EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

AI LITERACY COMPETENCIES FOR TEACHERS: A BIBLIOMETRIC ANALYSIS OF SCOPUS-INDEXED PUBLICATIONS FROM 2020 TO 2025

Indah Khoerunnisa[1]
Pendidikan Teknologi Informasi, Fakultas Keguruan dan Ilmu Pendidikan,
Universitas Lampung[1]
e-mail: indahkhoerunnisa@fkip.unila.ac.id[1]

Diterima: *01/06/2026*; Direvisi: *05/06/2026*; Diterbitkan: *15/06/2026*

ABSTRAK

Perkembangan kecerdasan buatan (artificial intelligence/AI), khususnya generative artificial intelligence, telah mengubah lanskap pendidikan dan menuntut guru memiliki kompetensi literasi AI yang mencakup pemahaman konseptual, kemampuan pedagogis, evaluasi kritis, serta kesadaran etis dalam pemanfaatannya. Meskipun kajian mengenai literasi AI guru terus berkembang, pemetaan komprehensif mengenai tren publikasi, struktur intelektual, tema penelitian dominan, dan arah pengembangan riset masih terbatas. Penelitian ini bertujuan untuk menganalisis perkembangan penelitian kompetensi literasi AI guru melalui pendekatan bibliometrik. Data penelitian berasal dari 625 dokumen terindeks Scopus yang diterbitkan pada periode 2020–2025. Analisis dilakukan menggunakan Biblioshiny dalam paket R-bibliometrix dan VOSviewer melalui analisis produktivitas publikasi, sumber jurnal, distribusi geografis, ko-sitasi, ko-kata kunci, serta peta tematik. Hasil penelitian menunjukkan bahwa publikasi mengalami peningkatan yang sangat signifikan dengan annual growth rate sebesar 239,65%, terutama pada tahun 2024 dan 2025. Produksi pengetahuan didominasi oleh negara dan institusi di kawasan Asia Timur, khususnya Tiongkok dan Hong Kong. Tema penelitian yang berkembang meliputi kerangka kompetensi literasi AI, integrasi generative AI dalam pendidikan guru, pengembangan instrumen asesmen, serta etika penggunaan AI. Selain itu, penelitian ini mengidentifikasi beberapa celah riset, yaitu terbatasnya kajian di kawasan Global South, minimnya studi longitudinal, kurangnya instrumen etika AI yang tervalidasi, dan rendahnya penerapan pendekatan co-design yang melibatkan guru. Temuan ini memberikan dasar konseptual dan empiris bagi pengembangan program pendidikan dan pelatihan guru yang adaptif, kontekstual, serta berorientasi pada penggunaan AI yang etis dan berkelanjutan.
Kata Kunci: *Literasi AI, Kompetensi Guru, Generative AI*

ABSTRACT

The rapid development of artificial intelligence (AI), particularly generative artificial intelligence, has transformed educational practices and created new demands for teachers to possess AI literacy competencies encompassing conceptual understanding, pedagogical capabilities, critical evaluation, and ethical awareness. Although research on teachers' AI literacy has grown substantially, comprehensive mapping of publication trends, intellectual structures, dominant themes, and future research directions remains limited. This study aims to analyze the development of research on teachers' AI literacy competencies through a bibliometric approach. The dataset consisted of 625 Scopus-indexed documents published between 2020 and 2025. Data were analyzed using Biblioshiny in the R-bibliometrix package and VOSviewer through publication productivity analysis, journal source analysis, geographic distribution mapping, co-citation analysis, keyword co-occurrence analysis, and thematic mapping. The findings reveal a remarkable increase in publications, with an annual growth rate

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

of 239.65%, particularly during 2024 and 2025. Knowledge production in this field is dominated by countries and institutions from East Asia, especially China and Hong Kong. Major research themes include AI literacy competency frameworks, the integration of generative AI in teacher education, assessment instrument development, and AI ethics. The study also identifies several research gaps, including the limited representation of Global South contexts, the scarcity of longitudinal studies, the lack of validated AI ethics instruments, and the limited adoption of teacher-involved co-design approaches. These findings provide a conceptual and empirical foundation for developing adaptive, contextualized, and ethically oriented teacher education and professional development programs in the AI era.
Keywords: *AI Literacy, Teacher Competence, Generative AI*

INTRODUCTION

The integration of artificial intelligence (AI) into global education systems has undergone rapid and substantial development in recent years. AI technologies are increasingly embedded in adaptive learning systems, automated assessment tools, and intelligent conversational agents that support teaching and learning processes (Crompton & Burke, 2023). The growing adoption of generative AI in educational settings has accelerated interest in AI-supported teaching, assessment, content generation, and personalized learning environments (Mittal et al., 2024). By reshaping the relationships between teachers, students, and digital technologies (Jeon & Lee, 2023). These developments indicate that AI is no longer a supplementary tool but a core component of modern educational ecosystems. Consequently, the role of teachers is also being redefined in response to these technological advancements.

