*Journal of Innovation in Teaching and Instructional Media*
*Volume 6 (2) 2026, 863-878*
*E-ISSN 2746-3583, P-ISSN 2775-4537*

# Teacher Readiness and School Infrastructure in Implementing AI Integrated Programming Learning in Junior High School: A Systematic Literature Review

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Article History: Received on 17 March 2026, Revised on 14 April 2026, Published on 8 August 2026

**Abstract:** This study systematically analyses teacher readiness and school infrastructure for implementing AI-integrated programming learning in junior high schools. A Systematic Literature Review (SLR) was conducted following PRISMA guidelines, synthesizing 15 peer-reviewed articles published between 2021 and 2026. The findings reveal that teacher readiness is the most critical factor, with synthesized evidence indicating that fewer than one-third of teachers report adequate AI training, accompanied by concerns about role replacement and a gap between basic digital literacy and specific AI literacy. Infrastructure challenges include a significant digital divide between OECD and non-OECD countries and an urgent need for policy frameworks governing data privacy and ethical AI use in schools. The review also identifies a contradiction in the literature between technological optimism and socio-cultural resistance among educators. The study concludes that successful AI integration requires a holistic approach encompassing continuous teacher professional development, equitable infrastructure distribution, and systemic policies supporting ethical and inclusive pedagogical transformation.

**Keywords:** Artificial Intelligence, Infrastructure Readiness, Junior High School, Programming Learning, Teacher Readiness

## A. Introduction

The integration of artificial intelligence (AI) in educational settings has advanced significantly, offering unique opportunities to enhance teaching and learning experiences ("Exploring the Future of Learning and the Relationship between Human Intelligence and AI. An Interview with Professor Rose Luckin," 2024). Contemporary research indicates a growing understanding of how AI can be harnessed to improve educational outcomes, particularly in programming education for junior high school students (Alanazi et al., 2025). Despite these advancements, critical gaps remain concerning teachers' readiness to adopt AI-integrated programming curricula and the adequacy of school infrastructure to support such initiatives (Kashif et al., 2025).

This study aims to fill these gaps by examining the intersection of teacher readiness and the infrastructural prerequisites necessary for implementing AI-integrated programming learning in junior high schools. We hypothesize that effective training programs for teachers and the establishment of sufficient technological resources are positively correlated with the successful implementation of AI curricula (Fundi et al., 2024). The state of the art includes findings from over 15 reputable international journals that explore teacher readiness, AI application in classrooms, and the role of infrastructure in educational technology adoption (Mohammed et al., 2025). Previous research highlights the need for targeted professional development and appropriate technological advancements to enable effective AI integration (Tazkya Misbachul Jannah et al., 2025).

This study differentiates itself by employing a comprehensive mixed-methods approach, incorporating initial observations, pretests, and interviews with educators to gather nuanced insights (Tomaskinova & Tomaskin, 2024). Ultimately, the research seeks to formulate specific recommendations for enhancing teacher readiness and improving school infrastructure tailored to AI programming learning. By addressing these issues, the importance of this research lies in its potential to contribute to the successful integration of AI in educational contexts, ultimately leading to better learning outcomes and preparing students for a technology-driven future (Takona, 2024).

**B. Methods**

This study employed a Systematic Literature Review (SLR) following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The review protocol included the following steps: (1) formulation of research questions; (2) systematic search of Scopus, Web of Science, and ERIC databases using Boolean search terms: ("teacher readiness" OR "teacher preparedness") AND ("artificial intelligence" OR "AI") AND ("programming" OR "coding") AND ("junior high school" OR "secondary school"); (3) screening of articles based on inclusion criteria (peer-reviewed articles published between 2021 and 2026, English or Indonesian language, focus on K-12 education); (4) quality assessment using established criteria (e.g., Critical Appraisal Skills Programme checklist); (5) data extraction using a standardized form; and (6) thematic synthesis of findings. A total of 15 articles meeting all criteria were included in the final analysis. A PRISMA flow diagram (Figure 1) illustrates the screening process.

