

MAPPING RESEARCH TRENDS ON DIGITAL LITERACY AND ARTIFICIAL INTELLIGENCE IN EDUCATION: A BIBLIOMETRIC ANALYSIS USING BIBLIOSHINY

Azizia Freda Savana1*), Arda Putri Winata2)

1 Department of Japanese Language Education, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia

2 Librarian, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia

aziziafreda@umy.ac.id¹, arda@umy.ac.id²

Abstract

The rapid development of artificial intelligence (AI) and digital literacy has significantly transformed contemporary educational practices, particularly in teaching, learning, pedagogy, classroom practices, and assessment. The increasing number of scientific publications in this field indicates growing academic interest, yet comprehensive mapping studies integrating these domains remain limited. This study aims to analyze global research trends related to digital literacy and artificial intelligence in education using a bibliometric approach. Data were collected from the Scopus database using structured search queries covering publications from 2015 to 2025. The analysis employed Biblioshiny through several stages, including descriptive bibliometrics, co-authorship analysis, co-citation analysis, co-word analysis, conceptual structure mapping, thematic evolution, and trend topic analysis. The findings indicate a substantial increase in publications in recent years, reflecting the accelerated integration of AI technologies in educational contexts. Research themes have evolved from technology-assisted learning toward generative AI, adaptive learning, intelligent tutoring systems, and AI-driven assessment. The study also identifies dominant publication sources, influential authors, collaborative networks, and emerging thematic clusters shaping future educational research. Furthermore, the analysis reveals several research gaps, particularly regarding pedagogical implementation, ethical considerations, teacher readiness, and equitable access to AI technologies. This study contributes to the development of a comprehensive research landscape on AI and digital literacy in education and provides strategic recommendations for future research, educational policy, and curriculum innovation in the era of digital transformation.

Keywords: Bibliometrics; Artificial Intelligence; Digital Literacy; Education; Biblioshiny

Introduction

The development of artificial intelligence (AI) has become one of the most significant transformations in education over the last decade. Global studies indicate that AI plays a strategic role in supporting the automation of learning processes, improving teaching quality, enabling adaptive assessment, and facilitating personalized learning (Li et al., 2025). Large language models such as ChatGPT are increasingly utilized in higher education to assist academic writing, provide

cognitive scaffolding, and enhance learning productivity, although risks related to plagiarism, algorithmic bias, and academic integrity remain major concerns (Guizani et al., 2025). This trend highlights the necessity for educational institutions to adapt to the evolving digital ecosystem through adequate AI literacy competencies and institutional policies.

Furthermore, the integration of advanced technologies such as Quantum AI, gamification, and augmented reality has expanded pedagogical boundaries through

more immersive and adaptive learning experiences. Quantum AI-based augmented reality systems have been shown to increase learner engagement through adaptive storytelling, although most studies remain at the prototype stage and lack long-term evaluation (Rahman, 2025). At the same time, research on AI in STEM education demonstrates that AI supports intelligent tutoring systems, adaptive assessment, and learning analytics that positively affect learning outcomes. However, challenges such as algorithmic fairness, teacher readiness, and institutional policies continue to hinder effective implementation (Nguyen et al., 2025).

Within the context of English as a Foreign Language (EFL/ELT) education, AI has demonstrated increasingly significant contributions. Studies reveal that AI supports personalized learning, enhances creativity and higher-order thinking skills, and strengthens students' confidence in speaking and writing activities (Andreou & Christani, 2025; García-López et al., 2025). The use of generative AI provides instant feedback and low-pressure learning environments, although risks such as technological dependency, plagiarism, and reduced cognitive effort among students must be mitigated through appropriate instructional design. Research has also found that computer vision technology can be utilized to automatically assess classroom behavior, including teacher–student interaction, gestures, and facial expressions, thereby generating more objective learning evaluations (Wang, 2025). Transformer–Bayesian-based teaching evaluation models have even demonstrated higher predictive accuracy compared to traditional evaluation methods (Huang et al., 2025).

