



Digital Literacy Revolution: The Role of Artificial Intelligence (AI) Technology in Personalizing Learning and Improving Students' Literacy Competency

Fujiono¹, Seful Bahri², Yuliana Trisanti³

¹Study Program of Informatics, Faculty of Engineering, Universitas Madura, Indonesia

²Study Program of English Education, Faculty of Languages and Arts,
Universitas Negeri Semarang, Indonesia

³Study Program of Digital Business, Faculty of Economics, Universitas Madura, Indonesia

Article Info	Abstract
Received: 2026-06-10 Revised: 2026-06-15 Accepted: 2026-06-25 Keywords: Artificial Intelligence; Literacy Competency; Digital Literacy; Personalization Learning; Educational Technology DOI: 10.24256/ideas.v14i1.7174 Corresponding Author: Fujiono fujiono@unira.ac.id Study Program of Informatics, Faculty of Engineering, Universitas Madura, Indonesia	<i>The digital era of the 21st century has brought a fundamental transformation in the global education landscape, where Artificial Intelligence (AI) technology has emerged as a key catalyst in the contemporary learning revolution that demands comprehensive digital literacy. This study aims to analyze the role of AI technology in revolutionizing digital literacy through learning personalization and its impact on improving student literacy competencies in a holistic and multidimensional manner. The research method uses a qualitative approach with systematic literature review referring to the PRISMA guide, analyzing 30 high-quality articles from the Scopus, Web of Science, IEEE Xplore, and Emerald Insight databases for the 2020-2024 period through thematic synthesis. The results of the study revealed that AI technology plays a transformative role in personalizing learning through an adaptive system that analyzes individual characteristics, cognitive preferences, and student learning patterns, thereby significantly increasing engagement and achievement of learning outcomes. The implementation of AI expands the dimensions of digital literacy to include cognitive, technical, ethical, evaluative, creative, communicative, social, and metacognitive aspects in an integrated framework. The conclusion shows that AI has great potential to create an adaptive and inclusive education ecosystem, but faces infrastructure challenges, educators' digital competencies, and ethical issues. It is recommended to develop a gradual implementation strategy, investment in professional development, and a comprehensive ethical framework for optimizing the use of AI in education.</i>

1. Introduction

In the 21st century, the digital era has resulted in major changes in the educational landscape around the world. Artificial Intelligence (AI) is a major factor driving the modern learning revolution. This phenomenon is characterized by the entry of AI into various aspects of daily life, which makes students of various levels of education need broad digital literacy. The rapid development of generative AI technologies and adaptive learning systems has created many opportunities for personalization of learning, but it has also posed complex challenges regarding educational institution's readiness and students' digital capabilities.

Empirical findings from various international studies reveal significant disparities in AI literacy levels among learners. (Zhong & Liu, 2025) In its study of 1,392 secondary students in China, it found that although male students showed higher mastery of AI knowledge, female students had better sensitivity to the affective aspects of AI, particularly in understanding the socio-economic implications of the technology.

These findings indicate the complexity of AI literacy that cannot be viewed monolithically, but rather requires a multidimensional approach that includes cognitive, affective, and behavioral aspects. Meanwhile, research (Babanoğlu et al., 2025; Southworth et al., 2023; Yue Yim, 2024) through a systematic review of 19 articles identified theoretical and pedagogical gaps in AI literacy education for primary school students, which are often overlooked compared to the focus on secondary and secondary education.

Through a literature review of 30 studies on the topic of AI literacy for higher education (Ayanwale et al., 2024; Hollands & Breazeal, 2024; Laupichler et al., 2022), it was found that research on AI literacy for adult education is still very new. There is an urgent need to define AI literacy as well as appropriate content for non-experts. These findings are reinforced by research (Babanoğlu et al., 2025; Fan & Zhang, 2024) which involved 252 prospective English teacher students in Turkey, identified four key patterns in the ethical perception of AI: distrust of AI, blind belief, ethical use, and unethical use.

Phenomenon *Black-box effect* and *techno-over-reliance* found in the study shows the urgency of developing balanced and critical AI literacy. Empirical studies on the implementation of AI in learning have also shown promising but uneven results. (Hornberger et al., 2023; M. Ma et al., 2025; Ng et al., 2025) in its study of 76 educators in Canada identified high optimism about the role of *Generative AI* (GenAI) in education, with three main implementation practices: teaching/learning, administration, and assessment.

However, the same research also revealed three major challenges: school readiness, teacher AI competence, and students' AI literacy and ethics. On the other hand, (Kohnke et al., 2025; Lyu & Salam, 2025; Southworth et al., 2023) A controlled experiment with 183 male adult learners in China proved that AI-based personalized learning significantly improved self-efficacy, motivation, and digital literacy compared to traditional learning methods.

Through a systematic review, research (Chandel & Lim, 2025; Chiu et al., 2024; Wen et al., 2024) found that GenAI has an impact on language learning outcomes, such as writing and vocabulary. They also found an impact on the development of multiliteracies, which includes engagement with multimodal texts and digital literacy. This discovery shows the potential of AI transformation in developing broad and integrated literacy skills.

