IJBER | International Journal of Basic Educational Research

Volume 02, Nomor 02, 2025
ISSN (e): 3047-0722
DOI: https://doi.org/10.14421/ijber.v2i2.11619

AI-Integrated Pedagogies in Primary Education: A Decade of Global Trends and Strategic Adaptation for Indonesia's Curriculum Transformation

Wildan Nuril Ahmad Fauzi[1], Yuli Setiawati[2], Deni Puji Hartono[3], Moh Rosyid Mahmudi[4], Mulyo Prayitno[5]

[1]Wildan Nuril Ahmad Fauzi. Universitas Negeri Yogyakarta, Yogyakarta, Indonesia. wildannuril.2023@student.uny.ac.id
ORCID: 0000-0001-8739-0934
[2]Yuli Setiawati, Universitas Islam Negeri Sunan Kalijaga, Yogyakarta, Indonesia. yulisetiawati819@gmail.com
ORCID: 0009-0005-1341-4645
[3]Deni Puji Hartono. Universitas PGRI Palembang, Indonesia. denipujihartono03@gmail.com
ORCID: 0009-0003-6865-8933
[4]Moh Rosyid Mahmudi. Universitas Dharmas Indonesia, Dharmas Sumatera Barat, Indonesia mohrosyidmahmudi@gmail.com
ORCID: 0000-0003-4006-8440
[5]Mulo Prayitno. Universitas Safin Pati, Indonesia. mulyoprayitno@usp.ac.id
ORCID: 0000-0003-3620-8164

Corresponding Author:
Wildan Nuril Ahmad Fauzi. Universitas Negeri Yogyakarta, Yogyakarta, Indonesia. wildannuril.2023@student.uny.ac.id

Submitted: 1/08/2025
1st Revised: 4/08/2025
2nd Revised: 4/08/2025
Accepted: 5/08/2025
Online Published: 7/08/2025

Citation: Ahmad Fauzi, W. N., Setiawati, Y., Puji Hartono, D., Mahmudi, M. R., & Prayitno, M. AI-Integrated Pedagogies in Primary Education: A Decade of Global Trends and Strategic Adaptation for Indonesia's Curriculum Transformation. International Journal of Basic Educational Research, 2(2). https://doi.org/10.14421/ijber.v2i2.11619

Abstract

This study investigates the global scholarly evolution of AI-integrated pedagogical practices in primary education and proposes strategic pathways for adapting these trends to enhance learning innovation in the Indonesian context. The urgency to align basic education with 21st-century competencies and the accelerating growth of artificial intelligence has created a significant research gap, particularly in translating global pedagogical models into localized applications. Through a bibliometric analysis of 126 peer-reviewed journal articles published between 2014 and 2024 and indexed in Scopus, this study employs the Bibliometrix R-package within RStudio to examine publication growth, source distribution, author collaboration, keyword co-occurrence, thematic mapping, and conceptual structures. Results indicate a sharp increase in research interest beginning in 2021, highlighting emerging themes such as computational thinking, adaptive learning, personalized education, generative AI, and affective computing. These patterns reveal a global pedagogical shift toward data-driven, student-centered, and emotionally intelligent instructional models. When viewed in relation to Indonesia's Curriculum Merdeka and Society 5.0 ambitions, the findings suggest high potential for contextual integration particularly through CPD programs that enable teachers to apply AI tools like chatbots, self-regulated learning dashboards, and real-time feedback systems in culturally relevant ways. The study concludes that successful adaptation depends on multi-level collaboration, policy support, and iterative design rooted in both global evidence and local realities. By bridging bibliometric insights with educational policy transformation, this research offers a timely and scalable contribution to the discourse on AI in education. It highlights how developing countries can leverage global innovation trajectories to achieve inclusive, future-ready classroom ecosystems.

Keywords: Adaptive learning, artificial intelligence, computational thinking, digital pedagogy, primary education

Introduction

In the last decade, artificial intelligence (AI) has rapidly transitioned from a technological innovation to a transformative force in education, reshaping instructional models (Radif, 2024), assessment systems (Boutyour et al., 2024), and learner engagement strategies across all levels of schooling (Singh, 2024). While its application in higher education and vocational training has been widely explored, the integration of AI into primary education remains a relatively emergent field. Nevertheless, this frontier is growing in both complexity and significance, as early-grade learning environments begin to adopt adaptive learning platforms, intelligent tutoring systems, and generative AI tools to personalize instruction and promote foundational skills (López-Minotta et al., 2025).

The urgency to explore AI in primary education is amplified by the global momentum toward digital transformation, especially in the aftermath of the COVID-19 pandemic, which accelerated the adoption of educational technologies in formal schooling. In primary contexts, where students are in critical stages of cognitive, social, and emotional development, the use of AI-integrated pedagogies must not only enhance academic outcomes but also foster creativity (Kabeer et al., 2025), communication (Edwards et al., 2025), and metacognitive awareness (Lee et al., 2025). As the boundaries between technology and pedagogy blur, educators and policymakers are challenged to ensure that these innovations remain child-centered, developmentally appropriate, and ethically sound (Erstad et al., 2015).