In this evolving context, AI literacy has emerged as a fundamental competency for teachers in the digital age. AI literacy refers to the ability to understand AI concepts, apply AI tools effectively, evaluate AI outputs critically, and internalize ethical principles in AI usage (Ng et al., 2023). Recent studies further emphasize that AI literacy should be developed through comprehensive competency frameworks that integrate technical, pedagogical, and contextual dimensions, particularly in developing countries (Kathala & Palakurthi, 2024). However, in contemporary educational discourse, AI literacy is increasingly viewed as a multidimensional construct that extends beyond technical proficiency. It integrates cognitive understanding, pedagogical application, and ethical reasoning in educational practice. Therefore, AI literacy is considered a critical competence for ensuring meaningful and responsible integration of AI in teaching and learning.

Teacher AI literacy competence is more complex than general AI literacy because it involves pedagogical decision-making in real classroom contexts. Teachers are expected not only to use AI tools but also to design, implement, and evaluate AI-supported learning environments effectively (Ng et al., 2023). Research indicates that teachers with higher digital and AI-related competencies are more capable of enhancing students' twenty-first-century skills in technology-rich learning environments. At the early childhood education level, teachers are required to understand the relevance of AI, determine age-appropriate AI concepts, and apply them in pedagogically meaningful ways (Yang, 2022). However, there remains a significant gap between these competency demands and teachers' actual preparedness. Recent evidence indicates that teachers' readiness to implement AI education is strongly influenced by their technological pedagogical content knowledge (TPACK) and attitudes toward AI integration (Yue et al., 2024).

One of the major challenges in developing teachers' AI literacy is the lack of contextualized training programs and validated assessment instruments. Many existing training

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

initiatives emphasize technical skills while neglecting pedagogical and ethical dimensions of AI integration (Su et al., 2023). In addition, most AI literacy frameworks remain heavily focused on cognitive and technical aspects, while ethical considerations such as fairness, transparency, and social responsibility are often underrepresented (Casal-Otero et al., 2023). This imbalance creates limitations in the holistic development of teacher competencies in the AI era. As a result, teachers may lack the necessary skills to implement AI responsibly and effectively in educational settings.

Ethical competence represents a critical dimension of AI literacy for teachers in the era of generative AI. Teachers are expected to understand key ethical principles such as transparency, accountability, data privacy, and the protection of students' rights in AI-assisted learning environments (Adams et al., 2023). Ethics should not be treated as an optional component but rather as a foundational element of AI-integrated education. Without strong ethical awareness, teachers risk unintentionally reinforcing algorithmic bias in instructional practices. Therefore, ethical literacy is essential to ensure responsible and equitable use of AI in education. This perspective aligns with the concept of responsible AI, which emphasizes accountability, transparency, and societal responsibility throughout the lifecycle of intelligent systems (Stahl, 2023).

In addition to ethical considerations, pedagogical strategies play a vital role in strengthening teachers' AI literacy competencies. Project-based learning approaches, such as digital storytelling, have been shown to effectively enhance students' AI literacy while simultaneously requiring teachers to develop AI-supported instructional design skills (Ng et al., 2023). Teachers with comprehensive AI literacy are better equipped to select, adapt, and evaluate AI tools that align with pedagogical goals. This competence is increasingly regarded as a minimum standard of professional teaching practice in the digital era (Yim & Su, 2025). Thus, AI literacy has direct implications not only for teachers but also for the quality of student learning outcomes.

Despite the growing importance of AI literacy, systematic studies mapping the development of research on teachers' AI literacy competencies remain limited. Most existing studies focus on technological innovation rather than examining teachers as key actors in AI integration within education systems (Ng et al., 2023). Furthermore, research on teachers' AI-related competencies is still fragmented and lacks a consolidated knowledge structure (Su & Zhong, 2022). The rapid emergence of generative AI has introduced new competency requirements, particularly in evaluating AI-generated content and guiding students in responsible AI use (van den Berg & du Plessis, 2023). However, these emerging demands have not yet been fully integrated into existing theoretical frameworks.