Meanwhile, (Korte et al., 2024; LaFlamme, 2025; Tzirides et al., 2024) proposes a multi-tiered instructional model for AI literacy in academic librarianship, with four progressive tiers: foundational awareness, applied problem-solving, critical evaluation, and ethical advocacy. Although various studies have explored specific aspects of AI literacy and learning personalization, there is a significant research gap in a comprehensive synthesis of how AI technology is holistically contributing to the digital literacy revolution through

learning personalization. Most of the existing research focuses on specific geographical contexts or educational levels, so global and cross-level understanding is still fragmented. In addition, the causal relationship between AI implementation, learning personalization, and digital literacy competency enhancement has not been systematically constructed within a single, unified theoretical framework.

The novelty of this research lies in the approach *systematic review* which integrates various dimensions of digital literacy (AI literacy, digital literacy, data literacy, computational thinking) with a focus on the role of AI technology in personalizing learning across multiple educational levels. To fill the theoretical gap, this research will create a comprehensive framework explaining the transformation mechanisms of artificial intelligence in the digital literacy revolution. In addition, the research will find implementation strategies and best practices that can be applied anywhere.

Based on the complexity of the phenomenon that has been described, this research is formulated in several specific and directed research questions. The main question that the investigation focuses on is: How does AI technology play a role in revolutionizing digital literacy through learning personalization to improve students' literacy competencies? This question is then elaborated into a more operational sub-question: What are the dimensions of digital literacy influenced by the implementation of AI technology in learning? How is the AI-based learning personalization mechanism in improving students' digital literacy competencies? What are the effective AI implementation strategies and models for the development of digital literacy across different educational contexts? Also, what are the challenges and opportunities that arise in the integration of AI technology for learning personalization and digital literacy development?

This research aims to comprehensively analyze the role of AI technology in revolutionizing digital literacy through learning personalization and its impact on improving students' literacy competencies. Specifically, this study aims to identify and analyze various dimensions of digital literacy influenced by the implementation of AI technology in the context of learning. Furthermore, this study will explore and explain the mechanism of AI-based learning personalization that contributes to improving students' digital literacy competencies through the synthesis of evidence-based research. This research also aims to identify and evaluate AI implementation strategies and models that have proven to be effective in developing digital literacy across various educational settings and demographic groups. Finally, this study aims to analyze the emerging challenges and opportunities in the integration of AI technology for learning personalization, as well as formulate strategic recommendations for optimizing the implementation of AI in the development of digital literacy.

This research is expected to make significant contributions both theoretically and practically in the domain of digital education and AI implementation. Theoretically, this research will produce a comprehensive conceptual framework regarding the relationship between AI technology, learning personalization, and digital literacy, which can serve as a foundation for the development of more robust digital learning theories. The synthesis of this systematic review will also identify existing theoretical gaps and formulate a priority future research agenda in the field of AI education. From a practical perspective, the results of this study will provide evidence-based guidance for education practitioners, including teachers, lecturers, education administrators, and curriculum developers in integrating AI technology for effective personalization of learning.

The resulting strategic recommendations can be a reference for educational institutions in designing digital literacy development programs that are adaptive and responsive to the development of AI technology. In addition, this research will provide

valuable insights for policy makers in formulating digital education policies that support the implementation of AI in a responsible and sustainable manner.

The benefits of this research also extend to the academic community and researchers in the fields of educational technology, AI in education, and digital literacy studies. This comprehensive systematic review will be an important reference for future research, as well as a baseline for evaluating the development of AI implementation in education. For students and young researchers, this research will provide a holistic understanding of the current state of the art in AI-powered personalized learning and digital literacy, as well as identify potential research opportunities for further exploration.

On a broader level, this research is expected to contribute to improving the quality of national education through the optimal use of AI technology for the development of future generations of digital literacy. Thus, this research not only has academic value but also social significance in preparing human resources who are digitally literate and ready to face the challenges of the *artificial intelligence era*.

2. Method

This study uses a qualitative approach with the Systematic Literature Review which refers to the guide Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to ensure transparency and reproducibility in the review process (Kajiwara & Kawabata, 2024; Q. Ma et al., 2024; Simamora & Gaffar, 2024). This approach was chosen to comprehensively and systematically analyze the relevant literature on the role of AI technology in personalizing learning and improving students' digital literacy competencies.

The literature search process was carried out through four main academic databases, namely Scopus, Web of Science, IEEE Xplore, and Emerald Insight, which were selected based on their relevance to the topics of educational technology, artificial intelligence, and digital literacy. The search strategy uses a combination of keywords in English developed based on the main concepts of the research, including: ("artificial intelligence" OR "AI technology" OR "machine learning") AND ("personalized learning" OR "adaptive learning" OR "individualized instruction") AND ("digital literacy" OR "AI literacy" OR "technological literacy") AND ("education" OR "learning" OR "student" OR "learner"). The search was limited to publications published between 2020 and 2024 to ensure the relevance and novelty of the findings, given the rapid development of AI technology in the last decade. Inclusion criteria include peer-reviewed journal articles written in English, discussing the implementation of AI technology in educational contexts, focusing on personalizing learning, and exploring the impact on digital literacy or related competencies.

Exclusions include articles that are not available in full-text, publications other than journal articles such as conference proceedings or book chapters, research that does not specifically address AI technology in learning, and articles that only discuss the technical aspects of AI without an educational context. The article selection process is carried out through the title and abstract screening stages, followed by a full-text assessment to ensure relevance to the research question. The quality of the article was assessed using criteria that included methodological clarity, strength of empirical evidence, and contribution to the understanding of the research topic.

The data extracted from each article included the characteristics of the study, the type of AI technology used, the population and setting of the research, the interventions or implementations carried out, digital literacy-related outcomes, as well as key findings and conclusions. Data analysis is carried out through a thematic synthesis approach to identify patterns, themes, and insights that emerge from the literature reviewed, then synthesized to answer research questions and achieve the goals that have been set.