Existing studies on AI in education tend to focus on secondary or tertiary education settings, where digital literacy and device access are more robust (Ocen et al., 2025). Consequently, there is a notable research gap regarding how AI-integrated pedagogies are conceptualized, implemented, and assessed within primary education. Furthermore, much of the current discourse remains fragmented, lacking a cohesive synthesis of trends, themes, and intellectual structures that shape this growing domain. Without such mapping, stakeholders in education particularly in low- and middle-income countries face difficulties in navigating the global knowledge landscape to inform local innovations.

In the Indonesian context, the urgency of this inquiry is heightened by the national rollout of the Curriculum Merdeka, a progressive framework emphasizing student agency, differentiated instruction, and 21st-century competencies. While the curriculum implicitly supports technology-enhanced learning, concrete pathways for integrating AI tools into primary classrooms remain underdeveloped. There is also a lack of empirically grounded guidance on how AI pedagogies rooted in global trends can be adapted to suit the socio-cultural, infrastructural, and pedagogical realities of Indonesian schools.

Moreover, the rise of generative AI, such as ChatGPT, and affective computing systems offers new affordances in dialogic learning, self-regulated learning, and formative feedback. These innovations have the potential to address long-standing challenges in Indonesian primary education, such as large class sizes, varied learning readiness, and limited teacher support for differentiated instruction. However, capitalizing on these potentials requires a clear understanding of how AI-integrated pedagogies have evolved globally and how they can be meaningfully localized.

To date, no study has systematically mapped the scholarly discourse on AI-integrated pedagogical practices in primary education with a focus on both quantitative trends and qualitative implications. Existing reviews are either too general lumping together all educational levels or lack the analytical depth required to inform curriculum and policy development at the foundational stage of education. This study addresses that gap by combining bibliometric analysis with conceptual synthesis, offering a dual perspective that is both data-driven and pedagogically informed.

Thus, this study aims to comprehensively map the scholarly dynamics related to AI-integrated pedagogical practices in the context of primary education, as well as to explore their potential adaptation to foster learning innovation in Indonesian primary schools. Through a bibliometric approach and conceptual analysis, this study is expected to contribute to strengthening the theoretical foundation and practical direction of educational policy development that is more responsive to global technological advancements, particularly in accelerating the transformation of classrooms into adaptive, contextual, and future-ready learning ecosystems.

Methods

This study employed a bibliometric approach to systematically examine the evolving landscape of research on AI-integrated pedagogical practices in primary education. Bibliometric analysis offers a powerful methodological framework to quantify publication patterns, identify influential themes, and map the intellectual structure of a scientific domain (Aria & Cuccurullo, 2017; Donthu et al., 2021). In this study, bibliometric methods were used to address the following research questions:

RQ1: How has scholarly research on AI-integrated pedagogical practices in primary education evolved from 2014 to 2024 in terms of publication trends, thematic developments, and intellectual structure?

RQ2: How can the evolving global discourse on AI-integrated pedagogies be adapted to enhance learning innovation in Indonesian primary classrooms?

All data were retrieved from the Scopus database (https://www.scopus.com) on June 27, 2025, owing to its extensive indexing of peer-reviewed literature across education, psychology, and the humanities, as well as its compatibility with bibliometric tools and metadata analysis (Fauzi et al., 2025). The search was constructed to capture documents that explicitly addressed the integration of artificial intelligence (e.g., "AI," "machine learning," "chatbot," "adaptive learning") within the context of primary or elementary education.

To ensure analytical precision, the dataset was refined using several inclusion parameters: (1) publication year between 2014 and 2024, (2) document type limited to journal articles, (3) final publication stage only, (4) English language, and (5) subject areas restricted to Social Sciences, Psychology, and Arts and Humanities. These filters ensured thematic coherence while excluding technically-oriented publications outside the pedagogical scope. The enhanced search query and bibliometric parameters are detailed in Table 1.

Table 1. Main bibliometric data summary

Description	Condition
Search query	TITLE-ABS-KEY ((("artificial intelligence" OR "AI" OR "chatbot" OR "machine learning" OR "adaptive learning") AND ("primary education" OR "elementary education" OR "elementary school" OR "primary school"))) → 1117
Search query after refining	TITLE-ABS-KEY ((("artificial intelligence" OR "AI" OR "chatbot" OR "machine learning" OR "adaptive learning") AND ("primary education" OR "elementary education" OR "elementary school" OR "primary school"))) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "ARTS")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (SRCTYPE , "j")) → 126
Date	June 27, 2025
Years	2014–2024
Document Type	Article
Publication Stage	Limited to Final
Language	Limited to English

The final dataset comprised 126 documents published across 74 peer-reviewed journals, with an annual growth rate of 46.65%, an average of 16.7 citations per article, and contributions from 402 authors (see Table 2). These data indicate a sharp increase in scholarly attention to the topic over the past decade. The dataset was then imported into RStudio (v4.4.3) and analyzed using the bibliometrix R package (Aria & Cuccurullo, 2017). Key analyses included: annual scientific production, author and source productivity, keyword co-occurrence, thematic mapping, and intellectual structure exploration.