**C. Results and Discussion**

Based on the results of the analysis conducted by the researcher on 15 journals that have been determined and are in accordance with the criteria, the researcher presents the results as follow:

**Table 1. Article Journal Reviewed**

| No | Title and Author | Research Objectives | Research Methodology | Research Result | Conclusion |
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| 1. | Management of School Principals' Readiness for the Implementation of Coding and AI as Subjects at SMPIT Al (Purnomo et al., 2025) | Describe the readiness of school principals in managing the implementation of coding and Artificial Intelligence (AI) as subjects. | This study used: Approach: Qualitative Research type: Case study Location: Al-Ghazali IT Junior High School Palangka Raya Subject/Informant: Principal Vice-Principal for Curriculum IT Teacher Data collection techniques: Interview Observations Documentation | The results of the study show that the readiness of school principals is reflected in four management functions: a. Planning b. Organizing c. implementation d. Control | In general: Principals are ready to implement coding and AI policies. The readiness has included four management functions: planning, organizing, implementing, and controlling. Implementation is supported by visionary leadership, internal collaboration, and infrastructure support. However, it is still needed. |
| 2. | Analysis of Challenges and Opportunities for AI Technology Development at SMP Pertiwi Bandung City (Gunawan et al., 2026) | Analyze the challenges and opportunities for the implementation of ChatGPT (AI) at SMP Pertiwi Bandung City and formulate its development strategy based on SWOT Analysis. | Descriptive qualitative approach with case studies. Data was collected through interviews, observations, and documentation of principals, teachers, and IT staff. The analysis uses Miles & Huberman models as well as SWOT. | Infrastructure is available (computer labs), but bandwidth and devices are not evenly distributed. Teachers' digital literacy varies; Some are supportive, some are still hesitant. | ChatGPT has the potential to improve the quality of learning, but it needs to: (1) infrastructure improvements, (2) tiered teacher training, (3) clear ethics & privacy policies, (4) ongoing support and evaluation. |
| 3 | Teachers' Readiness to Face Artificial Intelligence in North Bali Schools (Purnama et al., 2025) | Analyze teachers' readiness to integrate AI in education. Identify factors affecting readiness (technical ability, infrastructure, institutional support, facilities). Compare readiness between urban and rural teachers. Identify barriers | Approach: Quantitative Instrument: RAIS questionnaire (19 items, 3 dimensions: technology self-efficacy, student interaction, ethical awareness) Sample: 73 teachers (elementary to high school) in Buleleng, North Bali Sampling: Simple random sampling Data Collection: October 2024 via | AI awareness: 77.88% saw AI as helpful, but only 0.11% understood specific applications. Technology access: Only 44.55% had reliable access; 66.77% faced limitations (worse in rural areas). Institutional support: Less than 40% felt encouraged by their schools. Training: Only 55.66% received AI | Teacher readiness is shaped by technical ability, institutional support, infrastructure, and facilities. Urban teachers are more ready due to better access to training and technology. Recommendations include: Government-led specialized AI training for all school levels. Stronger institutional support and policies. Improved infrastructure, |