3. Result

The process of selecting articles in this systematic review follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to ensure transparency and methodological quality of the research. The PRISMA flowchart in Figure 1 illustrates the systematic stages in identifying, screening, and selecting literature relevant to the topic of AI digital literacy in learning personalization.

This procedure starts from a comprehensive search in various academic databases, followed by the elimination of duplication, feasibility assessment based on pre-established inclusion and exclusion criteria, to the result of 30 high-quality articles that meet the standards for in-depth analysis. This rigorous methodological approach ensures the validity and reliability of research findings in exploring the role of AI technology in the digital literacy revolution in various educational contexts.

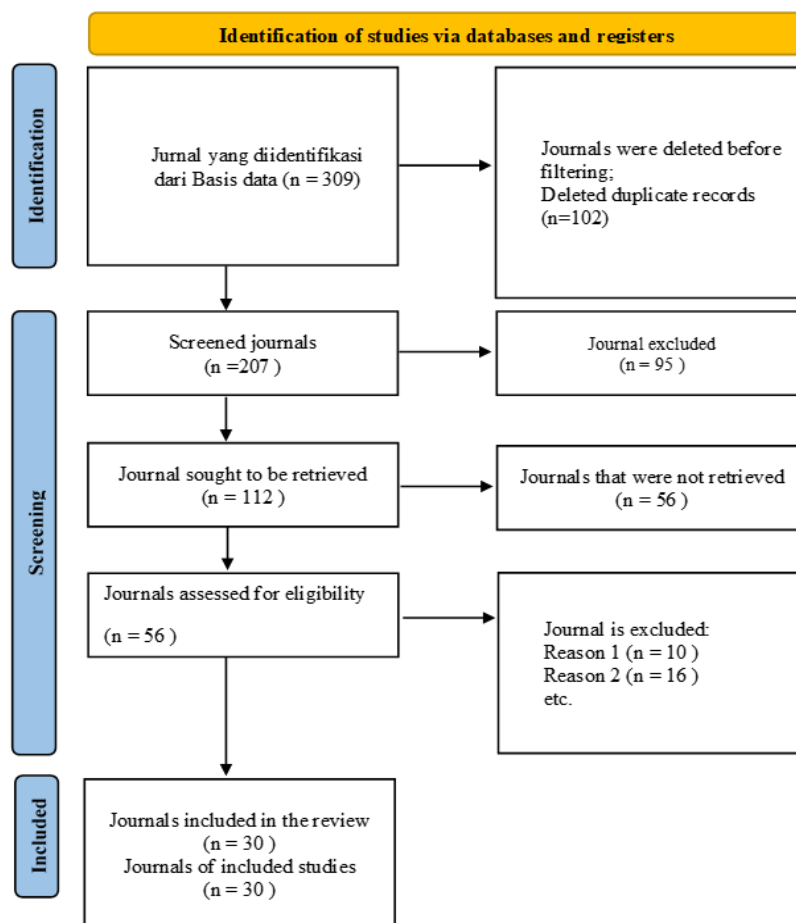


Figure 1. Flowchart PRISMA

Table 1 presents a comprehensive analysis of 30 selected articles and journals related to the digital literacy revolution and the implementation of AI technology in learning personalization. Each publication is evaluated based on its positive contribution and limitations to the research topic, providing a balanced perspective on the strengths and weaknesses of previous studies. This analysis reveals a variety of methodological approaches, ranging from systematic review, mixed methods, to case studies applied in the context of education from elementary to tertiary level. The geographical diversity of the research spans Asia, Europe, the Americas, and Africa, demonstrating the global relevance of AI literacy topics. This table is an important foundation in identifying research gaps,

methodological trends, and directions for the development of AI digital literacy that can be adapted in various educational contexts in Indonesia.

Table 1. Related Articles & Journals Digital Literacy Revolution: The Role of Artificial Intelligence (AI) Technology in Personalizing Learning and Improving Students' Literacy Competency

Yes	Author Name & Year	The (+) Relationship with Research	Relationship (-) with Research
1	(Yim, 2024)	Discuss AI literacy in primary education with an arts-based transdisciplinary approach that overcomes gender and age barriers. It is relevant to personalizing learning across educational levels and developing inclusive digital literacy competencies.	The focus is limited to basic education alone, not covering a wider spectrum of education. Arts-based methodologies may not be universally applicable to all learning contexts.
2	(Tan et al., 2025)	Highlighting the role of AI in teaching and professional development teachers (65% vs 35%), shows the inequality of research focus. Relevant to a comprehensive analysis of the implementation of AI in education and the needs of developing educators' digital competencies.	It shows a gap in the research on teacher professional development with AI, which indicates a lack of attention to the human capital aspect in the implementation of educational AI.
3	(Tzirides et al., 2024)	Exploring the impact of GenAI tools and cyber-social teaching methods on the development of student AI literacy. Presents a novel pedagogical model that combines human-AI synergy, relevant to the personalization of learning in higher education.	Limited to the context of higher education with a relatively small sample size (37 participants). Focusing on specific tools may not be generalizable for broader AI implementation.
4	(Hollands & Breazeal, 2024)	Developed a universally adaptable modular AI literacy curriculum with implementation on 12,000 students. Demonstrate increased knowledge, optimism, and confidence in AI. It is very relevant to the comprehensive framework of AI literacy.	The curriculum is short-format and modular which may not be sufficient for deep understanding AI. The evaluation is still preliminary without a long-term impact assessment.
5	(Korte et al., 2024)	Demonstrated cross-cultural AI literacy workshops with participants from 13 countries. Showing significant improvement in AI knowledge and awareness. Relevant to the global perspective and universal applicability framework.	The duration of the workshop is only 5 hours which is limited to comprehensive AI literacy development. The sample size was relatively small (29 participants) for global generalizations.
6	(Pei et al., 2025)	Using Bloom's Taxonomy and TAM3 to systematically evaluate AI literacy	Limited to pre-service teachers at one university.