Based on this context, three main research gaps are identified. First, bibliometric studies that systematically map thematic evolution, collaboration networks, and intellectual structures of teachers' AI literacy research during 2020–2025 remain scarce. Although bibliometric studies on AI literacy have been conducted, they generally focus on the broader AI literacy field rather than teacher-specific competencies and the emergence of generative AI in education (Tenório et al., 2023).. This period is particularly important because it covers both the pre- and post-expansion phases of generative AI adoption in education. Second, global research production in this field remains concentrated in Western countries and East Asia, while contributions from the Global South remain limited. Third, there is still no comprehensive thematic map that clearly identifies dominant themes, emerging trends, and underexplored areas in this field. Therefore, this study aims to analyze the development of research on teachers' AI literacy competencies using bibliometric methods, including productivity analysis, co-citation

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

analysis, keyword co-occurrence analysis, collaboration network analysis, and thematic mapping based on Scopus-indexed publications from 2020 to 2025. This study provides a comprehensive knowledge map that contributes to research development, policy formulation, and teacher professional development in the era of artificial intelligence.

RESEARCH METHOD

This study employed a quantitative bibliometric approach to map the knowledge structure, collaboration patterns, and research trends on teachers' AI literacy competencies. The data were retrieved from the Scopus database in May 2026, covering publications from 2020 to 2025. The search strategy was conducted using TITLE-ABS-KEY with the following query: ("AI literacy" OR "artificial intelligence literacy") AND ("teacher" OR "educator" OR "pre-service teacher") AND ("competenc*" OR "skills" OR "framework"). Inclusion and exclusion criteria were applied based on relevance to the topic, English language, completeness of metadata, and publication period. After screening and data cleaning, a total of 625 documents were retained as the final dataset for analysis. Data analysis was conducted using Biblioshiny (R-bibliometrix) and VOSviewer. Biblioshiny was used for descriptive analysis, citation analysis, co-citation analysis, and thematic mapping, while VOSviewer was applied to visualize co-authorship networks, institutional collaboration, and keyword co-occurrence. The analysis focused on annual publication trends, geographical distribution, influential authors and sources, and thematic clusters. These procedures were used to generate a comprehensive bibliometric map of research development on teachers' AI literacy competencies during the 2020–2025 period.

RESULTS AND DISCUSSION

Following the completion of data collection, screening, and bibliometric processing procedures, the next stage of the study involves presenting the empirical findings generated from the analysis of Scopus-indexed publications on teachers' AI literacy competencies. The results are organized to provide a comprehensive overview of the development of this research field, including publication growth, document characteristics, source distribution, collaboration patterns, intellectual foundations, and thematic trends. The findings are presented through tables, figures, and descriptive explanations to facilitate a clear understanding of the bibliometric patterns identified in the dataset. Subsequently, these findings are interpreted and discussed in relation to relevant theories and previous studies to highlight their implications for the development of AI literacy research, teacher professional competencies, and future educational practices in the era of artificial intelligence.

Results

This study employed a quantitative bibliometric approach to map the knowledge structure, collaboration patterns, and research trends on teachers' AI literacy competencies. The data were retrieved from the Scopus database in May 2026, covering publications from 2020 to 2025. The search strategy was conducted using TITLE-ABS-KEY with the following query: ("AI literacy" OR "artificial intelligence literacy") AND ("teacher" OR "educator" OR "pre-service teacher") AND ("competenc*" OR "skills" OR "framework"). Inclusion and exclusion criteria were applied based on relevance to the topic, English language, completeness of metadata, and publication period. After screening and data cleaning, a total of 625 documents were retained as the final dataset for analysis. Data analysis was conducted using Biblioshiny (R-bibliometrix) and VOSviewer. Biblioshiny was used for descriptive analysis, citation

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

analysis, co-citation analysis, and thematic mapping, while VOSviewer was applied to visualize co-authorship networks, institutional collaboration, and keyword co-occurrence. The analysis focused on annual publication trends, geographical distribution, influential authors and sources, and thematic clusters. These procedures were used to generate a comprehensive bibliometric map of research development on teachers' AI literacy competencies during the 2020–2025 period. The bibliometric analysis of 625 Scopus-indexed documents indicates a very rapid growth of research on teachers' AI literacy competencies during 2020–2025. The dataset shows a high annual growth rate, reflecting the accelerating global academic attention to AI in education. The field involves 1,871 authors across 368 publication sources, demonstrating a broad and interdisciplinary research landscape. The citation performance indicates moderate scholarly impact across the corpus. Overall, these indicators confirm that AI literacy in teacher education has become a rapidly expanding research domain.