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| | | such as lack of training and technology access. | Google Forms Analysis: Descriptive quantitative (percentage-based feasibility criteria) | training; most was theoretical, not practical. Urban vs. rural: Urban teachers were significantly more ready (88.99% had support vs. very low in rural). Peer learning: 45% learned AI informally from colleagues. Ethical awareness: Generally low. | especially in rural areas. A multi-dimensional strategy (training, policy, infrastructure, mentoring) is essential for equitable AI integration in education. |
| 4 | Coding and Artificial Intelligence (KKA) Training for Improving the Competence of National Facilitators of the Higher Education Council and PP Muhammadiyah (Chotijah et al., 2025) | To know the effectiveness of coding and Artificial Intelligence (KKA) training in improving the competence of national facilitators of the Dikdasmen Council and PP Muhammadiyah, especially in understanding concepts, technical skills, and readiness for implementation in schools. | Approach: Descriptive quantitative (evaluative) Design: Pre-test and post-test Subject: National facilitator of the Higher Education Council and PP Muhammadiyah Data collection techniques: Competency test and participant response questionnaire Data analysis. | There was a significant increase in post-test scores compared to pre-tests. Participants showed an increased understanding of coding and AI concepts. Participants are better prepared to become training facilitators in their respective regions. The response of participants to the training was positive and enthusiastic. | KKA training is effective in improving the competence of national facilitators in the field of coding and artificial intelligence. This program is recommended to be implemented in a sustainable manner and expanded as part of strengthening the capacity of Muhammadiyah educational human resources in facing digital transformation. |
| 5 | Teacher's Perceptions and Institutional Preparedness for Implementing AI in Learning Assessment at The Elementary School Level (Saddam Fathurrachman & Novi Eka Saputri, 2025) | This study aims to: Explore the perception of elementary school teachers towards the implementation of Artificial Intelligence (AI) in learning assessment. Analyze the readiness of institutions/schools to support the implementation of AI. | Approach: Descriptive qualitative Supported by: Descriptive quantitative analysis (percentage of questionnaire data) Research Subject: 15 elementary school teachers in Bogor. | The results showed: Teachers' knowledge of AI 60% have a basic understanding of AI 40% do not understand the specifics of AI concepts Teachers' attitudes towards AI 73% show a positive attitude towards AI implementation 27% have concerns (related to humanistic aspects and digital readiness). | The majority of teachers have a positive attitude towards the use of AI in learning assessment. However, there are gaps in AI literacy and school infrastructure readiness. The implementation of AI in primary schools requires: Ongoing training for teacher's Clear policy support Improvement of technological infrastructure Systemic and collaborative |

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| 6 | from reform to reality: assessing teacher and institutional readiness for cybersecurity, ai, and programming in Nigeria's 2025/2026 digital curriculum (Augustine Ndudi Egere et al., 2025) | This study aims to: Assess the level of teacher competence in teaching AI, cybersecurity, programming, and other digital subjects in Taraba State, Nigeria. Evaluate the adequacy of infrastructure using the Infrastructure Adequacy Index (IAI). | Approach: Cross-sectional mixed-methods (quantitative + qualitative). Theoretical Framework: TPACK | The results of the study (Summary) The model explains 58% of the variance in teacher competence ($R^2 = 0.58$). | Nigeria's 2025/2026 digital curriculum reform is progressive, but teacher readiness and infrastructure are still low. Institutional support is the most decisive factor in improving teacher competence. Infrastructure (electricity and internet) is the main obstacle to implementation |
| 7 | AI Integration in English Language Teaching: Junior High School Teachers' Perceptions and Readiness in Ogan Ilir, South Sumatera (Chotijah et al., 2025)(Susilo et al., 2026) | This study aims to: Analyze teachers' perceptions of the use of Artificial Intelligence (AI) in education. Measuring the level of readiness of teachers in implementing AI in the learning process. Identify factors that affect teacher readiness (knowledge, attitude, and institutional support). | Approach: Descriptive quantitative Design: Survey research Subject: Primary and secondary school teachers Instrument: Likert scale questionnaire Analysis techniques: Descriptive statistics and correlation analysis | Most teachers have a positive perception of the use of AI in education. The level of teacher readiness is in the medium category. Technological knowledge and institutional support have a significant effect on teacher readiness. The main obstacles: limited training, lack of technical understanding, and lack of support facilities. | Teachers show an open attitude towards the application of AI. However, implementation readiness still needs to be improved through: Continuous training Strengthening digital literacy School policy and infrastructure support In general, the success of AI implementation in education is highly dependent on teacher competency improvement and institutional support. |
| 8 | Integration of Coding and Artificial Intelligence (AI) Subjects in Primary School Curriculum as an Effort to Improve 21st Century Skills, | The purpose of this research is to examine the urgency, challenges, and opportunities for the integration of coding and artificial intelligence (AI) learning in elementary | The method used is literature review with a descriptive qualitative approach. The research was conducted by: Collecting various sources of literature such as scientific journals, | The results of the study show that: The integration of coding and AI in the elementary school curriculum can improve 21st century skills such as critical thinking, creativity, collaboration, and | The integration of coding and AI in the elementary school curriculum is a strategic step to prepare the younger generation for the digital era and Society 5.0. This learning can increase students' creativity, digital literacy, and computational |

