trend shows a significant increase in research on educational technology in Indonesia, with the highest number of publications occurring in 2024, indicating a strong and growing academic focus on this field in recent years. The results of Indonesian publications focus on the development and application of technology in the context of education, especially at the level of formal institutions and digital learning processes. This focus reflects a strong concern for the integration of technology in the education system and efforts to improve the quality and access to learning through digital innovation. The Word Cloud and keyword evolution together indicate that research on technology in education has progressed from an initial focus on digitalization and remote learning toward more complex, theoretical, and contextual approaches, reflecting a maturation and diversification of research themes over time. Based on the visualization of keyword evolution, “Artificial Intelligence” and “Augmented Reality” are recommended as potential future research directions due to their strong continuity from the previous period and their recent emergence in 2025, signaling increasing relevance, innovation, and growing interest in immersive and intelligent technologies within technology-based education.

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## 1. Introduction

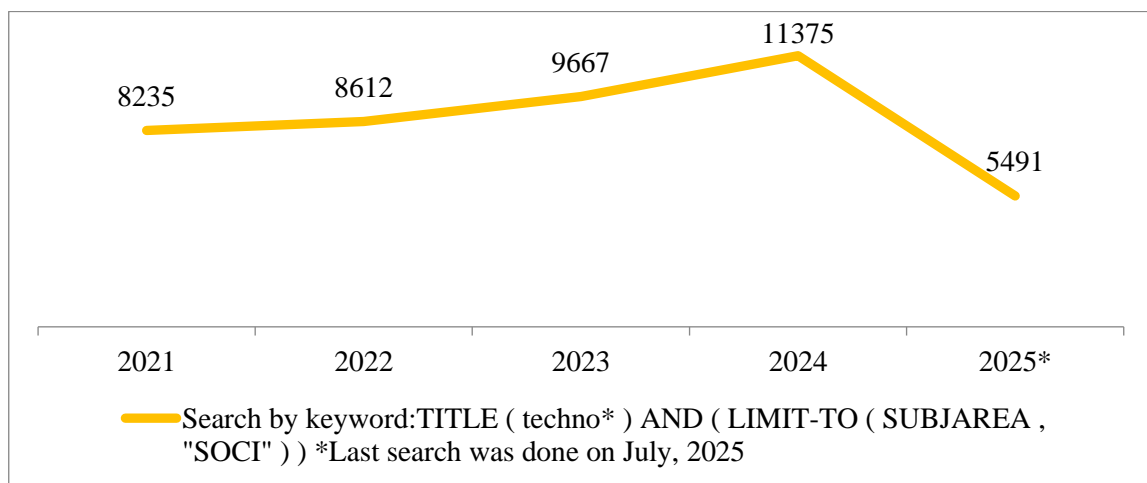
Education is the foundation of character building and the advancement of a nation [1], [2]. Through education, individuals are given the opportunity to fully develop their intellectual, emotional,

and social potential [3]–[5]. Education adds color to life by broadening horizons, fostering critical thinking, and encouraging creativity [6]–[8]. It is not merely a process of transferring knowledge but also a means of instilling strong moral and ethical values [9], [10]. Education plays a vital role in preparing future generations to adapt to the ever-changing world [10], [11]. Technology, culture, and social dynamics now increasingly influence the ways we teach and learn [12]–[14]. Yet behind all that complexity, there is one simple and powerful place where the entire journey of learning begins, and that place is the classroom.

The classroom is the primary space where the educational process takes place directly between teachers and students [15]. Classroom is a place of interaction, discussion, and the exchange of ideas that form the core of learning [16]–[18]. A positive classroom environment can foster motivation and a strong desire to learn [19], [20]. As times change, teaching methods within the classroom have also evolved to meet modern needs and challenges [21], [22]. Teachers are no longer the sole source of information but serve as facilitators who guide students to think critically and independently [23], [24]. Various learning innovations have been developed to create more engaging and effective educational experiences [25], [26]. One important approach that is increasingly emphasized in today's classroom learning is the use of technology.

Technology is a branch of knowledge that studies the skills involved in creating tools, machines, methods, and systems to make human life easier [27]. In education, technology plays a vital role in enhancing the teaching and learning process to become more effective and efficient. Its presence enables interactive, flexible, and accessible learning for everyone, anytime and anywhere [28]. Digital tools such as computers, projectors, and e-learning platforms have become integral parts of educational activities across all levels. Technology also opens up opportunities for collaboration and information exchange across regions and cultures [29]. As time progresses, technology continues to evolve, driving transformation in the field of education [30]. To understand its impact and future direction, numerous scientific studies are systematically conducted through research on the use of technology.

Although research on technology in education has grown significantly in recent years, much of it remains limited to specific contexts, such as music education [31]. This indicates a research gap in exploring the use of technology more broadly across various educational levels and disciplines. As researchers increasingly leverage technology to conduct studies more efficiently, accurately, and collaboratively, the volume of related publications has continued to rise. As shown in Fig. 1, research in this area has grown rapidly over the past five years, increasing from 8,235 to a peak of 11,375 documents. This surge reflects a growing academic interest in the potential of technology to enhance teaching and learning processes.



**Fig. 1.** Publication Trends Over the Last 5 Years with a Focus on Technology with a Social Sciences on the Scopus Database

Various forms of educational technology, including learning management systems, virtual classrooms, and interactive tools, have become frequent subjects of investigation. However, broader and more inclusive studies are still needed to fully understand the diverse applications of technology in education. Thus, the Research Question (RQ) in this paper is as follows.