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| | | pre-service teachers. Identify gaps in understanding AI mechanisms and the importance of hands-on training. Relevant to the assessment and professional development framework. | Focus on specific demographics that may not be representative of the broader educator population. |
| 7 | (Ng et al., 2023) | Comprehensive review of AI education in secondary schools with thematic analysis of 50 studies. Identify collaborative project-based learning as the main pedagogical approach. Relevant to systematic review methodology and pedagogical insights. | Limited to secondary education only, it does not cover a wider spectrum of education. The review period is only until 2022 which may not capture recent developments. |
| 8 | (Southworth et al., 2023) | Developed an "AI Across the Curriculum" model at the University of Florida for all students regardless of discipline. Demonstrate a comprehensive approach to AI integration. Relevant to the universal AI literacy framework. | It is still in the form of a position paper and a theoretical model without empirical validation. Implementation is limited to one institution which may not be generalizable. |
| 9 | (Kong et al., 2024) | An international collaborative piece that argues for a paradigm shift in AI literacy education. Emphasizing AI's role in equity, inclusiveness, and lifelong learning. Relevant to the comprehensive theoretical framework and global perspective. | It is an argumentative paper without empirical evidence. It does not provide specific implementation strategies or measurable outcomes. |
| 10 | (Ayanwale et al., 2024) | Using SEM to analyze AI literacy among 529 pre-service teachers. Identify significant predictors and trade-offs in AI applications. Relevant to quantitative methodology and large sample analysis. | Limited to pre-service teachers in Nigeria, geographic specificity may not be applicable to the global context. Focus on specific demographic groups. |
| 11 | (Law, 2024) | Scoping review of GenAI in language teaching with PRISMA-ScR guidelines. Identify research gaps and future directions in emerging fields. Relevant to systematic review methodology and identification of research priorities. | The focus is limited to language education only, not covering broader educational applications. The review period is limited and the rapidly evolving field requires continuous updates. |
| 12 | (Hornberger et al., 2025) | Develop and validate AI literacy test for university students with detailed psychometric information. Showing significant variance in AI literacy. Relevant to assessment development and measurement instruments. | Limited to German university students, cultural and linguistic specificity. Focus on knowledge assessment without comprehensive competency evaluation. |
| 13 | (Sperling et al., 2024) | Scoping review of AI literacy in teacher education using Aristotelian concepts. Identify research gaps in | It shows that AI literacy is almost absent in the teacher education context, indicating a |

		practical and ethical knowledge. Relevant to the comprehensive framework for teacher professional knowledge.	significant gap in current practices. Limited methodological diversity in reviewed studies.
14	(Kajiwara & Kawabata, 2024)	Develop a curriculum for the ethical use of LLM with a focus on AI ethical principles. Demonstrate technology acceptance factors and age-specific considerations. Relevant to ethical AI implementation and responsible use frameworks.	The sample was limited to specific age groups (12-24 years). Focus primarily on ethical use without comprehensive AI literacy development.
15	(Laupichler et al., 2022)	Scoping review of AI literacy in higher and adult education with 30 studies analysis. Identify research infancy and need for refinement in AI literacy definition. Relevant to adult education perspective and research gaps identification.	It shows that research is still in the infancy stage with a limited theoretical foundation. Lack of consensus in AI literacy definition for adult learners.
16	(Chiu et al., 2024)	Develop a comprehensive framework for AI literacy and competency with teacher perspectives. Using an iterative co-design cycle with experienced AI teachers. Relevant to competency-based approach and practical implementation insights.	Limited to middle school teachers from specific geographic areas. The framework still needs broader validation across different educational contexts.
17	(Kohnke et al., 2025)	Qualitative study pre-service teachers' perceptions of AI integration with thematic analysis. Identify challenges in developing AI literacy and the need for institutional support. Relevant to qualitative insights and implementation barriers.	Small sample size (15 participants) was limited to generalization. Focus on perceptions without actual implementation outcomes assessment.
18	(Hornberger et al., 2023)	Multinational AI literacy assessment across Germany, UK, and US with 1,465 students. Demonstrate cross-cultural differences and validation of assessment instruments. Relevant to international perspective and large-scale assessment.	Limited to three countries that may not be representative of the global context. Focus on knowledge assessment without comprehensive competency evaluation.
19	(Yao & Wang, 2024)	Using SEM to analyze factors influencing pre-service SPED teachers' intention toward AIED. Demonstrate the role of digital literacy and teacher self-efficacy. Relevant to specialized education context and behavioral intention analysis.	Limited to a highly specialized special education context. Geographic limitation in Chinese contexts that may not be globally applicable.
20	(Su & Yang, 2023)	Developed a ChatGPT literacy framework for language teachers with	The focus is limited to language teachers and specific