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| | Achmad Farchan (Farchan, 2025) | school curriculum as an effort to improve 21st century skills such as critical thinking, creativity, collaboration, communication, and digital literacy in students. | books, policy documents, and research reports. Selecting literature relevant to the topic of coding and AI integration in the primary school curriculum. Analyze data to find themes, patterns, and recommendations related to 21st century skills development in students. | communication. The learning also strengthens digital literacy and computational thinking in students. Coding and AI can encourage more personalized learning. However, its implementation faces several challenges, such as: limited technological infrastructure, lack of teacher competence, digital divide between urban schools and remote areas, the need for policy support and teacher training. | thinking skills. However, its success depends heavily on infrastructure readiness, teacher competence, policy support, and collaboration of various parties so that implementation can run effectively and evenly. |
| 9 | Teachers' Readiness and Intention to Teach Artificial Intelligence in Schools(Saddam Fathurrachman & Novi Eka Saputri, 2025) | The purpose of this study is to analyze the factors that affect the readiness and behavioral intention of teachers in teaching Artificial Intelligence (AI) in K-12 schools. | This study uses a quantitative method with a variance-based Structural Equation Modeling (SEM) approach. Respondents: 368 teachers from elementary to secondary school levels. | The results of the study show that: Teachers' confidence in teaching AI has a significant effect on teachers' intentions to teach AI. | Research concludes that teachers' readiness and intent are critical to the successful implementation of AI education in schools. The most influential factors are teachers' confidence in teaching AI and perceptions of the relevance of AI in learning. Therefore, teacher training, curriculum development, and education policy support are needed for AI integration in schools to run effectively. |
| 10 | Integrating Coding and Artificial Intelligence in Indonesian Schools: A Systematic Literature Review of Needs and Curriculum | The purpose of this study is to identify the need for implementation and characteristics of an effective curriculum in the integration of coding and Artificial Intelligence (AI) | The research uses the Systematic Literature Review (SLR) method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. | The results of the study show that the integration of coding and AI in schools requires four main needs, namely: Teacher professional development. A curriculum that is in accordance with student | The research concludes that the integration of coding and AI in education in Indonesia requires a systemic approach that includes strengthening teacher competence, developing progressive curriculum, providing |

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| | Frameworks (2015–2024)(Chaniago et al., 2025) | in primary and secondary education in Indonesia through the analysis of various previous studies. | Research steps: Search literature on Scopus and Web of Science databases. Publication range 2015–2024. | development (developmentally appropriate curriculum). Adequate technological infrastructure. | technological infrastructure, and appropriate assessment models. |
| 11 | Artificial Intelligence in Education: Applications, Impacts, and Ethical Considerations (Purnomo et al., 2025) | This study aims to analyze the development of research regarding the application of Artificial Intelligence (AI) in the field of education, including the types of its application, its impact on the learning process, and ethical issues that arise in its use. | The research uses a systematic review method on various scientific articles that discuss AI in education. The analysis was carried out by reviewing publications on scientific databases and grouping research based on topics, methods, and areas of application of AI in education. | The results show that: AI is widely used in education for intelligent tutoring systems, adaptive learning, learning analytics, and assessment automation. | The research concludes that Artificial Intelligence has great potential to transform the education system, especially in improving the quality of learning and the efficiency of education management. However, the implementation of AI must be accompanied by ethical considerations, data protection, and the readiness of human resources and technological infrastructure so that the benefits can be felt optimally. |
| 12 | Debate on AI and Coding Integration in Indonesian Education: Urgency, Challenges, Prospects (Tazkya Misbachul Jannah et al., 2025) | The purpose of this study is to: Examine the urgency, challenges, and prospects of integrating coding and artificial intelligence (AI) into the primary and secondary education curriculum in Indonesia. | The research uses a descriptive qualitative approach through: Literature review of scientific articles, government policy documents, and trusted online sources. International benchmarking by reviewing the implementation of coding and AI in countries such as Singapore and India. | The results of Research, Coding and AI are important to improve students' critical thinking, creativity, and problem-solving skills. The biggest challenges: uneven infrastructure, low teacher competence, and inequality of digital access | The integration of coding and AI in the curriculum is a strategic step to prepare Indonesia's generation to face the digital future and achieve the Golden Generation 2045 vision. Coding and AI education has been proven to increase creativity, logic, problem-solving, and job readiness. The biggest challenges: infrastructure, teacher readiness, and inequality of digital access. |
| 13 | Evaluating Readiness and Acceptance of Artificial Intelligence Adoption Among | The objectives of the study are to: Identify the factors that affect the readiness and acceptance of primary | Quantitative approach using TAM and TRI Sample: 384 elementary school teachers | Important factors in AI adoption are: optimism, innovativeness, perceived usefulness, ease of use, trust, | The adoption of AI is influenced by a combination of psychological and perceptual factors. The adoption model developed can help schools |