At the pedagogical level, digital technologies in differentiated ELT have continued to develop; however, research indicates that the utilization of AI, big data, and IoT remains limited and constrained by teacher readiness and unequal

technological infrastructure (Sahayu et al., 2026). In vocabulary instruction, bibliometric trends reveal that research is increasingly moving toward the integration of AI, virtual reality, gamification, and mobile learning as dominant themes (Mohd Zainol et al., 2025). Nevertheless, existing studies remain fragmented: some focus on vocabulary instruction, others on speaking and writing, gifted learners, or AR/VR applications. Comprehensive studies mapping the interrelationship between digital literacy, AI, pedagogy, and classroom practices are still lacking.

This is where the urgency of the present study emerges. Although numerous systematic reviews and bibliometric studies have been conducted, most focus only on specific subdomains such as vocabulary learning, productive skills, or ChatGPT integration. There remains no comprehensive study integrating the domains of digital literacy, artificial intelligence, teaching, learning, pedagogy, and classroom practices within a single global bibliometric analysis. By conducting bibliometric mapping using Biblioshiny, this study seeks to identify conceptual clusters, thematic trends, research evolution, collaboration networks, and research gaps that are often overlooked in thematic systematic literature reviews. This study contributes to the formulation of future research roadmaps and provides an empirical foundation for AI-based educational policy development.

This research proposal also emphasizes the substantive differentiation of the present study compared to previous bibliometric studies in artificial intelligence and digital literacy within education. The study clarifies its position at conceptual, methodological, and cross-domain synthesis levels. Conceptually, this research does not merely map AI in language education in general terms but explicitly analyzes the intersection between digital literacy, artificial intelligence, pedagogy, teaching–learning processes,

classroom practices, and assessment. This cross-domain approach distinguishes the study from previous bibliometric research, which has tended to remain fragmented across specific subtopics such as ChatGPT usage, vocabulary instruction, writing skills, or translation studies independently.

1. Artificial Intelligence in Education: Recent Developments, Opportunities, and Challenges

The development of artificial intelligence (AI) in education has experienced significant acceleration over the past decade. A systematic review regarding the implementation of Large Language Models (LLMs) in higher education indicates that ChatGPT and similar models can enhance academic productivity, support writing activities, and provide scaffolding for students in completing complex tasks. However, risks such as plagiarism, algorithmic bias, data privacy, and academic integrity remain major challenges. Therefore, educational institutions need to develop policies and instructional designs aligned with the presence of AI technologies (Guizani et al., 2025).

Furthermore, the integration of Quantum AI (QAI), gamification, and adaptive storytelling within educational augmented reality (AR) environments demonstrates considerable potential for immersive learning experiences. QAI enables AR systems to adjust narrative flows based on learners' cognitive responses, while gamification enhances motivation and learning retention. Nevertheless, most existing studies remain at the prototype stage with limited evaluation, highlighting the need for more comprehensive longitudinal research (Rahman, 2025).

The integration of AI in STEM education also reveals that these technologies are frequently utilized in intelligent tutoring systems, adaptive assessment, and learning analytics. These studies demonstrate

improvements in student engagement and learning outcomes. However, issues related to algorithmic fairness, teacher readiness, and institutional policy continue to represent significant barriers to implementation (Nguyen et al., 2025). These challenges align with studies connecting digital innovation, including AI, to the Sustainable Development Goals (SDGs), emphasizing that technology has the potential to improve educational quality while simultaneously increasing digital inequality if not supported by adequate infrastructure (Al Husaeni & Haristiani, 2025).

Collectively, these studies demonstrate that AI is no longer viewed merely as a technological tool but rather as an integral element within pedagogical ecosystems that requires adaptive approaches to instructional design, ethics, and educational policy. Consequently, bibliometric studies are necessary to map how global research on AI and digital literacy evolves and interacts across diverse educational contexts.