Table 1. Main Bibliometric Indicators

Indicator	Value
Documents	625
Sources	368
Authors	1,871
Annual Growth Rate	239.65%
Citations per Document	26.65

The publication trend shows a clear developmental trajectory across three phases. The early phase (2020–2022) reflects limited scholarly output, followed by a transitional phase in 2023 with gradual growth. The most dominant phase occurs in 2024–2025, where publication activity increases significantly and represents the majority of the dataset. This pattern indicates a structural shift in academic interest. The sharp increase coincides with the global expansion of generative AI technologies in education. The dataset consists of multiple document types, including journal articles, conference papers, book chapters, and reviews. Journal articles represent the dominant publication type, indicating increasing academic consolidation. Conference papers remain substantial, reflecting the technological and interdisciplinary nature of the field. Book chapters also contribute significantly, suggesting that a considerable portion of knowledge is disseminated through edited volumes. This distribution shows that the field is still in a mixed developmental stage between exploration and consolidation.

Table 2. Document Types Distribution

Document Type	Count
Article	330
Conference Paper	159
Book Chapter	70
Review	32
Book	10
Other types	24

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

The distribution across 368 sources indicates a relatively dispersed publication structure. However, a gradual concentration toward education and technology-focused journals is observable. This suggests the emergence of a semi-core publication system. The field is not yet fully centralized but shows signs of stabilization. Overall, the knowledge structure reflects interdisciplinary development. The most productive journals include *Education and Information Technologies*, *Computers and Education: Artificial Intelligence*, and *Education Sciences*. These journals function as the core outlets for research on AI literacy competencies. Several computer science conference proceedings also appear among the top publication sources. This demonstrates the strong interdisciplinary integration between education and artificial intelligence fields. The publication landscape is therefore shaped by both pedagogical and technical communities.

Table 3. Top Publication Sources

Sources	Articles
Education and Information Technologies	18
Computers and Education: AI	17
Education Sciences	13
Lecture Notes in Computer Science	12
Communications in Computer and Information Science	12
Others (5 sources)	< 10 each

Bradford's Law distribution shows that a small group of journals contributes a large proportion of publications. This indicates the presence of a developing core zone within the literature. However, the dispersion across many outlets suggests that the field is still expanding. The coexistence of education journals and technical proceedings confirms its hybrid identity. This structure reflects an evolving interdisciplinary knowledge system. The most productive authors are Ng, Su, Chiu, and Chu, who are primarily affiliated with The University of Hong Kong. These authors form a dominant intellectual cluster in the field. Their research contributions focus on AI literacy frameworks, teacher competencies, and generative AI integration. The collaboration network shows strong intra-institutional cooperation. This indicates a high level of research concentration in specific academic hubs.

The overall international co-authorship rate is relatively moderate. Collaboration tends to occur within regional or institutional clusters rather than globally distributed networks. This suggests limited cross-country integration in research production. The dominance of specific institutions may shape theoretical and methodological directions in the field. Overall, collaboration patterns reflect both concentration and gradual internationalization. China, the United States, and Hong Kong are the leading contributors to research output in this field. China represents the highest share of publications, followed by the United States and Hong Kong. However, collaboration patterns vary significantly across countries. The United Kingdom and Australia show stronger international collaboration compared to other countries. This indicates differences in global research connectivity.

Indonesia and several Global South countries remain underrepresented in the dataset. This reflects a structural imbalance in global knowledge production. Limited representation

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

may be linked to publication access and research infrastructure disparities. It also suggests potential bias in the global AI literacy research ecosystem. Therefore, broader international collaboration is required to ensure inclusivity. The co-citation analysis identifies Long's framework as the most influential intellectual foundation in the field. This framework provides a dominant conceptual structure for AI literacy research. Other highly cited works contribute complementary perspectives on teacher competencies and AI literacy development. The intellectual structure shows strong convergence around a limited number of foundational studies. This creates theoretical coherence within the field.