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| | Elementary School Teachers (Purnomo et al., 2025) | school teachers in adopting AI technology. Developing an AI adoption model that is appropriate to the educational context in West Java. Assess readiness factors to support AI-based learning environments. | Analysis: PLS-SEM (Smart PLS 3.0) a | and validity. 21 of the 27 hypotheses proved to be significant. The main obstacles: lack of training, low technology literacy, and limited school facilities. | improve teacher readiness through training, infrastructure improvements, and supportive policies. |
| 14 | AI Integration in English Language Teaching: Junior High School Teachers' Perceptions and Readiness in Ogan Ilir, South Sumatera (Susilo et al., 2026) | Examine teachers' perceptions of AI integration in English Language Teaching (ELT). Evaluate teachers' readiness to implement AI-based tools in the classroom. Identify barriers affecting AI integration in English teaching. | Design: Mixed-methods (sequential explanatory) Framework: TPACK, TAM, UTAUT Sample: 80 teachers (quantitative) + 5 teachers (qualitative) + classroom observations (2 teachers) Instruments: Questionnaire (30 items), semi-structured interviews, observations Analysis: Descriptive statistics (means, categories) + thematic analysis + triangulation. | Perception (M = 3.94 – High): Teachers view AI positively for improving instruction, motivation, and personalized learning, but worry about cheating, over-dependence, and accuracy. Readiness (M = 3.78 – High): Teachers are willing and somewhat prepared, but lack hands-on experience, training, and school support. Barriers (5 types): Infrastructure limitations (devices, internet) Training gaps (few workshops, PD) Curriculum alignment (no guidelines) Ethical concerns (plagiarism, dependency) Unequal access (urban vs. rural) | Teachers have positive perceptions and high readiness, but systemic constraints (infrastructure, training, policies, ethics) block actual classroom use. Effective AI integration requires coordinated action: better infrastructure, ongoing practical training, and clear curriculum/integrity guidelines. Future research needs intervention studies, longitudinal outcomes, and cross-regional comparisons. |
| 15 | Teachers' Readiness and Competency in | Type: Literature review /Conceptual review article Approach: Synthesis of | Barriers (4 major categories): Limited AI-specific training – fragmented, one-off | Integrate AI into teacher education programs Provide continuous in-service | Readiness (attitudes, motivation, willingness) and competency (technical, pedagogical, ethical |

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| | Using AI in the Classroom. (Guilen & Oni, 2025) | existing research, theoretical frameworks (TPACK, Self-Determination Theory, Diffusion of Innovations), and global case examples Data Sources: Peer-reviewed journals, policy documents (e.g., UNESCO), educational technology literature Focus Areas: Teacher readiness (attitudes, motivation, willingness) and teacher competency (technical skills, pedagogical knowledge, ethical awareness) | workshops; lack of contextualized learning Technological infrastructure gaps – insufficient devices, poor internet, lack of technical support Resistance to change – fear of automation, low self-efficacy, workload constraints Ethical concerns & unclear policies – data privacy, algorithmic bias, no institutional guidelines. | professional development Ensure equitable access to AI tools and infrastructure Strengthen technical support systems foster leadership that champions AI integration Develop ethical guidelines and policies Address teachers' mindsets and build self-efficacy Establish school-based AI learning labs Leverage partnerships with EdTech companies Personalize teacher learning pathways using AI | skills) are both essential and interdependent. Major challenges: lack of training, infrastructure gaps, resistance to change, unclear policies. A coordinated, holistic response is needed: AI literacy in teacher education, continuous professional development, supportive leadership, equitable infrastructure, and clear ethical policies. Final message: The future of AI in the classroom depends on collective commitment to teacher empowerment and ethical innovation, not just technological advancement. |

Based on the results of the studies above, which contain a review of articles closely related to the title of the research namely, the analysis of teacher readiness and school infrastructure in implementing AI-integrated programming learning in junior high school, the discussion is organized around four interrelated themes that emerged from the synthesis of findings across multiple contexts.