2. AI for Language Teaching and Learning: Evidence, Practices, and Pedagogical Implications

Recent studies on English as a Foreign Language (EFL) learning indicate that AI utilization can enhance personalized learning, students' productive skills, and feedback effectiveness. A systematic review concerning the use of AI in EFL/EL classrooms for gifted learners found that AI, particularly through chatbots and generative AI technologies, enables deeper personalized learning while improving creativity, critical thinking, and learner autonomy among gifted students. However, ethical concerns such as bias and teacher readiness in utilizing AI remain important challenges (García-López et al., 2025).

In the development of productive language skills, the systematic analysis conducted by Andreou and Christani (2025)

demonstrated that the use of generative AI technologies such as ChatGPT helps EFL learners improve fluency, linguistic complexity, and confidence in speaking and writing activities. Chatbots provide authentic, low-pressure learning environments and offer instant feedback. Nevertheless, the authors emphasize the importance of mitigating risks such as plagiarism, technological dependency, and reduced cognitive engagement among students.

AI has also been implemented in multimodal classroom evaluation. Wang (2025) demonstrated that computer vision technologies can detect students' facial expressions, teacher gestures, interaction intensity, and engagement indicators automatically, thereby generating more objective classroom assessments. Similarly, Huang et al. (2025) utilized Transformer and Bayesian modeling approaches to evaluate English language teaching effectiveness with greater predictive accuracy compared to traditional evaluation methods.

The integration of AI in differentiated instruction has likewise emerged as an important trend. Mohd Zainol et al. (2025) found that digital technologies—including Learning Management Systems (LMS), e-learning platforms, and adaptive learning systems—have increasingly been utilized to support differentiated instruction in language classrooms. However, AI implementation remains limited and continues to face obstacles related to teacher readiness, unequal access to technology, and insufficient differentiated assessment strategies.

In vocabulary instruction, bibliometric studies by Mohd Zainol et al. (2025) revealed that research trends increasingly emphasize the integration of AI, gamification, mobile learning, and immersive technologies such as VR/AR. Keywords including “artificial intelligence,” “virtual reality,” and “mobile learning” dominate publication trends,

indicating a shift in technological orientation within vocabulary teaching research.

On the other hand, the use of AI among pre-service teachers in lesson study activities demonstrates that generative AI technologies are increasingly employed to design instructional materials, develop classroom activities, and support pedagogical reflection. However, pre-service teachers continue to face challenges related to language accuracy, cultural appropriateness, and excessive dependence on technology (Kılıçkaya & Kic-Drgas, 2025). Minority language teachers, such as Maltese language educators, also encounter difficulties associated with AI output quality, cultural sensitivity, and infrastructure inequality (Żammit, 2025).

Overall, AI plays an increasingly significant role in expanding language learning practices through personalized learning, improved feedback quality, automated evaluation, and teacher professional development. Nevertheless, effective AI integration requires strong digital literacy competencies alongside clear ethical and pedagogical frameworks.

3. Systematic Reviews, Bibliometric Trends, and the Position of the Present Study

Global literature indicates the growing use of bibliometric analysis and systematic reviews to understand research patterns, trends, and developments related to AI and language learning. In vocabulary teaching research, Mohd Zainol et al. (2025) mapped more than 1,300 articles and found that technological integration—including AI and VR—has experienced substantial growth. Meanwhile, bibliometric analysis conducted by Al Husaeni and Haristiani (2025) demonstrated that digital innovation in language learning contributes significantly to educational accessibility but must be balanced with policies addressing digital inequality.

Research by Sahayu et al. (2026) revealed that digital technology utilization in differentiated ELT remains dominated by e-learning platforms, while AI, big data, and IoT technologies have not yet been fully explored as integral components of differentiated learning. Similar patterns are evident in STEM education studies, which indicate that AI integration remains uneven across educational contexts (Nguyen et al., 2025).

When examined closely, most existing literature remains thematic in nature, focusing on specific domains such as vocabulary instruction, productive language skills, gifted learners, or AR/VR integration. Comprehensive studies mapping the relationships between AI, digital literacy, and pedagogy within a global bibliometric framework remain limited. Existing studies have not yet provided a holistic understanding of how this field evolves over time, who the key contributors are, and how research themes continue to develop.