The results of this bibliometric analysis served as the empirical foundation to answer RQ1, while RQ2 was addressed through qualitative interpretation of trends and their relevance to educational practice in Indonesia, particularly in the primary school context.

Result

RQ1: How has scholarly research on AI-integrated pedagogical practices in primary education evolved from 2014 to 2024 in terms of publication trends, thematic developments, and intellectual structure?

Table 2 presents a summary of key bibliometric indicators that capture the scholarly dynamics of research on AI-integrated pedagogies in primary education over the past decade. A total of 126 peer-reviewed articles were identified from 74 academic journals, covering the publication period between 2014 and 2024. This reflects a substantial and accelerating growth in scholarly attention, as evidenced by a high annual publication growth rate of 46.65%, indicating that AI-related innovations in elementary-level pedagogy have gained increasing prominence in recent years.

The average age of the documents was 2.62 years, which suggests that the majority of contributions are relatively recent and aligned with current developments in educational technology and digital transformation in schools. Furthermore, the documents recorded an average of 16.7 citations per article, signaling a strong and cumulative academic impact within the field. In terms of research collaboration, the dataset included contributions from a wide range of scholars, with an international co-authorship rate of 19.84%. This figure indicates a growing trend of transnational cooperation and interdisciplinary engagement in studying AI applications at the primary school level.

Collectively, the indicators in Table 2 provide a robust empirical foundation for understanding the expansion and intensification of interest in this emerging area. These trends set the stage for deeper exploration of the conceptual structures, thematic patterns, and knowledge networks shaping the discourse on AI and pedagogy in primary education, which are analyzed in the subsequent sections.

Table 2. Main Bibliometric Indicators of research on AI-Integrated pedagogies in primary education (2014–2024)

Description	**Results**
Timeframe	2014–2024
Sources	74
Documents	126
Annual Growth Rate (%)	46.65
Document Average Age (years)	2.62
Average Citations per Document	16.70
International Co-authorships (%)	19.84

1. Annual scientific production

Based on the visualization presented in Figure 1, a significant surge is observed in the number of publications related to AI-integrated pedagogy in primary education, particularly since 2021. After a slow and fluctuating growth period between 2014 and 2020, the trend increased sharply with 17 articles in 2021, followed by 24 (2022), 26 (2023), and peaking in 2024 with 46 publications. This pattern indicates an exponential rise in global scholarly attention toward the integration of AI in primary school contexts, which may be associated with the expansion of post-pandemic technology adoption and the global push for digital transformation in basic education. These findings reflect that the topic is not only growing quantitatively but has also become a central strategic discourse in 21st-century education.

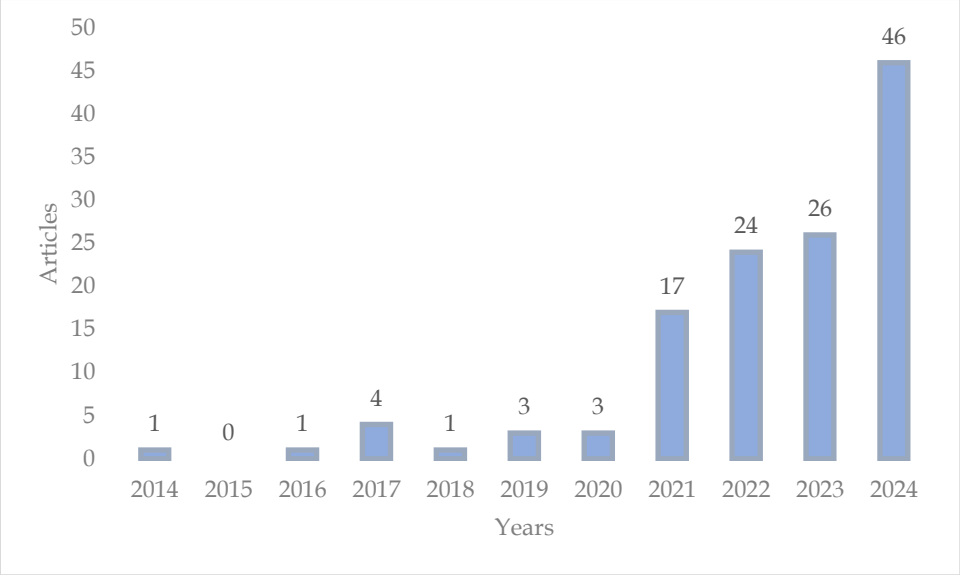

Figure 1. Annual scientific production

2. Most relevant sources

As illustrated in Figure 2, the distribution of publications across journals reveals a concentrated yet diverse source base supporting the discourse on AI-integrated pedagogies in primary education. The most prolific journal is Computers and Education: Artificial Intelligence with 9 articles, followed by Education Sciences (8 articles), and Frontiers in Education and Sustainability (Switzerland), each contributing 7 publications. These top-ranked sources highlight the interdisciplinary nature of the topic, with coverage spanning educational technology, cognitive psychology, and sustainable educational innovation. The presence of journals such as British Journal of Educational Technology, Behavioral Sciences, and International Journal of Child-Computer Interaction further emphasizes the pedagogical-technological nexus at the heart of this research domain. This source profile reflects both academic legitimacy and thematic depth, indicating that AI integration in primary education is not a marginal trend, but a growing field recognized across high-quality international publications.