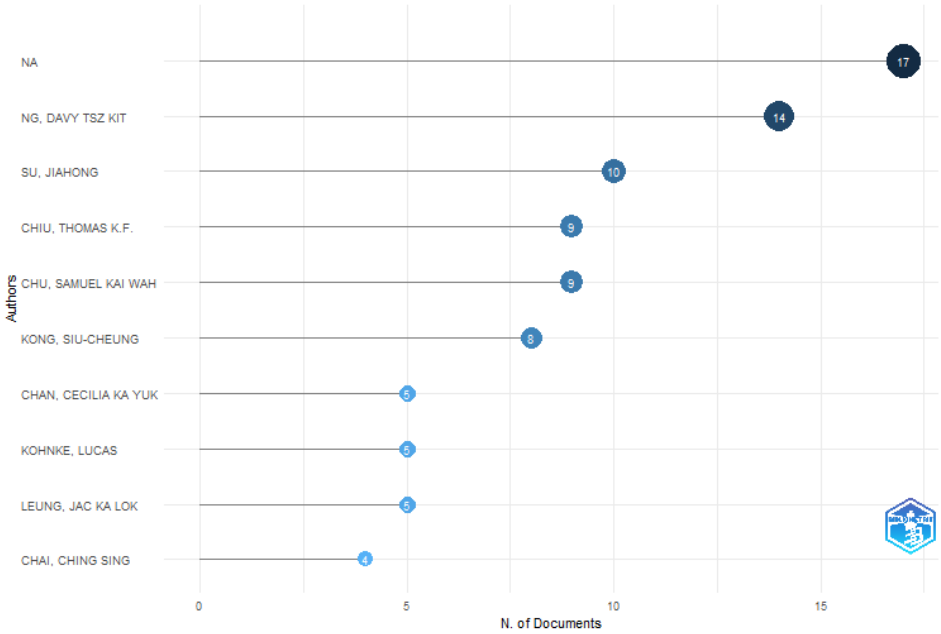

Figure 1. Co-Citation Network (Most Influential Authors)

However, this convergence also indicates potential dependency on established frameworks. Emerging studies begin to introduce alternative and context-specific perspectives. These studies challenge the universality of existing competency models. The intellectual structure therefore reflects both stability and gradual diversification. This dual pattern characterizes the current evolution of the field. Keyword analysis shows that "AI literacy" and "artificial intelligence" are the dominant thematic nodes in the field. Generative AI and teacher education act as bridging concepts between technical and pedagogical domains. These nodes connect multiple subfields within the research network. Thematic mapping reveals four main clusters: competency frameworks, generative AI integration, assessment instruments, and AI ethics. Each cluster represents a distinct dimension of research development.

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

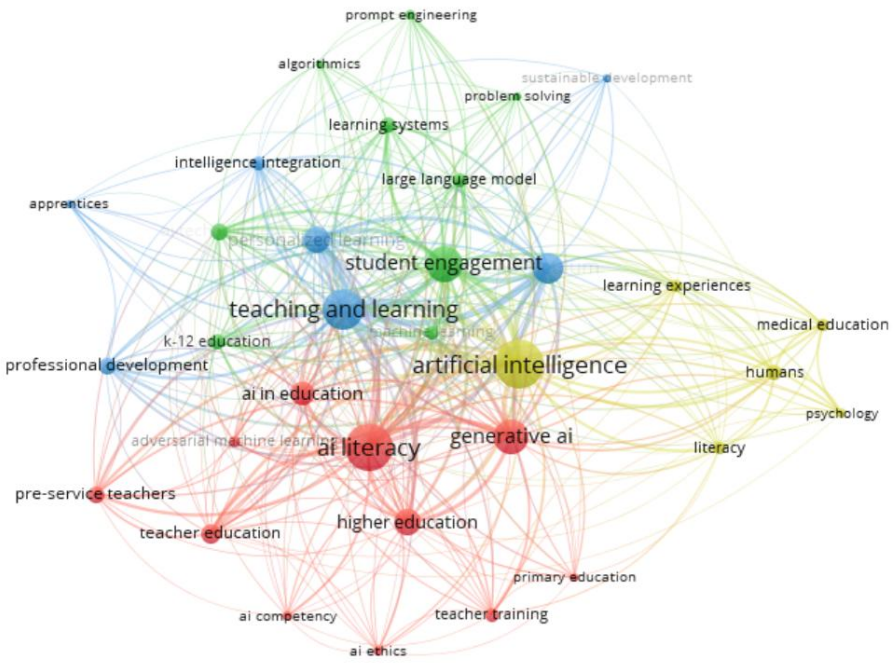

Figure 2. Keyword Co-occurrence Network (VOSviewer)

Ethical AI remains a relatively peripheral theme compared to technical and pedagogical dimensions. However, emerging keywords such as generative AI and critical thinking show rapid growth. This indicates a shift toward applied and practice-oriented research. Assessment-related studies are also increasing but remain methodologically fragmented. Overall, the thematic structure reflects a rapidly evolving and increasingly complex research landscape.