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| | | a global survey of 492 teachers from 41 countries. Using mixed methods for comprehensive analysis. Relevant to global perspective and specific AI tool literacy. | AI tools (ChatGPT). The framework may not be applicable for broader AI literacy development. |
| 21 | (M. Ma et al., 2025) | A systematic review of K-12 AI ethics education with 68 publications analysis. Develop a competency-based responsible AI literacy framework. Relevant to ethical AI literacy and comprehensive framework development. | Focus primarily on ethics education without broader AI literacy aspects. Limited empirical validation of proposed framework. |
| 22 | (Fan & Zhang, 2024) | Using SEM to analyze sequential mediation AI literacy, attitudes, and enjoyment in EFL learning. Shows indirect effects and continuance intention. Relevant to motivational factors and sustained engagement analysis. | Limited to the EFL context and Chinese learners. Focus on specific subject areas that may not be generalizable for broader educational applications. |
| 23 | (Chatikobo & Pasipamire, 2024) | Using AIRI and Chapnick's Framework to evaluate AI readiness in information literacy instruction. Showing institutional barriers and infrastructure challenges. Relevant to readiness assessment and implementation challenges. | Limited to single institution case studies. Focusing on library services that are specialized in context, may not be applicable to broader educational settings. |
| 24 | (Kong et al., 2024) | Analyze prompt patterns in AI-assisted academic writing based on AI literacy levels. Showing distinctive patterns and performance differences. Relevant to personalized learning and AI interaction analysis. | Small sample size (19 students) was limited to generalization. Focus on specific tasks (academic writing) that may not be comprehensive for broader learning applications. |
| 25 | (Hu, 2024) | Develop assignments for critical AI literacy through experiential learning about AI-generated stereotypes. Demonstrate practical implementation for awareness building. Relevant to critical thinking development and practical application. | Limited to single course assignments. Focus on specific aspects (stereotypes) without comprehensive AI literacy development. |
| 26 | (Wen et al., 2024) | Using quantitative methods to explore human-AI co-creation and AI literacy enhancement. Showing a positive relationship between co-creation and literacy development. Relevant to collaborative learning and AI interaction models. | Limited to Chinese college students. Focus on co-creation models that may not be applicable to all learning contexts. |

27	(Stolpe & Hallström, 2024)	Develop a framework for integrating AI literacy into technological literacy as multiliteracy. Demonstrate a comprehensive approach to technology education. Relevant to the integrated literacy framework and technology education perspective.	Primarily theoretical framework without empirical validation. Focus on technology education with a specialized context.
28	(Chiu & Sanusi, 2024)	Special issue overview with 18 articles from various regions. Identify five key areas and future research directions. Relevant to comprehensive literature overview and global perspective.	It is an editorial overview with no specific empirical contributions. Demonstrate the fragmented nature of current research in the AI literacy field.
29	(Ali et al., 2024)	Literature review AI applications in educational settings with 69 articles analysis. Identify five distinct challenge dimensions and strategic solutions. Relevant to comprehensive challenge analysis and implementation strategies.	Focus on challenges without sufficient emphasis on success factors. Limited empirical validation of proposed solutions.
30	(Su & Yang, 2023)	Intervention study AI literacy program for early childhood education with 26 young children. Showing a positive impact on basic AI concepts and creativity. Relevant to early childhood perspective and developmental approach.	Very small sample size and limited to early childhood context. The intervention period was relatively short (8 weeks) for comprehensive literacy development.

Table 2 presents a summary of the methodology and sample characteristics of the 30 studies analyzed, providing a comprehensive overview of the research approaches used in examining AI literacy in education. Methodological variations include systematic review, mixed methods, quantitative surveys, qualitative studies, and intervention studies, showing the complexity and multidimensionality of the AI digital literacy phenomenon. The research sample ranged from 15 to 12,000 participants, including elementary, middle and high school students, college students, prospective teachers, and experienced educators from various countries.

This methodological diversity reflects the maturity of the field of AI literacy research that requires a multifaceted approach to understanding the impact of technology on learning. This methodological analysis is important to identify best practices in digital literacy research and provide a reference for the development of a more robust research framework in the future.

Table 2. Methods & Sample Articles and Journals related to the Digital Literacy Revolution: The Role of Artificial Intelligence (AI) Technology in Personalizing Learning and Improving Students' Literacy Competency.

No	Author & Year	Heading	Method	Sample
1	(Yim, 2024)	Artificial intelligence literacy in primary education: An arts-based approach to overcoming age and gender barriers	Mixed methods (pilot study), paired t-test, Mann-Whitney, Kruskal-Wallis tests, qualitative analysis	25 elementary school students
2	(Tan et al., 2025)	Artificial intelligence in teaching and teacher professional development: A systematic review	Systematic review using the PRISMA principle	95 research articles (2015-2024)
3	(Tzirides et al., 2024)	Combining human and artificial intelligence for enhanced AI literacy in higher education	Convergent mixed methods case study	37 graduate students at the College of Education, a U.S. midwest university
4	(Hollands & Breazeal, 2024)	Establishing AI Literacy before Adopting AI	Online surveys and virtual interviews	265 global individuals (190 teachers with 12,000 students), 17 teacher interviews
5	(Korte et al., 2024)	Enhancing artificial intelligence literacy through cross-cultural online workshops	Mixed methods: paired-samples t-test, thematic-content analysis	29 students from 13 countries (Finland and Hong Kong)
6	(Pei et al., 2025)	Empowering preservice teachers' AI literacy: Current understanding, influential factors, and strategies for improvement	A multi-layered comprehensive survey based on Bloom's Taxonomy and TAM3, descriptive analysis and ANOVA	200 students who are prospective teachers at large state universities
7	(Ng et al., 2023)	Artificial intelligence (AI) literacy education in secondary schools: a review	Thematic analysis	50 AI education studies (2016-2022) for high school students
8	(Southworth et al., 2023)	Developing a model for AI Across the curriculum: Transforming the	Position paper/model development	University of Florida – all students (undergraduate,