RQ1. How is the publication trend from year to year on the topic technological trends in Indonesian educational research?

RQ2. How are the results of the Three-field Plot between countries, keywords, all keywords on the topic technological trends in Indonesian educational research?

RQ3. How are the Word Cloud results on the topic technological trends in Indonesian educational research?

RQ4. How is the evolution and novelty of keywords that can be recommended for future research on the topic technological trends in Indonesian educational research?

## 2. Method

### 2.1. Research Design

This study employs a bibliometric research design to systematically analyze scientific publications related to the use of technology in education in Indonesia. The design is descriptive and exploratory, focusing on mapping publication trends, identifying frequently used keywords, and analyzing the evolution and novelty of research topics [32]–[34]. Data were collected from reputable academic databases using specific keywords and inclusion criteria to ensure relevance and consistency. The analysis was conducted using the R programming language, which enabled the processing, visualization, and interpretation of bibliometric data effectively. Key indicators such as publication volume, keyword co-occurrence, and citation patterns were examined to uncover research dynamics in the field. This research design provides a structured approach to understanding the development and focus areas of educational technology studies within the Indonesian context.

### 2.2. Search Strategy

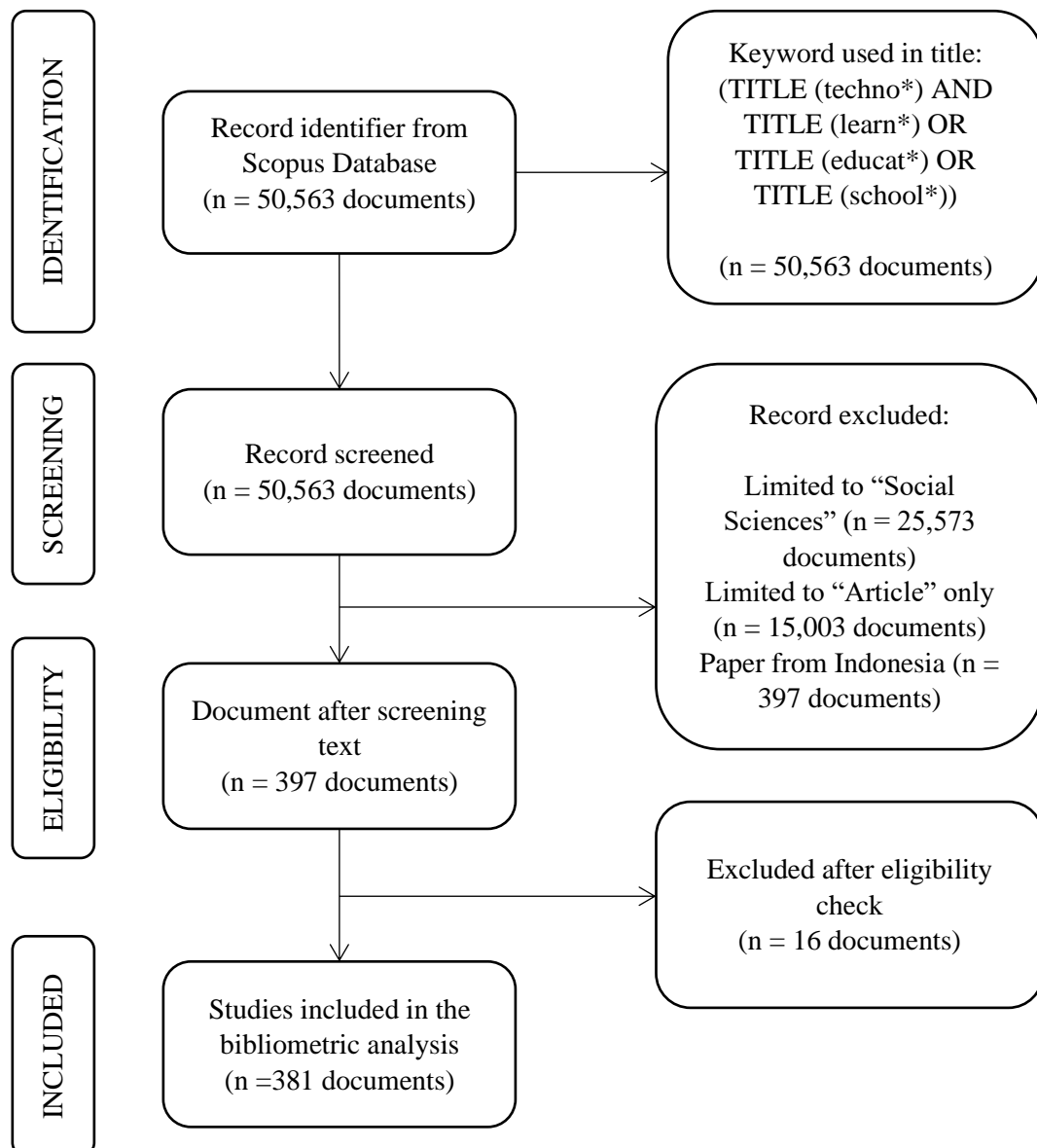
The search strategy for this study was designed to capture publications specifically related to the use of technology in educational settings. The search string used was (TITLE (techno) AND TITLE (learn) OR TITLE (educat\*) OR TITLE (school\*))\*\*, which aims to identify articles that contain variations of the word “technology” in the title, in combination with terms related to learning, education, or school. This approach ensures that the results are focused on works where technology is a central theme within an educational context. The use of truncation (e.g., techno, learn) allows for the inclusion of multiple word forms such as “technology,” “technological,” “learning,” or “learners.” The search was conducted within selected academic databases, and filters were applied to include only relevant, peer-reviewed publications. This strategy helps ensure a comprehensive yet focused dataset for bibliometric analysis.