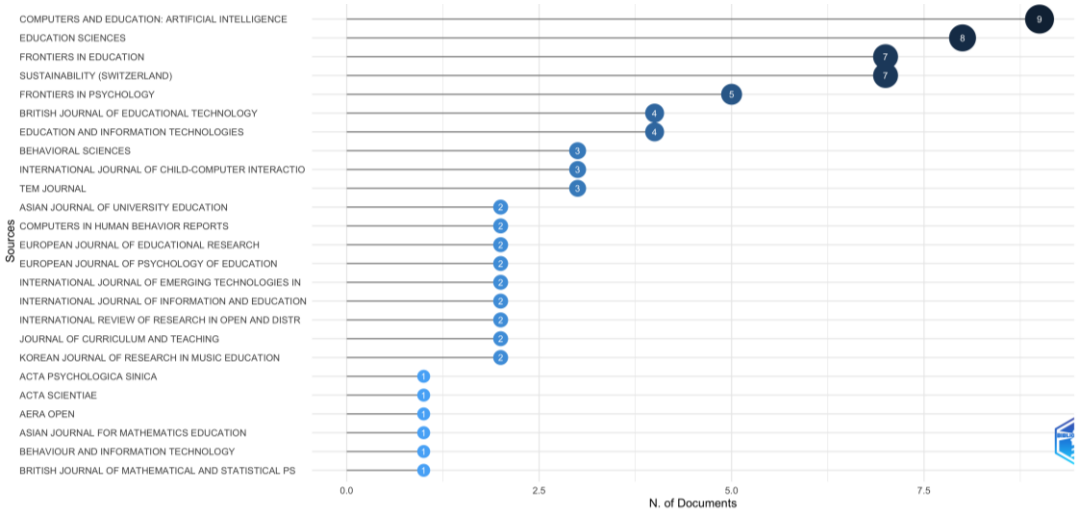

Figure 2. Most relevant sources

3. Most Relevant authors

As shown in Figure 3, the authorship landscape in AI-integrated pedagogical research for primary education is led by a few highly active contributors. Molenaar, Inge stands out as the most prolific author with 4 publications, followed by Horvers, Anne, Dai, Yun, and Knoop-van Campen, Carolien A. N., each contributing 3 articles. A significant number of other authors such as Ching-Sing Chai, Kelly Berthiaume, Rick Dijkstra, and Morris Siu-Yung Jong contributed 2 articles each, suggesting a growing scholarly community with emerging clusters of expertise. The presence of international authors from diverse academic affiliations also reflects the interdisciplinary and transnational character of this research field, reinforcing its global relevance and collaborative nature.

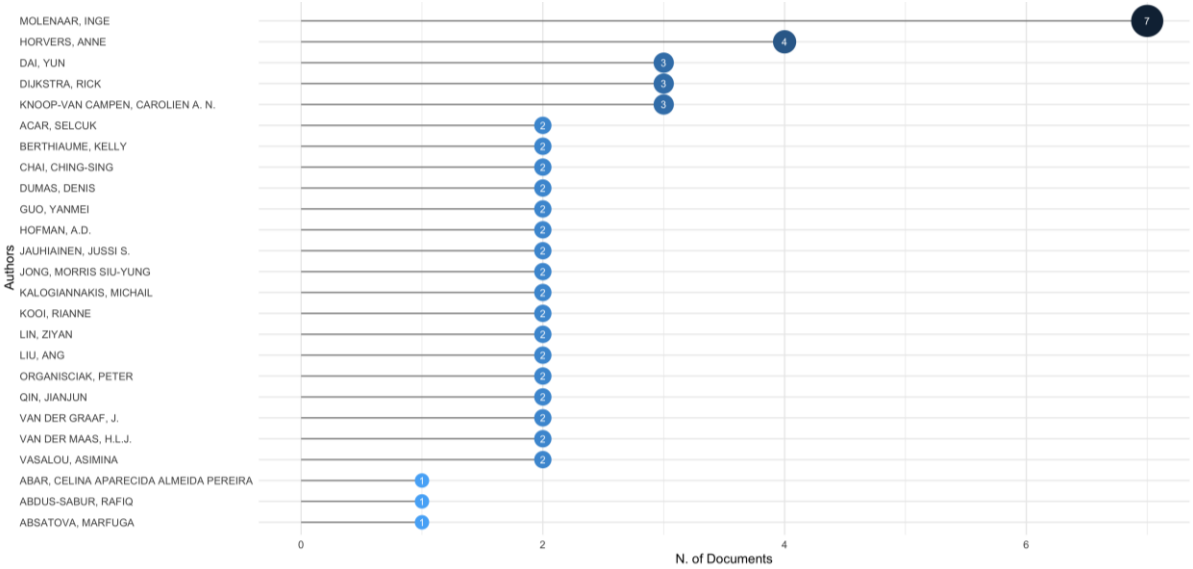

Figure 3. Most relevant authors

4. Authors' production over time

Figure 4 illustrates the temporal distribution of influential authors contributing to AI-integrated pedagogy in primary education. Notably, Inge Molenaar (2021, 2019a, 2019b) has demonstrated consistent scholarly output from 2019 to 2024, marked

by sustained citation influence (TC/year) across years. Other prominent contributors such as Carolien A. N. Knoop-van Campen, Rick Dijkstra, and Anne Horvers also show a strong presence beginning around 2019–2020, with a gradual rise in both quantity and citation impact. The visual progression of authors like Jong Morris Siu-Yung and Kelly Berthiaume post-2021 signals a growing diversification of active researchers entering the field. This trend highlights not only the consolidation of early leaders but also the emergence of new scholarly voices contributing to the evolving AI pedagogical discourse in primary education.