Therefore, the present study introduces an important novelty by constructing a large-scale landscape mapping of global research concerning digital literacy and AI in education through bibliometric analysis. Through this approach, the study seeks to identify research clusters, dominant themes, temporal trends, international collaboration networks, and research gaps that remain underexplored in thematic systematic reviews. Consequently, this research contributes to the development of a macro-level understanding of the dynamics of AI and education research, which is urgently needed for educational policymaking, curriculum innovation, and future research directions.

Method

This study employed a quantitative bibliometric approach to map research trends and intellectual structures in the fields of digital literacy and artificial

intelligence related to teaching, learning, pedagogy, and classroom practices. Data were collected from the Scopus database using advanced search with the following query: TITLE-ABS-KEY("artificial intelligence") AND TITLE-ABS-KEY("language teaching" OR "language learning" OR "pedagogy" OR "classroom practices" OR "assessment"). The search was limited to publications between 2015 and 2025 and filtered within the subject areas of Education, Social Sciences, and Computer Science.

Following the screening process, data cleaning, and metadata normalization—including duplicate removal, author name standardization, and keyword harmonization—a final dataset consisting of 523 Scopus-indexed articles was obtained. The analysis was conducted using Biblioshiny, which is based on the Bibliometrix package in R. The analytical procedures covered four major dimensions: (1) descriptive bibliometrics to identify publication productivity, influential authors and journals, and dominant countries; (2) intellectual structure analysis through co-citation and bibliographic coupling; (3) conceptual structure analysis through co-word analysis, thematic mapping, thematic evolution, and Multiple Correspondence Analysis (MCA); and (4) social structure analysis through global collaboration network mapping among authors and countries. Transparency in the search query and the implementation of strict inclusion–exclusion criteria were applied to minimize potential bias resulting from reliance on a single database and analytical platform.

Findings and Discussion

Dataset Characteristics

The bibliometric analysis identified a total of 197 documents indexed in Scopus published between 2016 and 2025. These publications were distributed across 105 sources, indicating that research on artificial intelligence in educational

contexts has been disseminated across diverse journals and conference proceedings. The dataset involved 494 authors, with an average of 2.62 authors per document, reflecting collaborative authorship patterns within the field.

The annual growth rate of publications reached 65.67%, demonstrating a substantial increase in scholarly attention toward artificial intelligence and language-related educational research during the examined period. In addition, the dataset recorded an average of 9.843 citations per document, indicating moderate citation impact across the publications.

The analysis also revealed that only 19.8% of the publications involved international co-authorship, suggesting that research collaboration across countries remains relatively limited despite the global relevance of the topic.

Annual Scientific Production

The analysis of annual scientific production demonstrated a clear upward trend in publication output over time. Research publications remained relatively limited during the early period between 2016 and 2019. However, publication growth increased substantially after 2020 and accelerated significantly in the final years of the dataset.

The highest publication outputs were recorded in:

No	Year	Total
1.	2024	58
2.	2025	94

This trend indicates that scholarly interest in artificial intelligence within educational and language learning contexts has intensified considerably in recent years.

Most Relevant Authors

The analysis of author productivity identified several contributors with relatively high publication frequencies. The most productive authors were:

No	Author	Articles
1.	Muthmainnah M	4
2.	Yang H	4
3.	Al Yakin A	3
4.	Liu J	3
5.	Chen G	2

The distribution of author productivity suggests that the research field is characterized by contributions from multiple researchers rather than domination by a small group of scholars.

The analysis of author productivity showed that Muthmainnah M and Yang H were the most productive authors, each contributing four publications within the dataset. However, fractionalized authorship analysis revealed differences in effective contribution levels. LIU J recorded the highest fractionalized contribution score (1.83) despite producing only three publications, indicating a relatively stronger authorship contribution per article. In contrast, authors with higher publication counts but lower fractionalized scores were more likely involved in collaborative publications with multiple co-authors. These findings demonstrate that publication quantity does not necessarily reflect the magnitude of individual scholarly contribution.