### 2.3. Inclusion and Exclusion Criteria

Fig. 2 presents the PRISMA flow diagram outlining the process of data selection for the bibliometric analysis. Initially, a total of 50,563 records were identified from the Scopus database using the search string (TITLE (techno) AND TITLE (learn) OR TITLE (educat\*) OR TITLE (school\*))\*\*. This broad query was intended to capture a wide range of publications that focus on the intersection of technology and education. After the initial identification, all records underwent a screening phase to narrow down the scope of the analysis. During the screening phase, several filters were applied. First, publications limited to the “Social Sciences” subject area were selected, reducing the dataset to 25,573 documents. Then, the filter was refined to include only those documents classified as “Article”, narrowing the records further to 15,003 documents. To focus specifically on the Indonesian context, documents affiliated with Indonesian authors were selected, resulting in 397 documents. After a final eligibility check, 16 documents were excluded due to irrelevance or

duplication, leaving a total of 381 studies included in the bibliometric analysis. This stepwise selection process ensures that the final dataset is both comprehensive and relevant to the research objectives.

The inclusion criteria for this study covered documents indexed in the Scopus database, classified as scientific articles, and authored by researchers affiliated with Indonesian institutions. Additionally, the titles of the documents had to contain keywords related to technology, learning, education, or school. The exclusion criteria included documents that were not articles, were not authored by Indonesian researchers, or were deemed irrelevant after the final screening process. Documents that were not aligned with the context of technology in education and were not research-based studies such as bibliometric analyses, literature reviews, and meta-analyses were also excluded in the final stage. This step was taken to ensure that only empirically grounded and topically relevant studies were included in the analysis.



**Fig. 2.** PRISMA Method for Document Selection

## 2.4. Data Analyze

Data analysis in this study was carried out using the R programming language through a bibliometric approach. The analysis included publication trend analysis to observe the growth of

articles over time, as well as a three-field plot illustrating the relationships among country, keyword, and all keywords, and Word Cloud. Additionally, a keyword evolution analysis was conducted to track changes in research themes over the years. Keyword recommendation was also generated to identify emerging or underexplored topics in the field of educational technology in Indonesia. This analysis provides comprehensive insights into research dynamics and directions, serving as a foundation for future research planning.

### 3. Results and Discussion

Before moving into the interpretative sections, the Main Information is first presented. This section aims to provide a general overview of the basic characteristics of the analyzed data [34]. The results in Fig. 3 show that publications on the use of technology in education in Indonesia were sourced from 171 different journals, including many ranked within Q1 to Q4 categories, indicating a wide distribution across reputable academic outlets. This diversity reflects the broad scope of research and the interdisciplinary nature of the topic. A total of 381 documents, all of which are journal articles, were analyzed, supported by a substantial number of references (18,032), highlighting the depth of literature cited in this body of work.

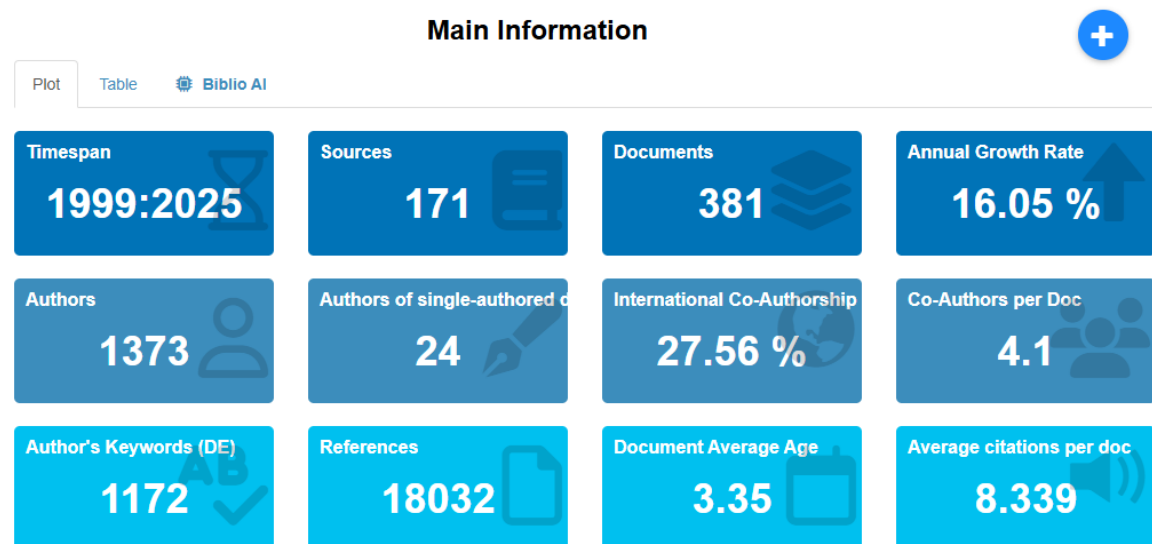
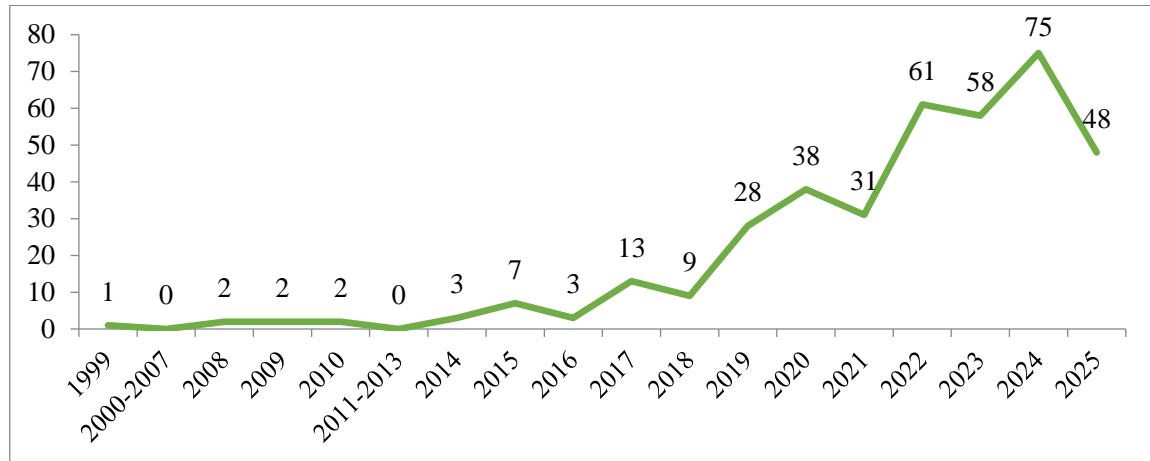