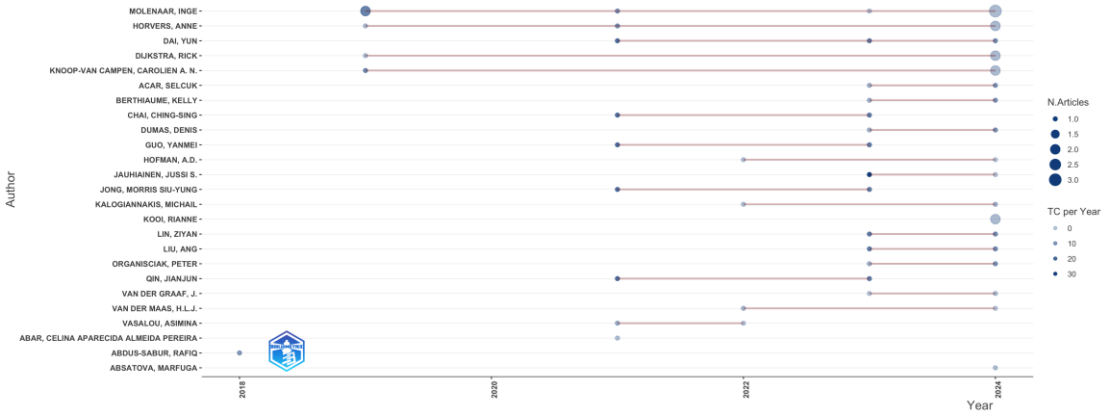

Figure 4. Authors' production over time

5. Countries' scientific production

The global distribution of research on AI-integrated pedagogies in primary education (2014–2024) reveals a distinct dominance by technologically advanced nations, with the United States (n= 67) and China (n= 57) leading scientific contributions, followed by Spain (n= 34) and the Netherlands (n= 33) (see Figure 5). This concentration indicates not only access to robust research ecosystems and digital infrastructure but also national prioritization of AI-driven educational transformation. Notably, Indonesia's inclusion (n= 15) signals emerging scholarly engagement from the Global South, suggesting increasing responsiveness to global educational innovation. However, the geographical asymmetry highlights an ongoing North–South divide in knowledge production, underscoring the urgent need for equitable academic partnerships and inclusive research capacity building to ensure that advancements in AI-enhanced education are contextually relevant and globally accessible.

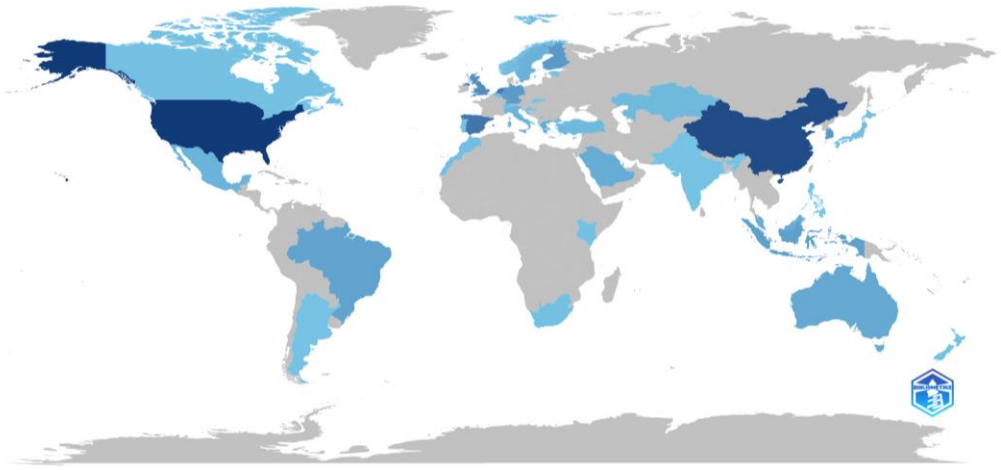

Figure 5. Countries' scientific production

6. Co-ocurrence network

The co-occurrence network (see Figure 6) reveals a multi-clustered semantic landscape in which artificial intelligence (AI) emerges as the central and most dominant thematic node, closely associated with key educational settings such as elementary school, primary education, and special education. The red cluster, radiating around "artificial intelligence," highlights interdisciplinary integrations with themes like creativity, music education, and computational thinking, indicating an expanding pedagogical application of AI across cognitive and affective learning domains. The blue cluster connects primary education with adaptive technologies (e.g., dashboards, learning analytics, and self-regulated learning), pointing to a sustained focus on personalized and data-informed instruction. Meanwhile, the green and purple clusters emphasize conventional curriculum areas (mathematics education, elementary education) and online learning modalities, while the orange cluster anchored by ChatGPT and generative AI marks an emergent frontier signaling the disruptive influence of large language models. This structure underscores both the consolidation of AI in foundational educational contexts and the rise of novel, rapidly evolving subfields that reshape instructional paradigms.