Author Citation Performance

The author citation analysis revealed differences between publication productivity and citation impact among researchers within the dataset. Several authors demonstrated relatively high academic influence despite having a limited number of publications. For example, Chen G recorded the highest citation performance in 2024 with 48 total citations from a single publication, followed by Klimova B with 32 citations from two publications. In contrast, authors such as Al Yakin A and Fan W showed higher publication frequency but lower citation accumulation, particularly for publications published in 2025, which had not yet received citations due to their recent publication period. These

findings indicate that citation impact within the field is not solely determined by publication quantity, but also by the scholarly influence and visibility of individual studies.

Tabel 3. Author Citation Performance

Author	year	freq	TC	TCpY
AL YAKIN A	2024	2	3	1,5
AL YAKIN A	2025	1	0	0
CHEN G	2024	1	48	24
CHEN G	2025	1	2	2
CHEN M	2022	1	9	2,25
CHEN M	2025	1	0	0
FAN W	2025	2	0	0
KLIMOVA B	2024	2	32	16
LI S	2021	1	3	0,6
LI S	2024	1	2	1

Most Relevant Sources

The retrieved publications were distributed across a variety of academic sources. The most productive publication venues included:

1. *British Journal Of Educational Technology*
2. *Asee Annual Conference And Exposition, Conference Proceedings*
3. *Cogent Education*
4. *Computers And Education*
5. *Education And Information Technologies*
6. *International Journal Of Educational Research*
7. *Lecture Notes On Data Engineering And Communications Technologies*
8. *Proceedings - Frontiers In Education Conference, Fie*
9. *Technology In Language Teaching And Learning*

Tabel 4. Most Influential Sources

N	h_ind	g_ind	m_in	T	N	PY_st
o	ex	ex	dex	C	P	art
1.	3	5	3	29	7	2025
2.	2	2	1	11	2	2024
3.	2	3	1	32	3	2024
4.	2	2	0,333	54 3	2	2020

5.	2	2	0,667	26	2	2023
6.	2	2	1	84	2	2024
7.	2	3	0,5	28	3	2022
8.	2	3	0,25	15	3	2018
9.	2	2	1	13	2	2024

Source impact analysis revealed that several journals and conference proceedings played significant roles in disseminating research on artificial intelligence and education. *British Journal of Educational Technology* emerged as the most productive source with seven publications and an h-index of 3. However, *Computers and Education* demonstrated the highest citation impact, accumulating 543 total citations from only two publications, indicating the strong scholarly influence of articles published in this journal. Other influential sources included *International Journal of Educational Research*, *Cogent Education*, and *Education and Information Technologies*, which also showed notable citation performance. These findings indicate that highly cited studies in the field are concentrated in established educational technology journals with strong international visibility.

Citation Analysis

Citation analysis showed variations in citation performance across publication years. Earlier publications generally accumulated higher citation counts compared to more recent publications. Publications published around 2020 demonstrated relatively stronger citation performance, indicating their influence within the development of research on artificial intelligence and education.

In contrast, publications from 2024 and 2025 had comparatively lower citation counts, which is expected due to their more recent publication dates and shorter citation exposure periods.

Collaboration Characteristics

The dataset demonstrated collaborative research practices, as reflected by the

average number of authors per document. However, international collaboration remained relatively limited, accounting for only 19.8% of the publications. This finding suggests that although research on artificial intelligence in education is expanding rapidly, cross-country collaboration networks have not yet developed extensively within the dataset.

Conclusions

This bibliometric study demonstrates a significant increase in global research on artificial intelligence in education, particularly in relation to language teaching, learning, pedagogy, and classroom practices during the 2016–2025 period. The findings reveal rapid publication growth, increasing scholarly attention, and the emergence of interdisciplinary contributions across education and technology-related fields. The analysis also indicates that research production is distributed among various authors and academic sources, reflecting the dynamic and evolving nature of the field.

Despite the growing volume of publications, international research collaboration remains relatively limited, suggesting opportunities for broader global cooperation in future studies. Overall, the results confirm that artificial intelligence has become an increasingly important area within educational research and continues to shape contemporary discussions on digital learning and pedagogical innovation.

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