AI-Enhanced Learning Media for Elementary School Students: A Literature Review of Cognitive Stimulation and Islamic Pedagogical Values

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Abstract

Artificial intelligence (AI) is increasingly used in learning media, creating opportunities for adaptive feedback, personalized learning support, and interactive learning activities. However, these capabilities do not automatically lead to meaningful learning. AI can help children reason, but it can also take over the thinking effort that is essential to learning. This article examines how AI-enhanced learning media can support cognitive development while remaining aligned with Islamic pedagogical values. The study employs a targeted structured literature review with thematic synthesis, in which themes emerging from selected literature are grouped and interpreted. It focuses on research on AI in primary education, scaffolding for thinking processes, AI literacy, teacher roles, and Islamic education, while retaining classic works that provide theoretical foundations. The literature search was targeted and purposive rather than exhaustive across all scholarly databases. The synthesis identifies themes concerning AI as a support for thinking, Islamic values for responsible AI use, and the teacher's role in connecting technology with educational goals. Based on this synthesis, the article proposes the conceptual framework Human-in-the-Loop for Islamic AI-Enhanced Learning (HITL-IAL), which integrates cognitive scaffolding, student agency, teacher guidance, and information verification. This framework remains conceptual and has not yet been tested in field research. The article argues that AI should help children think rather than replace their thinking; AI may support ta'lim, or instruction, but it cannot replace ta'dib, or education that cultivates adab.

Keywords: artificial intelligence, cognitive stimulation, Islamic pedagogy, teacher mediation, elementary education

Introduction

Artificial intelligence (AI) is developing rapidly in education, including in learning media designed for children. AI-based systems can provide adaptive learning pathways, automated feedback, intelligent tutoring, interactive activities, and personalized assistance. Recent reviews indicate that the use of AI in primary education is expanding, although concerns remain regarding child development, privacy, teacher roles, and responsible implementation (Boulhrir & Hamash 2025). Meta-analytic evidence also suggests that AI may positively influence 21st-century thinking skills, with particularly promising potential among elementary school students and in adaptive or personalized applications (Tian & Zheng 2025; . These developments make AI-based learning media an important issue in elementary education. Baek & Jeong 2025)

However, the educational potential of AI should not be equated with guaranteed learning gains. The central question is whether AI supports productive cognitive effort or encourages learners to offload their thinking to technology (cognitive offloading). This issue is particularly important in elementary education because children are still developing reasoning, self-regulation, source evaluation, and independent problem-solving skills. Research on generative AI in K–12 education indicates that its use should be aligned with cognitive development and should not eliminate students' thinking activities Tao (2025). Research on AI-assisted learning increasingly distinguishes between technologies that simply provide answers and those that scaffold thinking. This distinction underpins the main proposition of this study: AI should function as a cognitive scaffold, not a cognitive substitute.

These issues become more complex in the context of Islamic education. Islamic pedagogy views education as more than the transfer of information. The concept of ta'dib, as developed in Islamic educational thought, connects knowledge with adab, responsibility, and recognition of the proper status and purpose of knowledge (Al-Attas 1980). Therefore, AI use in learning should be evaluated not only in terms of effectiveness but also in relation to adab, amanah, source authenticity, verification, and the teacher's role as a mediator of knowledge. Recent studies on generative AI in Islamic religious education emphasize the importance of human mediation and source verification and caution against positioning AI as a replacement for teachers or religious authority (Mat Yusoff et al. 2026). Research on Qur'anic education likewise identifies AI's potential to support learning while highlighting concerns about accuracy, authenticity, dependency, and the possible weakening of the relational and spiritual dimensions of learning (Almajdoub et al. 2026).

This study is guided by three research questions: (1) How can AI-enhanced learning media support cognitive stimulation among elementary school students, and what risks arise when students rely excessively on AI-generated answers? (2) How can Islamic pedagogical values, particularly adab, amanah, and tabayyun, guide the responsible use of AI-enhanced learning media? (3) How can a human-in-the-loop approach—one that ensures continued human involvement in directing and overseeing technology—integrate cognitive support, teacher guidance, and Islamic pedagogical values into a single conceptual framework?

Methods

Literature Review Design

This article adopts a targeted structured literature review with thematic synthesis. A targeted structured literature review selects and examines sources according to clearly defined research questions and a specific focus, without claiming to cover every publication available. Thematic synthesis involves grouping, comparing, and interpreting ideas from selected sources to answer the research questions and develop a conceptual framework. This approach suits the study's aim of connecting several related fields: AI in primary education, scaffolding for thinking processes, AI literacy, teacher mediation, and Islamic pedagogy (Grant & Booth 2009;. Snyder 2019)

Search Strategy and Literature Selection Criteria

Literature was gathered through targeted searches based on its relevance to the research questions, covering AI in primary education, cognitive support and cognitive

scaffolding, AI literacy, teacher roles, and Islamic pedagogy. Empirical studies and research reviews were used to map developments and findings, while theoretical or classical works were retained when they provided a conceptual foundation. Literature not directly related to these areas did not serve as a primary basis for the synthesis. The search was purposive rather than exhaustive; accordingly, this article does not claim to cover all available publications.

Data Extraction and Thematic Synthesis

Information from the selected sources was reviewed and recorded according to the study's focus, findings on cognitive support or risks, teacher roles, and relevant Islamic pedagogical principles. The findings were then compared and grouped into three themes: AI as support for thinking, Islamic values for responsible use, and human mediation in learning. These themes were interpreted comparatively to answer the research questions and formulate the HITL-IAL framework. This synthesis is conceptual rather than a meta-analysis and is not used to infer causal relationships.