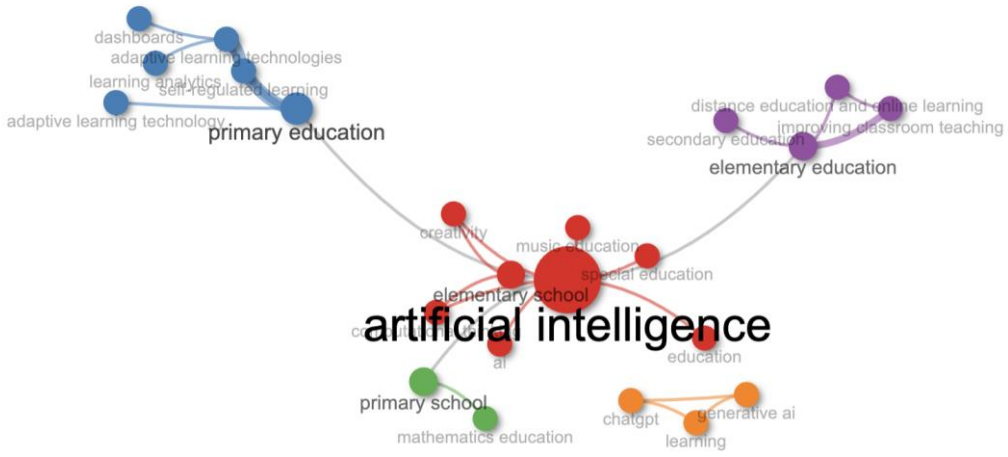

Figure 6. Co-ocurrence network

7. Thematic map

The thematic network map (Figure 7) visualizes a complex and multidimensional landscape of research on artificial intelligence in primary education, with "artificial intelligence" acting as the conceptual nucleus. Surrounding this core are densely connected themes such as computational thinking, elementary school, critical thinking, adaptive learning, digital transformation, and curriculum design, each forming distinct yet overlapping clusters. The close proximity of clusters related to machine learning, personalization, and emotion recognition suggests an emerging trend toward affective computing integration in learning environments. Additionally, the prominence of themes like ChatGPT, AI in education, and pedagogy indicates a growing research interest in both generative AI and its pedagogical implications. This thematic structure reflects a transition from foundational AI integration in education toward a more nuanced exploration of its cognitive, emotional, and instructional dimensions, confirming the field's dynamic evolution and interdisciplinary expansion.

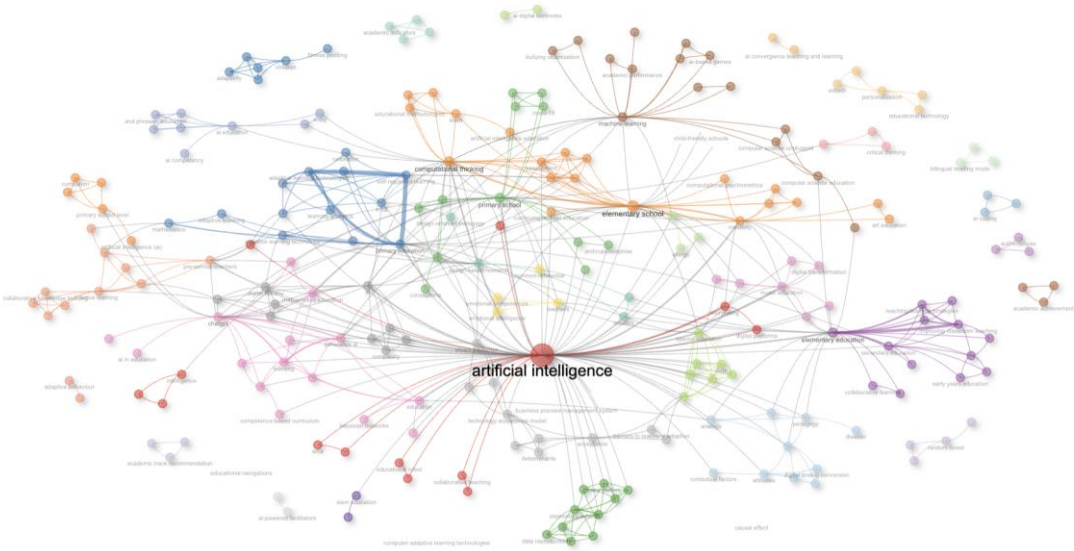

Figure 7. Thematic map

RQ2: How can the evolving global discourse on AI-integrated pedagogies be adapted to enhance learning innovation in Indonesian primary classrooms?