Fig. 3. Main Information about Trends of Using Technology in Education on Indonesia

In terms of author collaboration, 1,373 authors contributed to the publications, with an average of 4.1 co-authors per article, indicating a relatively high level of teamwork. Although 24 articles were single-authored, the majority of research was produced through collaborative efforts, including international partnerships. This is evidenced by the international co-authorship rate of 27.56%, showing significant global engagement by Indonesian researchers. The annual growth rate of publications stands at 16.05%, suggesting strong development in the field, although the trend over the years appears to be fluctuating, reflecting the shifting focus and investment in this area of research.

#### 3.1. Publications Trends

Analysis by looking at publication trends from year to year aims to understand the development and dynamics of research topics over a certain period of time [34]. This helps identify increasing interest, changes in focus, and potential future research directions. The publication data from 1999 to 2025 reveals a significant pattern in the development of educational technology research in Indonesia (Fig. 4). Between 2000 – 2007 and 2011 – 2013, there was a complete absence of publications, indicating a period of minimal to no academic activity in this area. Only a few studies emerged sporadically between 2008 and 2013, suggesting that interest in the field was still in its early stages and had not yet gained widespread academic attention.

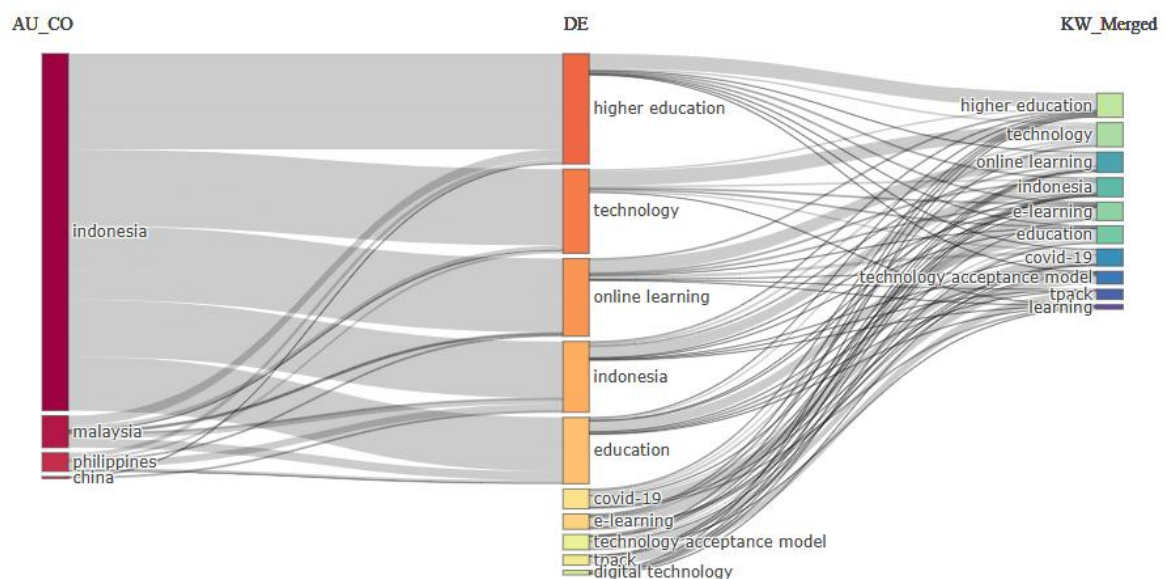


**Fig. 4.** Number of Publications During the Last 25 Years on the Topic of Technology Use in Education in Indonesia in the Scopus Database

A notable shift began in 2014, with a gradual increase that became more pronounced in 2019. From that point, the number of publications surged, peaking in 2024 with a total of 75 paper, the highest in the observed period. This rapid growth reflects a heightened focus on technology integration in education, likely driven by digital transformation trends and global events such as the COVID-19 pandemic. Although there is a slight drop in 2025, the overall upward trend underscores a strong and growing research interest in this domain in recent years.

### 3.2. Three-Field Plot

Based on Fig 5, Indonesia stands out as the most dominant contributor to research on the use of technology in education. Publications originating from Indonesia are strongly associated with keywords such as “higher education”, “technology”, “online learning”, “education”, and “indonesia”, indicating a clear focus on the transformation of higher education through digital tools and online platforms. However, several important keywords like “covid-19”, “technology acceptance model”, and “tpack” are not prominently linked to Indonesian research. This suggests that theoretical frameworks and global context-related themes are still underexplored in Indonesian educational technology studies.