		higher education landscape via innovation in AI literacy		graduate, professional)
9	(Kong et al., 2024)	Artificial Intelligence (AI) literacy—an argument for AI literacy in education	International collaborative position paper	Not mentioned (international collaborative paper)
10	(Ayanwale et al., 2024)	Examining artificial intelligence literacy among pre-service teachers for future classrooms	Quantitative study with Structural Equation Modeling (SEM)	529 prospective teacher students in Nigerian universities
11	(Law, 2024)	Application of generative artificial intelligence (GenAI) in language teaching and learning: A scoping literature review	Scoping literature review follows the PRISMA-ScR guidelines	41 of 215 initial papers (2010-July 2023)
12	(Hornberger et al., 2025)	What do university students know about Artificial Intelligence? Development and validation of an AI literacy test	Development and validation of multiple-choice tests	German university students (number not specifically stated)
13	(Sperling et al., 2024)	In search of artificial intelligence (AI) literacy in teacher education: A scoping review	Scoping review with Aristotelian concepts (episteme, techne, phronesis)	34 Papers and Proceedings (2000-2023)
14	(Kajiwara & Kawabata, 2024)	AI literacy for ethical use of chatbot: Will students accept AI ethics?	Technology Acceptance Model, analysis of educational effectiveness	Students aged 12-24 years (number not specified specifically)
15	(Laupichler et al., 2022)	Artificial intelligence literacy in higher and adult education: A scoping literature review	Scoping literature review	30 of 902 initial records from 10 research databases
16	(Chiu et al., 2024)	What are artificial intelligence literacy and competency? A comprehensive framework to support them	Iterative co-design cycle with a teacher's perspective	30 experienced AI teachers from 15 secondary schools

17	(Kohnke et al., 2025)	Preparing future educators for AI-enhanced classrooms: Insights into AI literacy and integration	Qualitative study with semi-structured interviews and thematic analysis	15 Prospective Teachers
18	(Hornberger et al., 2023)	A multinational assessment of AI literacy among university students in Germany, the UK, and the US	Multinational assessment with Item Response Theory	1,465 students from Germany, the UK and the US
19	(Yao & Wang, 2024)	Factors influencing pre-service special education teachers' intention toward AI in education: Digital literacy, teacher self-efficacy, perceived ease of use, and perceived usefulness	Structural Equation Modeling (SEM) based on Technology Acceptance Model	274 students of special education teacher candidates at Chinese Normal University
20	(Su & Yang, 2023)	Exploring ChatGPT literacy in language education: A global perspective and comprehensive approach	Mixed methods: quantitative and qualitative surveys with confirmatory analysis and thematic analysis	492 language teachers from 41 countries
21	(M. Ma et al., 2025)	Fostering responsible AI literacy: A systematic review of K-12 AI ethics education	Systematic review	68 peer-reviewed publications (January 2014-March 2025)
22	(Fan & Zhang, 2024)	From literacy to learning: The sequential mediation of attitudes and enjoyment in AI-assisted EFL education	Structural Equation Modeling	417 EFL China learners
23	(Chatikobo & Pasipamire, 2024)	Readiness to embrace artificial intelligence in information literacy instruction at a	Case study with the Artificial Intelligence Readiness Index (AIRI) and	Library, finance, and ICT staff of Bindura University of Science Education Library

		Zimbabwean University	Chapnick's Framework	
24	(Kong et al., 2024)	Students' prompt patterns and its effects in AI-assisted academic writing: Focusing on students' level of AI literacy	Content analysis and categorical data analysis, Wilcoxon signed-rank test	19 university students with different levels of AI literacy
25	(Hu, 2024)	Generative AI, communication, and stereotypes: Learning critical AI literacy through experience, analysis, and reflection	Assignment design with experiential, analytical, and reflective learning	Students in the Emerging Communication Technologies course
26	(Wen et al., 2024)	Enhancing College Students' AI Literacy through Human-AI Co-Creation: A Quantitative Study	Quantitative survey method	401 Chinese students
27	(Stolpe & Hallström, 2024)	Artificial intelligence literacy for technology education	Critical analysis of the AI literacy component in the literature	5 AI literacy frameworks from the educational technology literature
28	(Chiu & Sanusi, 2024)	Define, foster, and assess student and teacher AI literacy and competency for all: Current status and future research direction	Special issue compilation and analysis	18 articles from different regions (Canada, Finland, Germany, Hong Kong, Iran, Saudi Arabia, South Africa, Sweden, USA)
29	(Ali et al., 2024)	The effects of artificial intelligence applications in educational settings: Challenges and strategies	Literature review with classification structure	69 of 618 articles (2018-2023)
30	(Su & Yang, 2023)	Artificial Intelligence (AI) literacy in early childhood education: an intervention study in Hong Kong	Intervention study	26 early childhood (average 4 years) in Hong Kong kindergarten

4. Discussion

The Role of AI Technology in Revolutionizing Digital Literacy through Personalization of Learning

The learning paradigm transformed by artificial intelligence (AI) technology has led to a major revolution in our understanding of contemporary digital literacy. The use of AI in the education ecosystem is not only changing the way learning takes place, but also redefining the literacy skills needed in the modern era. AI technology acts as a catalyst in the personalization of learning by providing an adaptive and responsive learning experience to the individual needs of learners (Ali et al., 2024; Ng et al., 2025; Wen et al., 2024). AI's ability to analyze students' learning patterns, cognitive preferences, and comprehension levels enables the creation of dynamically tailored learning paths (Fan & Zhang, 2024; Laupichler et al., 2022; Yue Yim, 2024).