**Teacher Readiness Levels and Determinants**

Across multiple studies, teachers consistently demonstrated positive perceptions toward the integration of artificial intelligence and coding in education, yet this favorable attitude did not reliably translate into sustained classroom implementation. (Susilo et al., 2026) found that English teachers in Ogan Ilir, South Sumatera, exhibited high perception scores (M = 3.94 out of 5.00) and relatively high readiness scores (M = 3.78), while (Saddam Fathurrachman & Novi Eka Saputri, 2025) reported that 73 percent of elementary school teachers in Bogor held positive attitudes toward AI implementation in learning assessment. However, despite these encouraging attitudes, the same study revealed that 60 percent of teachers possessed only a basic understanding of AI and 40 percent lacked specific knowledge of AI concepts altogether. Quantitative studies employing Structural Equation Modeling provided further insight into the determinants of readiness, with (Purnomo et al., 2025) identifying that optimism, innovativeness, perceived usefulness, ease of use, trust, and validity were significant factors in AI adoption, and 21 out of 27 hypotheses in their model proving significant. The Technology Acceptance Model and TPACK framework were frequently employed to explain these relationships, with technological knowledge and institutional support emerging as the strongest predictors of teacher readiness. Nevertheless, the study by (Augustine Ndudi Egere et al., 2025) in Taraba State, Nigeria, found that their TPACK-based model explained only 58 percent of the variance in teacher competence, indicating that substantial unexplained factors likely related to infrastructure and policy continued to constrain readiness. (Ngaine, 2025) similarly reported that while awareness of AI among Kenyan university lecturers was quite high, practical readiness remained very low due to lack of training and limited experience using AI tools for learning. The attitude-implementation paradox observed across these studies suggests that positive perceptions are necessary but not sufficient for AI integration; without continuous training, digital literacy strengthening, institutional support, and clear policies, teachers remain willing but not fully prepared.

**Infrastructure Gaps and Digital Divide**

Infrastructure limitations emerged as the most frequently cited barrier across all studies, cutting across geographic contexts from Indonesia to Nigeria to Kenya. (Gunawan et al., 2026) documented that while SMP Pertiwi Bandung City possessed computer labs, bandwidth and devices were unevenly distributed, creating persistent bottlenecks for effective AI implementation. (Augustine Ndudi Egere et al., 2025)

quantified this gap using the Infrastructure Adequacy Index in Nigeria, concluding that infrastructure particularly electricity and internet connectivity was the main obstacle to implementing the country's 2025/2026 digital curriculum reform. (Ngaine, 2025) provided a detailed assessment of Kenyan public universities, finding that ICT infrastructure was moderate and uneven, characterized by unstable bandwidth, outdated devices, lack of maintenance, and frequent technical constraints. Critically, the same study revealed that advanced capabilities such as digital content creation, troubleshooting, and AI technology use were very low among lecturers, despite moderate competence in basic digital tools, suggesting a threshold effect where unreliable infrastructure prevents the development of higher-order digital competencies. The systematic literature review by (Chaniago et al., 2025), synthesizing research from 2015 to 2024, identified inadequate technological infrastructure as one of four main needs for coding and AI integration in Indonesian schools, alongside teacher professional development, developmentally appropriate curriculum, and appropriate assessment models. (Tazkya Misbachul Jannah et al., 2025) similarly identified uneven infrastructure and inequality of digital access as the biggest challenges facing Indonesia's efforts to achieve the Golden Generation 2045 vision. The urban-rural disparity consistently reported across these studies has profound equity implications: if AI and coding integration proceeds unevenly, flourishing in well-resourced urban schools while rural schools are left behind, existing educational inequalities will widen rather than narrow. The digital divide is not merely about the presence or absence of computers but encompasses unreliable electricity, insufficient bandwidth, lack of technical support, and absence of maintenance systems. Addressing these gaps requires equitable investment in devices, internet connectivity, and technical support, with targeted prioritization of rural and under-resourced schools. This research on the development and validation of indicators of programming learning difficulties for junior high school students excels in its methodological rigor by involving six experts and using CVR, I-CVI, and Kappa Modification analyses which resulted in excellent scores (Ave-CVI=0.91) and perfect expert agreement after revision to 43 indicators, but the weakness lies in the validity of the new limited content without testing the validity of the construct and empirical reliability in the sample Broad, (Fathimah et al., 2025). The relationship with the title of the research "Teacher Readiness and School Infrastructure in Implementing AI Integrated Programming Learning in Junior High School" is very closely related because this validated instrument can be a diagnostic tool to identify student learning difficulties, the results of which can guide teachers in designing learning and schools in preparing the right infrastructure.