**Fig. 5.** Three-Field Plot Results by Country, Keyword, and All Keywords



In addition to Indonesia, other countries such as Malaysia, the Philippines, and China have also contributed to this research landscape, albeit to a lesser extent. These countries bring in diverse topics such as “e-learning”, “digital technology”, and “technology acceptance model”, offering complementary perspectives and theoretical depth. Their presence highlights the global nature of educational technology research and signals opportunities for Indonesia to engage in cross-national collaborations to enrich and expand the scope of its research efforts.

### 3.3. Word Cloud

Word Cloud analysis aims to identify the most frequently occurring keywords within a collection of publications, providing an overview of the main research focuses and emerging themes [35]. By examining the size and frequency of each word, researchers can gain insights into dominant trends and commonly discussed issues.

Based on the Fig 6, the most prominent words indicated by their larger size are “higher education”, “technology”, “online learning”, “education”, “e-learning”, and “indonesia”. The dominance of the term “higher education” suggests that much of the research is centered on the application of technology at the university level. Meanwhile, the keywords “technology”, “online learning”, and “e-learning” emphasize the strong focus on digital tools and remote learning methods within the field of educational research.



Fig. 6. Word Cloud based on “All Keywords”

The presence of “indonesia” as one of the largest words highlights that the geographical context of these studies is strongly rooted in Indonesia, aligning with the bibliometric analysis focus. The term “education” indicates that while higher education is a key focus, the research may also cover broader educational contexts. The large size of these keywords reflects the main themes and dominant directions in technology-enhanced education research in Indonesia, pointing to the growing importance of digitalization in shaping the national education landscape.

While many keywords in the Word Cloud such as “online learning”, “learning outcomes”, and “digital technology” are expected in the context of educational technology in Fig. 7, several unexpected terms stand out and offer intriguing insights. Words like “critical thinking”, “structural equation”, and “perceived usefulness” suggest that Indonesian researchers are not only focusing on the implementation of technology but also delving into cognitive outcomes and advanced statistical modeling. The presence of terms like “perceived ease” and “perceived usefulness” indicates the use of theoretical frameworks like the Technology Acceptance Model (TAM), which is a sophisticated approach not always prevalent in early-stage educational technology research.

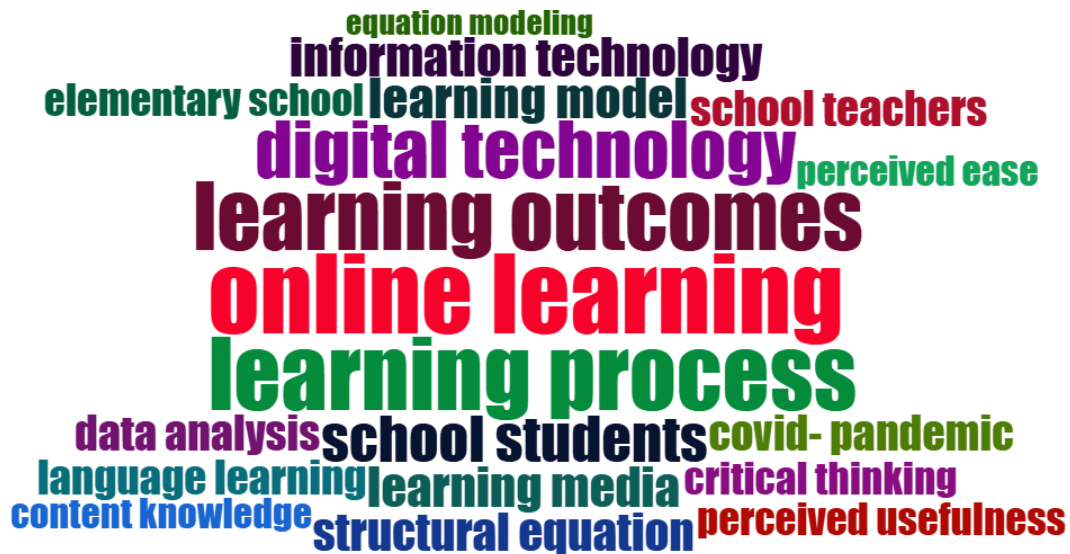


Fig. 7. Word Cloud based on “Abstract”

Additionally, keywords such as “elementary school”, “school teachers”, and “language learning” reveal a broadening of focus beyond higher education, which typically dominates the field. These terms show that researchers are also exploring how technology impacts foundational education levels and specific subjects. The inclusion of “data analysis” and “structural equation” implies a methodological shift toward more rigorous and quantitative approaches. Altogether, the presence of these unexpected keywords suggests a maturing and diversifying research landscape in Indonesia, where educational technology is being studied not just for its tools, but also for its theoretical, practical, and pedagogical implications.

### 3.4. Keywords Evolution

Keyword evolution analysis in bibliometrics aims to track changes in research focus and topics over time [36]. In this way, researchers can identify emerging trends, emerging new concepts, and shifts in the direction of studies in a particular field.