Discussion

The findings of this study indicate that research on teachers' AI literacy competencies is rapidly expanding and increasingly structured around competency-based, pedagogical, and ethical dimensions. This growth aligns with recent studies showing that AI integration in education is reshaping teacher professional requirements, particularly in terms of technological adaptation and instructional redesign (Aminah et al., 2025). Other studies also confirm that the use of AI in educational contexts is accelerating methodological and thematic diversification in academic research (Fu et al., 2025). In addition, large-scale bibliometric evidence indicates that AI in education research has experienced a significant global surge in recent years (Guo et al., 2024). In this context, AI literacy is no longer conceptualized as a peripheral skill but as a core professional competence for educators in the digital era. Therefore, the increasing publication trend confirms that AI literacy has become a central academic concern in teacher education discourse.

The dominance of competency-based frameworks in the literature reflects the ongoing effort to structure AI literacy into measurable dimensions for teacher development. This is consistent with empirical studies that emphasize structured training models such as TPACK-AI for strengthening teacher competencies in AI integration (Putri et al., 2026). Similar findings also highlight the effectiveness of workshop-based interventions in improving teacher capacity to design AI-supported learning materials (Gustafi et al., 2026). These results support the argument that teacher preparedness in AI environments requires systematic capacity building

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

rather than incidental exposure to technology. However, the results also suggest that existing competency models still tend to focus heavily on technical and pedagogical dimensions while underrepresenting contextual adaptability. Consequently, there remains a need to refine AI literacy frameworks to better reflect classroom realities and institutional diversity.

From a global perspective, the findings reveal a significant imbalance in knowledge production between developed and developing regions, particularly the Global South. This aligns with studies emphasizing structural inequality in AI education research and persistent disparities in technological infrastructure and research capacity (Chakraborty & Galatro, 2025). Other work also highlights that educational systems in the Global South face systemic challenges in adapting AI-driven innovations due to policy and resource limitations (Reimers et al., 2025). The limited representation of Southeast Asia, Africa, and Latin America indicates that dominant AI literacy frameworks may not fully capture contextual educational needs in these regions. As a result, there is a risk of epistemic dependency on Global North frameworks that may not be fully transferable. Therefore, strengthening localized research on AI literacy is essential to ensure contextual relevance and equity in global educational innovation.

Another important finding concerns the lack of longitudinal evidence in the development of teacher AI literacy competencies. This finding is particularly relevant because recent literature reviews have highlighted the growing need for continuous professional development programs that prepare teachers for educational environments increasingly influenced by generative AI technologies (Brandão et al., 2024).Prior research on teacher professional development shows that short-term interventions often fail to capture the sustainability of competency development over time (Boeve-de Pauw et al., 2022). In addition, longitudinal studies in teacher training suggest that professional development outcomes may decline without continuous institutional support and reinforcement (Cabero-Almenara et al., 2024). In the context of AI literacy, this limitation restricts understanding of whether training outcomes are durable or temporary. Therefore, future research should prioritize longitudinal designs to capture the evolution of teacher competencies over time in a more realistic and sustained manner.

The findings further highlight a critical gap in the development of validated instruments for assessing ethical dimensions of AI literacy. Recent systematic reviews show that AI ethics in education is increasingly recognized but remains fragmented in its practical implementation (Yan et al., 2025). Other studies also demonstrate that ethical learning in AI education is often limited to theoretical awareness rather than applied decision-making skills in real instructional contexts (Usher & Barak, 2024). This gap suggests that teachers may understand ethical principles but struggle to apply them when interacting with AI systems in classroom environments. Therefore, developing robust and context-sensitive assessment tools for AI ethics competence remains a pressing research priority.