This personalization approach not only improves learning effectiveness, but also facilitates the development of more comprehensive and contextual digital literacy skills (Chatikobo & Pasipamire, 2024; Kong et al., 2024; Laupichler et al., 2022). Research shows that the implementation of AI in learning has resulted in significant improvements in student engagement and learning outcomes achievement (Korte et al., 2024; LaFlamme, 2025; Tan et al., 2025). In addition, AI technology allows for real-time discovery of learning errors, which allows pedagogical interventions to be carried out more on target and effectively. A new paradigm in learning was created by this revolution. This paradigm is more responsive, inclusive, and focuses on 21st century skills development. (Chandel & Lim, 2025; Hu, 2024; Law, 2024).

In addition, artificial intelligence redefines the role of educators from informants to learning facilitators who utilize artificial intelligence as a partner in pedagogical processes, enabling cross-lingual and cross-cultural learning. Students gain metacognitive skills and critical thinking abilities when interacting with digital technologies thanks to the use of AI in learning personalization.

Digital Literacy Dimension Influenced by the Implementation of AI Technology

Several important aspects of digital literacy have changed since the use of AI in learning. The cognitive dimension of digital literacy has evolved because we can now understand how AI works, machine learning algorithms, and how technology affects human cognitive processes. (Hornberger et al., 2023; Pei et al., 2025; Simamora & Gaffar, 2024). The technical dimension includes the skills to interact with AI systems, design effective prompts, and understand the limitations and capabilities of AI in learning. The ethical dimension is in the main focus, with an understanding of algorithmic bias, data privacy, fairness in technology access, and the responsibility to use AI (Kajiwara & Kawabata, 2024; Simamora & Gaffar, 2024; Tan et al., 2025).

On the creative side, the concept of co-creation between humans and AI, where students learn to collaborate with technology to produce creative works, changes the evaluative dimension, where students learn to assess the quality of AI outputs, verify the accuracy of information, and develop a critical attitude towards the content generated by technology (Hu, 2024; Su & Yang, 2023; Tzirides et al., 2024). The communicative dimension develops through learning human-AI interaction, understanding natural language processing, and skills in communicating ideas through the mediation of AI technology.

The social dimension of digital literacy is expanded with an understanding of the impact of AI on society, changes in work structures, and the social implications of the massive adoption of AI technology (Ayanwale et al., 2024; Tzirides et al., 2024; Wen et al.,

2024). The metacognitive dimension emerged as a new aspect that includes the ability to reflect on the AI-mediated learning process and evaluate the effectiveness of personalized learning strategies. The integration of these dimensions creates a comprehensive and holistic AI literacy framework (Laupichler et al., 2022; Yao & Wang, 2024; Yue Yim, 2024). The development of this digital literacy dimension requires an integrative pedagogical approach that is responsive to technological developments.

AI-Based Learning Personalization Mechanism in Improving Digital Literacy Competency

Adaptive systems enable AI-based learning personalization mechanisms to analyze individual learning characteristics and dynamically adjust content, methods, and assessments. Machine learning algorithms continuously analyze student learning data to identify learning patterns, cognitive preferences, and levels of conceptual understanding. Su & Yang, 2023; Tzirides et al., 2024; Yao & Wang, 2024). AI systems leverage learning analytics to monitor learning progress in real-time, identify learning difficulties, and provide timely and relevant feedback (Ali et al., 2024; Southworth et al., 2023; Sperling et al., 2024). Content personalization is done through automatic curation of learning materials tailored to students' individual ability levels, learning styles, and interests (Chatikobo & Pasipamire, 2024; Sperling et al., 2024; Wen et al., 2024).

The learning path adaptation mechanism allows students to explore the concept of digital literacy through an approach that best suits their cognitive characteristics (Wen et al., 2024; Yao & Wang, 2024; Yim, 2024). The AI recommendation system provides personalized suggestions for learning activities, learning resources, and strategies based on a comprehensive analysis of student learning data (M. Ma et al., 2025; Yue Yim, 2024; Zhong & Liu, 2025). Natural Language Processing technology facilitates a more natural interaction between students and the learning system, enabling communication in everyday language to access learning content (Hollands & Breazeal, 2024; Tzirides et al., 2024; Wen et al., 2024). The automated scaffolding mechanism provides tiered learning support, ranging from intensive assistance to independent learning according to competency development (Kajiwarara & Kawabata, 2024; Kohnke et al., 2025; Tzirides et al., 2024; Yim, 2024).

Adaptive assessment systems use AI to evaluate learning progress through a variety of modalities, including text, visual, and multimodal interactions. Temporal personalization allows for the adjustment of learning time based on individual learning rhythms and optimization of time for the achievement of maximum results (Chiu et al., 2024; Tzirides et al., 2024; Yue Yim, 2024). The integration of gamification and personalized motivational elements increases student engagement and persistence in developing digital literacy competencies through AI technology.