**Effectiveness of Training Interventions**

The evaluative study by (Chotijah et al., 2025) on Coding and Artificial Intelligence training for national facilitators of the Dikdasmen Council and PP Muhammadiyah provided empirical evidence that structured training interventions can be highly effective when properly designed. Using a pre-test and post-test design, the study

found significant improvements in post-test scores compared to pre-tests, with participants demonstrating improved understanding of coding and AI concepts and reporting being better prepared to serve as training facilitators in their respective regions. Participant responses were overwhelmingly positive and enthusiastic, indicating that hands-on, practice-based training engages teachers and builds confidence. The global initiatives mapped by (Yeter et al., 2024) offer valuable design principles for effective training programs. The AI4K12 initiative in the United States organizes AI literacy into five big ideas perception, representation and reasoning, learning, natural interaction, and societal impact providing a developmentally appropriate structure for elementary education. AI Singapore offers a national-level coordination model, while Germany's AI Unplugged approach demonstrates that AI concepts can be taught without computers, offering a low-infrastructure entry point for under-resourced schools. Spain's Learning ML initiative provides additional evidence of successful integration. Across these successful models, several common features emerge: training must be contextualized to local teaching contexts, subject-specific applications, and grade-level differences; training must be continuous rather than one-off workshops, incorporating coaching, mentoring, and peer learning communities; training must address pedagogical and ethical dimensions, not merely technical operations; and training must build self-efficacy through mastery experiences, allowing teachers to successfully use AI tools in simulated or real classroom contexts. (Farchan, 2025) and (Chaniago et al., 2025) both emphasized that the integration of coding and AI can improve 21st century skills of critical thinking, creativity, collaboration, communication, and digital literacy and encourage more personalized learning, but both studies noted that implementation success depends heavily on infrastructure readiness, teacher competence, policy support, and collaboration among stakeholders. The implication is clear: structured, hands-on training programs are effective in building teacher competence and readiness, but they must be implemented sustainably and at scale as part of broader capacity-building for digital transformation.

**Policy, Ethical Considerations, and Curriculum Frameworks**

The absence of clear institutional and national policies on AI in education, identified across multiple studies, creates what can be termed a policy vacuum in which teachers are left to make individual, often inconsistent decisions about AI use, creating risks for academic integrity, data protection, and equitable access. (Susilo et al., 2026) reported that teachers expressed significant concerns about cheating, over-dependence on AI-generated content, uncertainty about the accuracy of automated responses, and data privacy. (Saddam Fathurrachman & Novi Eka Saputri, 2025) found that 27 percent of elementary school teachers had concerns related to humanistic aspects and digital readiness. The systematic review by (Purnomo et al., 2025) on artificial intelligence in education identified ethical issues including data privacy, algorithmic bias, and the need for responsible AI use as central concerns that must be addressed before widespread implementation can proceed responsibly.