Based on the keyword evolution data (Fig. 8) from 1999 to 2025, there is a significant transformation in the focus of research on technology-based education. In the early phase (1999–2020), topics such as “blended learning”, “e-learning”, “higher education”, and “information technology” served as foundational themes, reflecting an exploratory period in applying technology to the educational domain. The stability of keywords like “mobile learning” and “information technology” indicates a consistent interest in device- and network-based learning access. The 2021–2022 period marked a drastic shift with the emergence of “covid-19” as a dominant keyword, which accelerated the integration of technology into education systems. Keywords like “technology integration”, “mobile learning”, and “technology acceptance model” became more prominent, reflecting a shift from technology introduction to practical implementation. The transition from “blended learning” to “covid-19” and “education” illustrates a global response to the urgent need for massive online learning due to the pandemic.

Thickness represents the degree of connection and continuity between topics. Thick arrows from keywords such as “e-learning”, “education”, and “technology” toward topics like “online learning”, “technology acceptance model”, and “higher education” indicate dominance and ongoing relevance. In contrast, thinner arrows connecting keywords like “critical thinking skills” and “gamification” suggest that although these are emerging trends, they have yet to demonstrate strong continuity. By 2023–2025, research focus shifts to more advanced and contextual topics such as “artificial intelligence”, and “augmented reality” indicating growing complexity and specialization in educational technology research.



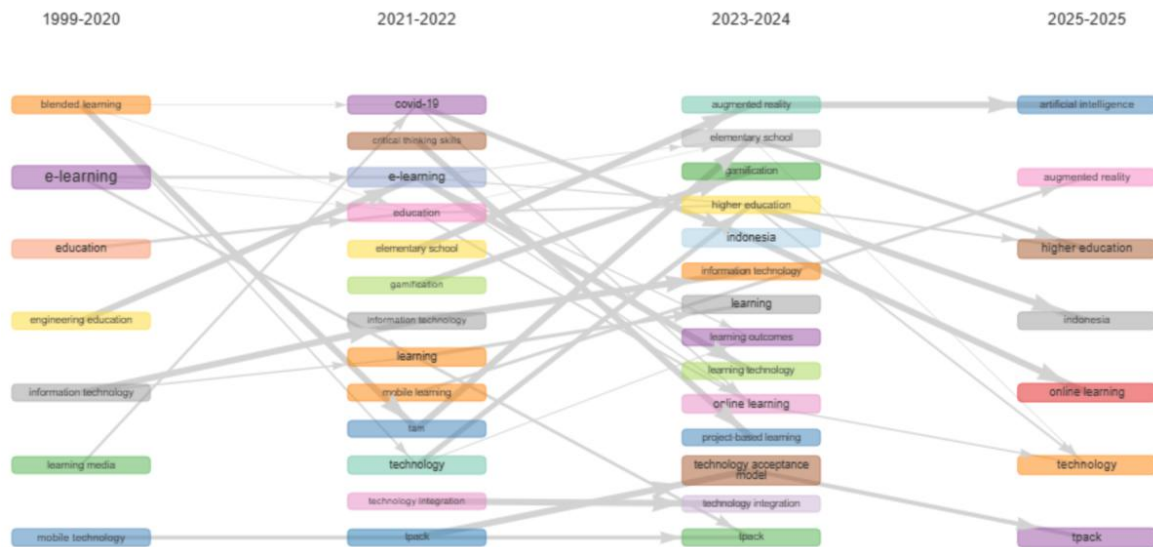


Fig. 8. Keyword Evolution based on “All Keywords”

### 3.5. Keywords Novelty

Based on the visualization of keyword evolution in Fig. 8, “Artificial Intelligence” and “Augmented Reality” are recommended as potential keywords for further research because they are indicated by bold arrows from the previous period (2023–2024) to 2025–2025, reflecting continuity and increasing relevance in the topic of educational technology. In addition, these two keywords are relatively new in the period 2025–2025 and have not been seen in the previous period, indicating that the topic is a developing research area and has prospects for further exploration in the context of technology-based education in Indonesia.

The keyword “Artificial Intelligence” emerged as a new topic in 2025, indicated by a thick arrow from the previous period, particularly from the theme “elementary school.” This suggests that AI is gaining attention in the context of early education, marking a shift toward integrating intelligent technologies into foundational learning processes. The application of AI in education opens opportunities for personalized learning, automated student data management, and more efficient assessment systems signaling a significant development in the direction of educational research and technological innovation.

Meanwhile, “Augmented Reality” also appeared for the first time in 2025, supported by a thick arrow from the previous period, reflecting a strong continuity and growing interest in immersive technologies. AR allows educational content to be delivered in an interactive and visual format, enhancing student engagement and conceptual understanding. Its emergence indicates a growing focus on research that explores visually rich, context-based learning experiences, highlighting a broader trend toward more practical and engaging technology integration in educational environments.

## 4. Conclusion

The conclusion of this analysis is that the publication trend shows a significant increase in research on educational technology in Indonesia, with the highest number of publications occurring in 2024, indicating a strong and growing academic focus on this field in recent years. The results of Indonesian publications focus on the development and application of technology in the context of education, especially at the level of formal institutions and digital learning processes. This focus reflects a strong concern for the integration of technology in the education system and efforts to improve the quality and access to learning through digital innovation. The Word Cloud and keyword evolution together indicate that research on technology in education has progressed from an initial focus on digitalization and remote learning toward more complex, theoretical, and contextual

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## Declaration

**Supplementary Materials:** The supplementary materials of this study include the complete dataset retrieved from Scopus and the visualizations generated using R Program.