The evolving global discourse on AI-integrated pedagogies presents several promising directions that can be strategically contextualized to advance learning innovation in Indonesian primary schools.

1. The prominence of themes such as computational thinking, adaptive learning, and personalized education underscores a global pedagogical shift toward learner-centered designs that promote flexibility, differentiation, and digital fluency. These constructs align well with the vision of "curriculum Merdeka", offering opportunities to embed adaptive technologies that accommodate students' diverse needs, readiness levels, and learning trajectories.
2. The emergence of ChatGPT and generative AI as pedagogical tools reflects a rising global interest in dialogic, expressive, and interdisciplinary applications of AI potentials that could be harnessed in Indonesian classrooms to cultivate critical thinking, expressive literacy, and cross-subject creativity, in line with Society 5.0 goals.

3. The growing emphasis on emotional intelligence, self-regulated learning, and dashboard-based feedback systems signals a broader movement toward nurturing student agency and reflective metacognition, which remains underdeveloped in many conventional Indonesian classrooms.

For these global trends to be meaningfully adapted, educators in Indonesia must be supported through targeted and sustained Continuing Professional Development (CPD) programs that bridge international AI pedagogical models with local curricular, infrastructural, and cultural realities. Ultimately, integrating these AI-driven pedagogical innovations into Indonesia's educational reform agenda can accelerate the transformation of classrooms into adaptive, future-ready learning ecosystems provided that such adaptation is accompanied by iterative evaluation, collaborative design, and policy alignment.

Discussion

This discussion section synthesizes the quantitative bibliometric findings (RQ1) and qualitative interpretive insights (RQ2) to provide a comprehensive understanding of how AI-integrated pedagogies have evolved globally and how these developments can be meaningfully adapted to the Indonesian primary education context. The discussion is organized into five sub-sections: (1) Growth and Maturity of the Research Landscape, (2) Emerging Intellectual and Thematic Structures, (3) Global Leadership and Regional Participation, (4) Practical Adaptation to Indonesian Classrooms, and (5) Implications for Policy and Future Research.

1. Growth and Maturity of the Research Landscape

   The rapid growth in scholarly output since 2021, with a peak of 46 publications in 2024, signals a strong momentum in the academic investigation of AI-integrated pedagogical models in primary education. The annual publication growth rate of 46.65%, coupled with an average of 16.7 citations per article, reflects both quantitative expansion and intellectual impact. These indicators affirm that the field is transitioning from exploratory to more consolidated research phases, with increased methodological sophistication and theoretical grounding. This trajectory confirms the global prioritization of AI as a transformative force in early educational settings and situates primary education as a fertile ground for AI experimentation and innovation.

2. Emerging Intellectual and Thematic Structures

   The co-occurrence and thematic map analyses reveal a dynamic and multidimensional knowledge structure. Central themes such as artificial intelligence, computational thinking, adaptive learning, and personalized education represent a convergence of cognitive, technological, and pedagogical concerns. These clusters demonstrate the maturity of certain research foci (e.g., AI in classroom personalization), while also highlighting emergent domains such as generative AI, ChatGPT integration, and affective computing. The network structure indicates a growing complexity in how AI is being conceptualized not only as a tool for instruction but as an ecosystem for rethinking teaching, learning, and assessment in holistic ways.

3. Global Leadership and Regional Participation

   The dominance of countries such as the United States and China in AI-in-education research reflects their robust digital infrastructures and strong AI research ecosystems. However, the visible emergence of Indonesia (with 15 articles) in the dataset signals increasing engagement from the Global South. While this contribution

remains modest, it reflects a broader shift toward global inclusivity and potential for cross-regional collaboration. The international co-authorship rate of 19.84% further confirms the field's transnational character and the potential for Indonesian researchers and policymakers to actively participate in global AI-pedagogical innovation networks.

4. Practical Adaptation to Indonesian Classrooms

The thematic alignment between global trends and the priorities of Indonesia's Curriculum Merdeka (e.g., personalization, digital literacy, learner agency) opens substantial avenues for practical integration. Adaptive learning systems, as highlighted in the global discourse, could address diverse student readiness levels in Indonesian classrooms, particularly in remote or under-resourced areas. Likewise, the pedagogical application of generative AI tools such as ChatGPT holds potential to enhance critical thinking and expressive literacy, aligning with Society 5.0 aspirations. Furthermore, the integration of dashboard-based feedback and self-regulated learning mechanisms can support the cultivation of reflective, independent learners goals embedded within Curriculum Merdeka yet still under-realized in practice. To operationalize these insights, educators must be equipped with sustained, context-sensitive Continuing Professional Development (CPD) programs that bridge global innovations with local pedagogical realities.

5. Implications for Policy and Future Research

The findings of this study underscore the urgency for policy frameworks that enable scalable, equitable AI integration in primary education. This includes investments in digital infrastructure, teacher training, ethical guidelines for AI use, and research funding aligned with Indonesia's educational transformation agenda. Future research should examine the contextual factors that shape the successful adoption of AI in diverse school environments, including sociocultural norms, teacher beliefs, and community engagement. Longitudinal and design-based studies are also needed to evaluate the sustained impact of AI tools on student learning outcomes and well-being. By integrating insights from both bibliometric patterns and grounded educational needs, this study contributes to a strategic roadmap for transforming Indonesian primary education into a digitally enriched, learner-centered ecosystem that is globally informed and locally responsive.