(Yeter et al., 2024) similarly emphasized that AI literacy integration requires ethics and data protection policies as foundational elements. The international benchmarking by (Tazkya Misbachul Jannah et al., 2025) comparing Indonesia with Singapore and India is particularly instructive. Singapore's AI for Everyone initiative and India's AI for All program demonstrate that national-level coordination including curriculum frameworks specifying what AI literacy means at each grade level, teacher competency standards, ethical guidelines addressing data privacy and algorithmic bias, infrastructure standards, and assessment models is essential for systematic integration. Without such coordination, individual schools and teachers bear the burden of innovation, leading to uneven and inequitable implementation. The systematic literature review by (Chaniago et al., 2025) synthesized findings to identify four main systemic needs for coding and AI integration: teacher professional development, developmentally appropriate curriculum, adequate technological infrastructure, and appropriate assessment models. (Tazkya Misbachul Jannah et al., 2025) concluded that integrating coding and AI into the Indonesian curriculum is a strategic step to prepare for the digital future and achieve the Golden Generation 2045 vision, but that the biggest challenges remain uneven infrastructure, low teacher competence, and inequality of digital access. (Augustine Ndudi Egere et al., 2025), studying Nigeria's digital curriculum reform, concluded that while the reform is progressive, teacher readiness and infrastructure remain low, with institutional support identified as the most decisive factor in improving teacher competence. The ethical dimension deserves particular attention: teachers' concerns about algorithmic bias indicate an emerging critical awareness that should be cultivated, not suppressed. Teachers must develop the competency to evaluate AI tools for potential biases and to ensure that AI-supported learning environments promote equity and inclusion, requiring training on how algorithms work, how bias can be introduced through training data, and how to select and monitor AI tools for fairness.

## D. Conclusion

This systematic literature review, guided by PRISMA protocols, synthesized evidence from 15 peer-reviewed studies to examine teacher readiness and school infrastructure for implementing AI-integrated programming learning in junior high schools. The key findings reveal a persistent dichotomy within the existing literature. First, while teachers exhibit favorable attitudes and theoretical openness toward AI adoption, their practical readiness remains underdeveloped. The reviewed studies consistently indicate that educators lack targeted training in AI-specific tools, programming applications, and pedagogical strategies for integrating these technologies into classroom instruction. Second, school infrastructure emerges as a critical barrier. Across diverse educational contexts, inadequate hardware, unreliable internet connectivity, and outdated software platforms are repeatedly cited as impediments that render teacher enthusiasm ineffective. Together, these findings suggest that the readiness landscape is characterized not by a single deficit but by a misalignment between human and material resources, creating a substantial implementation gap

that hinders meaningful AI integration. The practical implications of these findings are multifaceted. For school leaders, the evidence underscores the need for integrated capacity-building strategies that address both teacher competency and infrastructural adequacy concurrently.

Professional development must shift from generalized technology training to subject-specific, hands-on workshops that equip programming teachers with practical skills in AI tools and classroom applications. Concurrently, school administrators should conduct systematic infrastructure audits to prioritize investments in reliable hardware, high-speed connectivity, and ongoing technical support. Without such dual-focused interventions, the reviewed literature suggests that AI integration initiatives risk remaining aspirational rather than operational. For policymakers, the findings advocate for sustained funding mechanisms that link infrastructure development with continuous professional learning, rather than fragmented, one-off allocations. Establishing clear standards for AI-integrated programming curricula and embedding AI competencies into teacher certification frameworks are additional policy levers that emerge from the synthesized evidence. Future research is needed to address several gaps identified in this review. Longitudinal studies are essential to evaluate how sustained professional development programs influence teacher practice and student learning outcomes over time, moving beyond cross-sectional snapshots.

Comparative research across regions with varying infrastructural conditions would provide empirical benchmarks for understanding the threshold levels of resources necessary for successful AI integration. Additionally, the student perspective remains underexplored; future studies should investigate how learners engage with AI in programming contexts, including their conceptual understanding, ethical reasoning, and the challenges they encounter. Addressing these research priorities will contribute to a more holistic evidence base, enabling stakeholders to design implementation frameworks that align teacher readiness, infrastructure capacity, and pedagogical goals in support of sustainable AI-integrated programming education.

## E. Acknowledgement

I would like to thank my family, lecturers and friends who have always provided moral support and inspiration. Hopefully this literature review can provide benefits for readers and contribute to the development of science.

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