Effective AI Implementation Strategies and Models for Digital Literacy Development

Effective implementation of AI for the development of digital literacy requires a multi-dimensional strategy that systematically integrates pedagogical, technological, and organizational aspects. The phased implementation model has proven to be effective by starting from a pilot program, evaluation, and gradual expansion based on the learning outcomes of the previous phase (Hornberger et al., 2025; Tzirides et al., 2024; Yue Yim, 2024). Professional development strategies for educators are a crucial foundation in preparing teachers with adequate AI competencies to facilitate effective learning (Tan et al., 2025; Tzirides et al., 2024; Yim, 2024).

A collaborative model between institutions allows for the sharing of resources, expertise, and best practices in the implementation of AI for digital literacy (Korte et al., 2024; Tan et al., 2025; Yao & Wang, 2024). A transdisciplinary approach that integrates art,

science, and technology has proven effective in addressing gender and age barriers in AI learning (Tzirides et al., 2024; Wen et al., 2024; Yim, 2024). The modular curriculum strategy allows flexibility in adapting AI content according to the local context and the specific needs of the educational institution (Hollands & Breazeal, 2024).

Blended learning models that combine face-to-face learning and AI-mediated create an optimal and balanced learning experience (Law, 2024). The implementation of a comprehensive ethical framework ensures the responsible use of AI and in accordance with educational values. The community engagement strategy involves parents, the community, and stakeholders in supporting the implementation of AI for digital literacy (M. Ma et al., 2025; Su & Yang, 2023; Wen et al., 2024). The continuous evaluation model uses mixed methods to monitor the effectiveness of implementation and make necessary adjustments (Sperling et al., 2024; Tan et al., 2025; Tzirides et al., 2024).

The inclusive design approach ensures that AI technology is accessible to all students regardless of socio-economic background or ability (Kong et al., 2024; Tzirides et al., 2024; Wen et al., 2024). Institutional capacity building strategies include the development of technology infrastructure, HR training, and the formation of an innovation culture that supports the adoption of AI in learning.

Challenges and Opportunities in the Integration of AI Technology for Personalization of Learning and Development of Digital Literacy

The integration of AI technology in learning personalization faces complex challenges that require comprehensive and strategic solutions. Technological infrastructure challenges are a significant obstacle, especially in developing countries where access to the internet, hardware, and technical support is still limited (Chatikobo & Pasipamire, 2024; Kajiwarra & Kawabata, 2024; Wen et al., 2024). The digital competency gap between educators and students creates barriers to the effective implementation of AI technology, requiring substantial investment in professional training and development programs (Yao & Wang, 2024; Yim, 2024; Zhong & Liu, 2025). Ethical and data privacy issues are becoming a major concern with the increasing collection and analysis of student data by AI systems, demanding a strict and transparent regulatory framework. Resistance to change from various education stakeholders hinders the adoption of AI technology, requiring a sensitive and inclusive change management strategy (Yao & Wang, 2024; Yue Yim, 2024; Zhong & Liu, 2025).

Algorithmic bias and discrimination in AI systems can exacerbate educational inequities if not addressed with a proactive and systematic approach. Economic challenges are related to the cost of implementing, maintaining, and upgrading AI technology that requires long-term financial planning (Ali et al., 2024; Kong et al., 2024; Law, 2024). Educational transformation opportunities through AI create the potential to democratize access to high-quality learning for all levels of society (Kajiwarra & Kawabata, 2024; Lyu & Salam, 2025; Southworth et al., 2023). The development of 21st-century skills through interaction with AI prepares students for an increasingly digital future workforce.

Opportunities for pedagogical innovation through human-AI co-creation open up the possibility of learning methodologies that have never existed before. Global collaboration in AI literacy development creates opportunities for knowledge exchange and best practices across cultures and countries (Hornberger et al., 2023; Kajiwarra & Kawabata, 2024). The potential of interdisciplinary research in AI and education opens up new frontiers in the understanding of human learning and the optimization of technology for pedagogical purposes (Chiu & Sanusi, 2024; Tzirides et al., 2024; Yim, 2024).

5. Conclusion

Based on a comprehensive analysis of 30 studies studied in this systematic review, it can be concluded that AI technology has a transformative role in revolutionizing digital literacy through personalized learning. The implementation of AI has proven to be effective in developing students' digital literacy competencies through adaptive mechanisms that are able to adjust content, methods, and assessments based on individual characteristics of learners. Research shows that AI-based learning personalization significantly improves student engagement, learning outcome achievement, and 21st-century skill development. The dimension of digital literacy has expanded to include cognitive, technical, ethical, evaluative, creative, communicative, social, and metacognitive aspects that are integrated in a holistic framework.

However, the implementation of AI in education faces substantial challenges in the form of technology infrastructure gaps, limited digital competencies of educators, ethical issues and data privacy, resistance to change, algorithmic bias, and financial limitations. To overcome these challenges, it is recommended to develop a phased implementation strategy with a collaborative model between institutions, investment in professional development of educators, the establishment of a comprehensive ethical framework, and an inclusive design approach that ensures technological accessibility for all levels of society.

Future research needs to focus on longitudinal studies to measure long-term impacts, the development of universal definitions of AI literacy, and the exploration of innovative human-AI co-creation learning models. The integration of AI technology in learning personalization has great potential to create an educational ecosystem that is more adaptive, inclusive, and responsive to the individual needs of students in the digital age.

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