**Author Contribution:** Z: Conceptualization, Writing – Original Draft, Editing and Visualization; MHMM: Review & Editing, Formal analysis, and Methodology; MNMR: Validation and Supervision; H: Writing – Review & Editing; MAPP: Validation and Supervision. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## References

- [1] P. S. Figueiró, D. M. Neutzling, and B. Lessa, “Education for sustainability in higher education institutions: A multi-perspective proposal with a focus on management education,” *J. Clean. Prod.*, vol. 339, p. 130539, 2022, <https://doi.org/10.1016/j.jclepro.2022.130539>.
- [2] S. AlDaajeh, H. Saleous, S. Alrabae, E. Barka, F. Breiting, and K.-K. Raymond Choo, “The role of national cybersecurity strategies on the improvement of cybersecurity education,” *Comput. Secur.*, vol. 119, p. 102754, 2022, <https://doi.org/10.1016/j.cose.2022.102754>.
- [3] C. Adams, P. Pente, G. Lerner, and G. Rockwell, “Ethical principles for artificial intelligence in K-12 education,” *Comput. Educ. Artif. Intell.*, vol. 4, p. 100131, 2023, <https://doi.org/10.1016/j.caeai.2023.100131>.
- [4] T. Alqahtani *et al.*, “The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research,” *Res. Soc. Adm. Pharm.*, vol. 19, no. 8, pp. 1236–1242, 2023, <https://doi.org/10.1016/j.sapharm.2023.05.016>.
- [5] A. Nguyen, H. N. Ngo, Y. Hong, B. Dang, and B.-P. T. Nguyen, “Ethical principles for artificial intelligence in education,” *Educ. Inf. Technol.*, vol. 28, no. 4, pp. 4221–4241, 2023, <https://doi.org/10.1007/s10639-022-11316-w>.
- [6] M. Samaniego, N. Usca, J. Salguero, and W. Quevedo, “Creative Thinking in Art and Design Education: A Systematic Review,” *Education Sciences*, vol. 14, no. 2, 2024, <https://doi.org/10.3390/educsci14020192>.
- [7] H. E. Wilson, S. HwanHee, J. Julie, P. Lucinda, and K. and Olson, “Effects of transdisciplinary STEAM lessons on student critical and creative thinking,” *J. Educ. Res.*, vol. 114, no. 5, pp. 445–457, Sep. 2021, <https://doi.org/10.1080/00220671.2021.1975090>.
- [8] Y.-L. E. Liu, T.-P. Lee, and Y.-M. Huang, “Enhancing university students’ creative confidence, learning motivation, and team creative performance in design thinking using a digital visual collaborative environment,” *Think. Ski. Creat.*, vol. 50, p. 101388, 2023, <https://doi.org/10.1016/j.tsc.2023.101388>.
- [9] H. Akram, A.-A. Ahmad Samed, A. Sarfraz, and M. I. and Khan, “Pedagogical practices and challenges in cultivating moral values: A qualitative study of primary school teachers in Pakistan,” *Educ. 3-13*, vol. 51, no. 4, pp. 607–619, May 2023, <https://doi.org/10.1080/03004279.2021.1992471>.
- [10] N. Knoth *et al.*, “Developing a holistic AI literacy assessment matrix – Bridging generic, domain-specific, and ethical competencies,” *Comput. Educ. Open*, vol. 6, p. 100177, 2024,

<https://doi.org/10.1016/j.caeo.2024.100177>.