In addition, the study reveals a limited presence of co-design and participatory approaches in AI literacy research for teachers. Prior research indicates that participatory design in educational technology is still underutilized despite its strong potential to improve contextual relevance and implementation quality (Nicholson et al., 2022). Other studies further emphasize that educator involvement in the co-design of AI-based professional development enhances engagement and sustainability of learning outcomes (Nazaretsky, 2025). The absence of strong co-design practices suggests that teachers are often positioned as passive recipients rather than active contributors in AI literacy development. Therefore, strengthening participatory approaches is essential to improve the relevance and effectiveness of AI literacy programs.

https://doi.org/10.51878/edutech.v6i3.11776

EDUTECH : Jurnal Inovasi Pendidikan Berbantuan Teknologi
Vol. 6, No. 3, Juni-Agustus 2026
e-ISSN : 2797-0140 | p-ISSN : 2797-0590
Online Journal System : https://jurnalp4i.com/index.php/edutech

Overall, the synthesis of bibliometric patterns and thematic structures demonstrates that research on teachers' AI literacy competencies is advancing rapidly but remains uneven in several critical dimensions. While technical and pedagogical aspects are well developed, ethical, contextual, and participatory dimensions are still underrepresented. This imbalance may limit the applicability of existing frameworks across diverse educational settings. The findings of this study provide a comprehensive research agenda emphasizing the need for inclusivity, methodological diversity, and sustainability in AI literacy research. Addressing these gaps is essential to ensure that teacher AI competencies evolve in line with the rapidly changing educational landscape driven by artificial intelligence.

CONCLUSION

This study concludes that research on teachers' AI literacy competencies has experienced an extraordinary and accelerated growth between 2020 and 2025, particularly after the global emergence of generative artificial intelligence, which has fundamentally reshaped the direction of educational technology research. The bibliometric evidence demonstrates that AI literacy has transitioned from an emerging topic into a central domain of inquiry in teacher education, reflecting its increasing importance in contemporary pedagogical transformation. However, this rapid expansion is accompanied by a strong geographical and institutional concentration of knowledge production, indicating that dominant conceptual frameworks are largely shaped by limited academic ecosystems. As a result, the generalizability of existing AI literacy models remains an open question that requires further empirical validation across diverse educational contexts. The study also concludes that the intellectual structure of this field is primarily organized around three dominant thematic pillars, namely competency frameworks, generative AI integration, and assessment instrument development. While these themes indicate theoretical consolidation, critical dimensions such as AI ethics and co-design remain marginal within the overall research landscape, despite their high practical relevance for classroom implementation. This imbalance suggests that the current development of AI literacy research still prioritizes technical and structural dimensions over ethical and participatory considerations. Consequently, there is a need to broaden the conceptual scope of future studies to ensure a more holistic understanding of teacher AI competencies.

Furthermore, this study identifies four critical research gaps that must be addressed to advance the field in a more inclusive and sustainable direction. These include the lack of contextually grounded studies in the Global South, the dominance of cross-sectional methodologies that limit understanding of long-term competency development, the scarcity of validated instruments for assessing ethical dimensions of AI literacy, and the limited adoption of co-design approaches involving teachers as active contributors. Addressing these gaps is essential to ensure that AI literacy frameworks are not only theoretically robust but also practically applicable across different educational systems and cultural contexts. Finally, this study emphasizes that future research should move toward longitudinal, multi-contextual, and participatory approaches that better capture the complexity of teacher AI literacy development in real educational environments. Expanding data sources beyond single-database limitations and incorporating multilingual and regional publications will also be essential to construct a more comprehensive global knowledge map. Practically, the findings of this study can inform policymakers, teacher educators, and curriculum developers in designing more adaptive AI literacy training programs that integrate technical competence, ethical awareness, and contextual sensitivity. In this way, teacher AI literacy can evolve into a sustainable professional

https://doi.org/10.51878/edutech.v6i3.11776

competence that supports equitable and meaningful integration of artificial intelligence in education systems worldwide.

REFERENCES

Adams, C., Pente, P., Lemermeyer, G., & Rockwell, G. (2023). Ethical principles for artificial intelligence in K-12 education. *Computers and Education: Artificial Intelligence, 4*, 100131. https://doi.org/10.1016/j.caeai.2023.100131

Aminah, S., Widodo, S., Elviani, U., Sari, A. P., & Barri, M. A. F. (2025). Membaca masa depan pendidikan: Kesiapan guru Indonesia di tengah disrupsi kecerdasan buatan. *Jurnal Pendidikan, Penciptaan Seni dan Budaya, 1*(2), 52–61. https://teewanjournal.com/index.php/jppsb/article/view/2308

Boeve-de Pauw, J., Olsson, D., Berglund, T., & Gericke, N. (2022). Teachers' ESD self-efficacy and practices: A longitudinal study on the impact of teacher professional development. *Environmental Education Research, 28*(6), 867–885. \ https://doi.org/10.1080/13504622.2022.2042206