Conclusion

This study has provided a comprehensive bibliometric overview and thematic synthesis of AI-integrated pedagogical practices in primary education between 2014 and 2024. The findings revealed an exponential growth in scientific production, increasing international collaboration, and the emergence of key thematic clusters such as adaptive learning, computational thinking, and generative AI. These trends reflect a paradigmatic shift toward learner-centered, data-driven, and emotionally responsive instruction models. Moreover, the evolving global discourse presents valuable opportunities for Indonesian education reform, particularly in aligning AI-driven innovations with the aspirations of the Curriculum Merdeka and the broader goals of Society 5.0. By contextualizing global insights and investing in sustained teacher professional development, Indonesia can accelerate the transformation of its primary classrooms into inclusive, adaptive, and future-ready learning environments.

Declarations

Author contribution statement

All authors contributed equally to the conception, design, analysis, and writing of this manuscript. The first author led the bibliometric and systematic synthesis.

Funding statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. No publicly archived datasets were used or generated during the current study.

Declaration of interests statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Additional information

This manuscript has not been published elsewhere and is not under consideration by another journal. The authors affirm that all analyses were conducted ethically and in accordance with academic integrity principles.

References

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An r-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Boutyour, Y., Idrissi, A., & Uden, L. (2024). Artificial Intelligence and Assessment Generators in Education: A Comprehensive Review. In *Modern Artificial Intelligence and Data Science 2024: Tools, Techniques and Systems* (Vol. 1166, pp. 265–284). Studies in Computational Intelligence. https://doi.org/10.1007/978-3-031-65038-3_21

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*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Edwards, J., Nguyen, A., Lämsä, J., Sobocinski, M., Whitehead, R., Dang, B., Roberts, A. S., & Järvelä, S. (2025). Human-AI Collaboration: Designing Artificial Agents to Facilitate Socially Shared Regulation Among Learners. *British Journal of Educational Technology*, *56*(2), 712–733. https://doi.org/10.1111/bjet.13534

Erstad, O., Eickelmann, B., & Eichhorn, K. (2015). Preparing teachers for schooling in the digital age: A meta-perspective on existing strategies and future challenges. *Education and Information Technologies*, *20*(4), 641–654. https://doi.org/10.1007/s10639-015-9431-3

Fauzi, W., Wuryandani, W., Supartinah, S., Santosa, I., & Setiawati, Y. (2025). Mapping the evolution of creative thinking in education: A decade-long bibliometric studies. *International Journal of Education in Mathematics, Science and Technology*, *13*(2), 275–290. https://doi.org/10.46328/ijemst.4671

Kabeer, A., Bhat, R. A., Antony, S., & Tramboo, I. A. (2025). Enhancing Creative Writing Skills in Secondary School Students through Prompt Engineering and Artificial Intelligence. *Forum for Linguistic Studies*, *7*(3), 800–815. https://doi.org/10.30564/fls.v7i3.8511

Lee, H., Stinar, F., Zong, R., Valdiviejas, H., Wang, D., & Bosch, N. (2025). Learning Behaviors Mediate the Effect of AI-powered Support for Metacognitive Calibration on Learning Outcomes. *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems*, 1–18. https://doi.org/10.1145/3706598.3713960

López-Minotta, K. L., Chiappe, A., & Mella-Norambuena, J. (2025). Implementation of Artificial Intelligence to Improve English Oral Expression. *Multidisciplinary Journal of Educational Research*, *15*(1), 43–71. https://doi.org/10.17583/remie.16188

Molenaar, I., Horvers, A., & Baker, R. S. (2021). What can moment-by-moment learning curves tell about students' self-regulated learning? *Learning and Instruction*, *72*, 101206. https://doi.org/10.1016/j.learninstruc.2019.05.003

Molenaar, I., & Knoop-van Campen, C. A. N. (2019a). How Teachers Make Dashboard Information Actionable. *IEEE Transactions on Learning Technologies*, *12*(3), 347–355. https://doi.org/10.1109/TLT.2018.2851585

Molenaar, I., & Knoop-van Campen, C. A. N. (2019b). How Teachers Make Dashboard Information Actionable. *IEEE Transactions on Learning Technologies*, *12*(3), 347–355. https://doi.org/10.1109/TLT.2018.2851585

Ocen, S., Elasu, J., Aarakit, S. M., & Olupot, C. (2025). Artificial intelligence in higher education institutions: review of innovations, opportunities and challenges. *Frontiers in Education*, *10*, 1530247. https://doi.org/10.3389/feduc.2025.1530247

Radif, M. (2024). Artificial Intelligence in Education: Transforming Learning Environments and Enhancing Student Engagement. *Educational Sciences: Theory & Practice*, *24*(1), 93–103.

Singh, P. (2024). Artificial Intelligence and Student Engagement. In *In Cases on Enhancing P-16 Student Engagement With Digital Technologies* (pp. 201–232). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-5633-3.ch008