- [11] D. Kosatka, C. Michal, and M. and Kosatkova, "The Crisis of Knowledge as a Background for a Pedeutological Approach: Construction and Orientation in Information Environment," *Eur. Educ.*, pp. 1–18, <https://doi.org/10.1080/10564934.2025.2490502>.
- [12] I. Levin and D. Mamlok, "Culture and Society in the Digital Age," *Information*, vol. 12, no. 2. 2021, <https://doi.org/10.3390/info12020068>.
- [13] M. H. Al-khresheh, "Bridging technology and pedagogy from a global lens: Teachers' perspectives on integrating ChatGPT in English language teaching," *Comput. Educ. Artif. Intell.*, vol. 6, p. 100218, 2024, <https://doi.org/10.1016/j.caeai.2024.100218>.
- [14] P. Mishra, W. Melissa, and R. and Islam, "TPACK in the age of ChatGPT and Generative AI," *J. Digit. Learn. Teach. Educ.*, vol. 39, no. 4, pp. 235–251, Oct. 2023, <https://doi.org/10.1080/21532974.2023.2247480>.
- [15] E. B. Moraes *et al.*, "Integration of Industry 4.0 technologies with Education 4.0: advantages for improvements in learning," *Interact. Technol. Smart Educ.*, vol. 20, no. 2, pp. 271–287, Jan. 2023, <https://doi.org/10.1108/ITSE-11-2021-0201>.
- [16] T. Wut and J. Xu, "Person-to-person interactions in online classroom settings under the impact of COVID-19: a social presence theory perspective," *Asia Pacific Educ. Rev.*, vol. 22, no. 3, pp. 371–383, 2021, <https://doi.org/10.1007/s12564-021-09673-1>.
- [17] M. Cevikbas and G. Kaiser, "Student Engagement in a Flipped Secondary Mathematics Classroom," *Int. J. Sci. Math. Educ.*, vol. 20, no. 7, pp. 1455–1480, 2022, <https://doi.org/10.1007/s10763-021-10213-x>.
- [18] E. A. van Es and M. G. Sherin, "Expanding on prior conceptualizations of teacher noticing," *ZDM – Math. Educ.*, vol. 53, no. 1, pp. 17–27, 2021, <https://doi.org/10.1007/s11858-020-01211-4>.
- [19] M. Wang and Y. Wang, "A structural equation modeling approach in examining EFL students' foreign language enjoyment, trait emotional intelligence, and classroom climate," *Learn. Motiv.*, vol. 86, p. 101981, 2024, <https://doi.org/10.1016/j.lmot.2024.101981>.
- [20] M. P.-C. Lin and D. Chang, "CHAT-ACTS: A pedagogical framework for personalized chatbot to enhance active learning and self-regulated learning," *Comput. Educ. Artif. Intell.*, vol. 5, p. 100167, 2023, <https://doi.org/10.1016/j.caeai.2023.100167>.
- [21] A. Almufarreh and M. Arshad, "Promising Emerging Technologies for Teaching and Learning: Recent Developments and Future Challenges," *Sustainability*, vol. 15, no. 8. 2023, <https://doi.org/10.3390/su15086917>.
- [22] M. Sofi-Karim, A. O. Bali, and K. Rached, "Online education via media platforms and applications as an innovative teaching method," *Educ. Inf. Technol.*, vol. 28, no. 1, pp. 507–523, 2023, <https://doi.org/10.1007/s10639-022-11188-0>.
- [23] R. Li, M. Cevikbas, and G. Kaiser, "Mathematics teachers' beliefs about their roles in teaching mathematics: orchestrating scaffolding in cooperative learning," *Educ. Stud. Math.*, vol. 117, no. 3, pp. 357–377, 2024, <https://doi.org/10.1007/s10649-024-10359-9>.
- [24] H.-Y. Lee, P.-H. Chen, W.-S. Wang, Y.-M. Huang, and T.-T. Wu, "Empowering ChatGPT with guidance mechanism in blended learning: effect of self-regulated learning, higher-order thinking skills, and knowledge construction," *Int. J. Educ. Technol. High. Educ.*, vol. 21, no. 1, p. 16, 2024, <https://doi.org/10.1186/s41239-024-00447-4>.
- [25] F. Karataş, F. Y. Abedi, F. Ozek Gunyel, D. Karadeniz, and Y. Kuzgun, "Incorporating AI in foreign language education: An investigation into ChatGPT's effect on foreign language learners," *Educ. Inf. Technol.*, vol. 29, no. 15, pp. 19343–19366, 2024, <https://doi.org/10.1007/s10639-024-12574-6>.
- [26] L. Cai, M. M. Msafiri, and D. Kangwa, "Exploring the impact of integrating AI tools in higher education using the Zone of Proximal Development," *Educ. Inf. Technol.*, vol. 30, no. 6, pp. 7191–7264, 2025, <https://doi.org/10.1007/s10639-024-13112-0>.
- [27] K. S. Suryanarayana, V. S. P. Kandi, G. Pavani, A. S. Rao, S. Rout, and T. S. R. Krishna, "Artificial Intelligence Enhanced Digital Learning for the Sustainability of Education Management System," *J. High Technol. Manag. Res.*, vol. 35, no. 2, p. 100495, 2024, <https://doi.org/10.1016/j.hitech.2024.100495>.

- [28] C. Yu, J. Yan, and N. Cai, "ChatGPT in higher education: factors influencing ChatGPT user satisfaction and continued use intention," *Front. Educ.*, vol. 9, 2024, <https://doi.org/10.3389/feduc.2024.1354929>.
- [29] P. Radanliev, "Cyber diplomacy: defining the opportunities for cybersecurity and risks from Artificial Intelligence, IoT, Blockchains, and Quantum Computing," *J. Cyber Secur. Technol.*, vol. 9, no. 1, pp. 28–78, Jan. 2025, <https://doi.org/10.1080/23742917.2024.2312671>.
- [30] I. M. García-López, C. S. González González, M.-S. Ramírez-Montoya, and J.-M. Molina-Espinosa, "Challenges of implementing ChatGPT on education: Systematic literature review," *Int. J. Educ. Res. Open*, vol. 8, p. 100401, 2025, <https://doi.org/10.1016/j.ijedro.2024.100401>.
- [31] Y. Ma and C. Wang, "Empowering music education with technology: a bibliometric perspective," *Humanit. Soc. Sci. Commun.*, vol. 12, no. 1, p. 345, 2025, <https://doi.org/10.1057/s41599-025-04616-2>.
- [32] V. K. Singh, P. Singh, M. Karmakar, J. Leta, and P. Mayr, "The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis," *Scientometrics*, vol. 126, no. 6, pp. 5113–5142, 2021, <https://doi.org/10.1007/s11192-021-03948-5>.
- [33] M. Tekdal, "Trends and development in research on computational thinking," *Educ. Inf. Technol.*, vol. 26, no. 5, pp. 6499–6529, 2021, <https://doi.org/10.1007/s10639-021-10617-w>.
- [34] H. Retnawati and R. Hidayat, "Research Trends in Scopus Database on Technological Innovation in the Process of Mathematics Learning: A Bibliometric Analysis," *Int. J. Cogn. Res. Sci. Eng. Educ.*, vol. 13, no. 1, pp. 97–116, 2025, <https://doi.org/10.23947/2334-8496-2025-13-1-97-116>.
- [35] F. D. Zengul, N. Oner, J. D. Byrd, and A. Savage, "Revealing Research Themes and Trends in 30 Top-ranking Accounting Journals: A Text-mining Approach," *Abacus*, vol. 57, no. 3, pp. 468–501, Sep. 2021, <https://doi.org/10.1111/abac.12214>.
- [36] Y. Bai, H. Li, and Y. Liu, "Visualizing research trends and research theme evolution in E-learning field: 1999–2018," *Scientometrics*, vol. 126, no. 2, pp. 1389–1414, 2021, <https://doi.org/10.1007/s11192-020-03760-7>.