Brandão, A., Pedro, L., & Zagalo, N. (2024). Teacher professional development for a future with generative artificial intelligence–an integrative literature review. *Digital Education Review*, (45), 151-157. https://revistes.ub.edu/index.php/der/article/view/46517

Cabero-Almenara, J., Barragán-Sánchez, R., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2024). Technological and sustainable security: A longitudinal study on teacher training. *Computers in the Schools, 41*(3), 263–280. https://doi.org/10.1080/07380569.2024.2381717

Casal-Otero, L., Catala, A., Fernández-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023). AI literacy in K-12: A systematic literature review. *International Journal of STEM Education, 10*(1). https://doi.org/10.1186/s40594-023-00418-7

Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education, 20*(1). https://doi.org/10.1186/s41239-023-00408-3

Chakraborty, S., & Galatro, D. (2025). Artificial intelligence (AI) equality in engineering education: Strategies to unite the AI gap between the global North & South. In *2025 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1–10). IEEE. https://ieeexplore.ieee.org/abstract/document/11016563/

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education, 20*(1), 1–22. https://doi.org/10.1186/s41239-023-00392-8

Fu, Y., Weng, Z., & Wang, J. (2025). Examining AI use in educational contexts: A scoping meta-review and bibliometric analysis. *International Journal of Artificial Intelligence in Education, 35*(3), 1388–1444. https://doi.org/10.1007/s40593-024-00442-w

Guo, S., Zheng, Y., & Zhai, X. (2024). Artificial intelligence in education research during 2013–2023: A review based on bibliometric analysis. *Education and Information Technologies, 29*(13), 16387–16409. https://doi.org/10.1007/s10639-024-12491-8

Jeon, J., & Lee, S. (2023). Large language models in education: A focus on the complementary relationship between human teachers and ChatGPT. *Education and Information Technologies, 28*(12), 15873–15892. https://doi.org/10.1007/s10639-023-11834-1

Kathala, K. C. R., & Palakurthi, S. (2024, September). AI literacy framework and strategies for implementation in developing nations. In *Proceedings of the 2024 the 16th*

https://doi.org/10.51878/edutech.v6i3.11776

International Conference on Education Technology and Computers (pp. 418-422). https://doi.org/10.1145/3702163.3702449

Mittal, U., Sai, S., Chamola, V., & Sangwan, D. (2024). A comprehensive review on generative AI for education. *Ieee Access*, *12*, 142733-142759. https://ieeexplore.ieee.org/abstract/document/10695056/

Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2023). A review of AI teaching and learning from 2000 to 2020. *Education and Information Technologies, 28*(7), 8445–8501. https://doi.org/10.1007/s10639-022-11491-w

Olari, V., & Romeike, R. (2021). Addressing AI and data literacy in teacher education: A review of existing educational frameworks. *ACM International Conference Proceedings*, 1–7. https://doi.org/10.1145/3481312.3481351

Stahl, B. C. (2023). Embedding responsibility in intelligent systems: from AI ethics to responsible AI ecosystems. *Scientific Reports*, *13*(1), 7586. https://www.nature.com/articles/s41598-023-34622-w

Tenório, K., Olari, V., Chikobava, M., & Romeike, R. (2023, March). Artificial intelligence literacy research field: a bibliometric analysis from 1989 to 2021. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1* (pp. 1083-1089). https://doi.org/10.1145/3545945.3569874

Yang, W. (2022). Artificial intelligence education for young children. *Computers and Education: AI, 3*, 100061. https://www.sciencedirect.com/science/article/pii/S2666920X22000169

Yi, Y. (2021). Establishing the concept of AI literacy: Focusing on competence and purpose. *JAHR – European Journal of Bioethics, 12*(2), 353–368. https://doi.org/10.21860/j.12.2.8

Yim, I. H. Y., & Su, J. (2025). AI learning tools in K-12 education: A scoping review. *Journal of Computers in Education, 12*(1), 93–131. https://doi.org/10.1007/s40692-023-00304-9

Yue, M., Jong, M. S. Y., & Ng, D. T. K. (2024). Understanding K–12 teachers' technological pedagogical content knowledge readiness and attitudes toward artificial intelligence education. *Education and information technologies*, *29*(15), 19505-19536. https://link.springer.com/article/10.1007/s10639-024-12621-2

https://doi.org/10.51878/edutech.v6i3.11776