Results

AI-Based Learning Media in Elementary Education

The reviewed literature indicates that AI is being used in elementary education through adaptive systems, personalized learning pathways, intelligent tutoring, automated feedback, interactive environments, and AI-supported learning activities. Boulhrir and Hamash identify growing attention to AI in primary education while highlighting concerns about child development, privacy, and teacher roles (Boulhrir & Hamash 2025). Farhood et al. also indicate that AI-based personalized learning can adapt learning experiences to students' needs, although its success still depends on pedagogical design and human oversight (Farhood et al. 2025). In a meta-analysis of 42 studies involving elementary school students, Baek and Jeong Baek & Jeong (2025) found that AI-based educational programs had positive effects on students' competencies, cognitive outcomes, and attitudes. These findings are consistent with other studies of AI use in education (Almasri 2024; . Dong, Tang & Wang 2025).

AI as a Cognitive Scaffold

The second theme concerns the conditions under which AI can stimulate cognition. Cognitive scaffolding traditionally refers to temporary support that enables learners to perform tasks they cannot yet complete independently (Wood, Bruner & Ross 1976). In AI-based environments, scaffolding may take the form of prompts, hints, feedback, alternative explanations, examples, adaptive questions, error diagnosis, and metacognitive reminders. The key issue is whether such support preserves students' responsibility for the intellectual work (Vygotsky 1978).

Recent empirical evidence provides a useful illustration. A study comparing two approaches to metacognitive support—adaptive scaffolding and planned scaffolding—in generative-AI-supported programming involved 74 elementary school students Liu et al. (2026). Adaptive scaffolding improved contextual computational-thinking performance, supported the use of more complex skills, encouraged recursive metacognitive behavior, and reduced mental effort, while planned scaffolding also supported meaningful engagement. These findings suggest that adaptive AI support can be beneficial when it structures learning without removing students' active role.

Overall, the literature supports a distinction between AI that generates answers and AI that supports thinking. Answer-generating designs reduce cognitive effort by completing tasks for learners. By contrast, thinking-supportive designs provide graduated assistance while still requiring learners to explain their reasoning, test alternatives, justify responses, identify errors, and revise initial answers. Tao also emphasizes that AI use should be appropriate to learners' developmental stages and should reduce the risk of cognitive offloading (Tao 2025). The implication for elementary learning media is that AI should make productive thinking easier to undertake, not make thinking unnecessary.

AI Literacy and Critical Engagement

AI literacy is an important complement to the use of AI-based learning media. In their literature review, Ng et al. (2021) identify four dimensions of AI literacy: understanding AI, using AI, evaluating and creating AI, and understanding ethical issues. Their review also finds that the studies examined place greater emphasis on understanding and using AI than on evaluating and creating it. This highlights the importance of teaching students not only to use AI but also to assess its outputs critically. Similarly, Long and Magerko (2020) formulate 17 AI literacy competencies, including recognizing AI's capabilities and limitations, understanding how AI works, and considering the role of humans and ethical issues in its use. Other studies also address AI literacy competencies, technological limitations, and the importance of ethical considerations in AI use Ng et al. (2021). Long & Magerko (2020) (Atias & Mawasi 2025; Bewersdorff, Nerdel & Zhai 2025; Yeter 2024; Yim & Su 2025)

Teacher Mediation in AI-Assisted Learning

The literature indicates that AI does not eliminate the need for teachers; rather, it changes their tasks and responsibilities. Holmes et al. explain that ethical AI use in education requires the involvement of the educational community rather than a technology-only approach (Holmes et al. 2022). Holmes and Tuomi likewise argue that AI should be understood in relation to educational purposes and human learning processes (Holmes & Tuomi 2022). UNESCO UNESCO (2021, identifies learner protection, teacher capacity, and a human-centred approach as important elements of AI use. In this article, teacher mediation refers to the active process of designing activities, guiding thinking, checking understanding, and directing technology use in line with educational objectives. Luckin et al. (2016) describe AI's potential to support learning through feedback and assistance tailored to learners' needs 2023). Teacher involvement remains essential to ensure that technology encourages thinking and active engagement rather than replacing the educator. Luckin et al. (2016)

Wiese et al. (2025) emphasize the importance of AI ethics education through learning activities that help students understand and consider ethical issues. In elementary education, this can involve teaching students to verify information (tabayyun), use technology responsibly (amanah), and maintain adab in learning. AI-based learning media should therefore integrate cognitive stimulation, teacher guidance, and ethical values Wiese et al. (2025). (Tagare, Karki & Yu 2025)

Islamic Pedagogical Values in the Use of AI

Islamic pedagogy provides a moral and epistemic foundation for the use of AI. The concept of ta'dib connects knowledge with adab and the ability to place things in their proper order (Al-Attas, 1980). In AI-assisted learning, adab, amanah, tabayyun, shiddiq, maslahah, and tawazun complement one another as principles for using technology responsibly, honestly, critically, beneficially, and in a balanced manner. These values should not remain

abstract ethical principles; they should also inform learning activities and teacher guidance (Al-Attas 1980). (Ibrohim, Aziz & Sahrodi 2026; Mat Yusoff et al. 2026; Ubaidah & Haris 2026)

Taken together, these values encourage students to respect knowledge and the learning process (adab), take responsibility for their use of AI and their work (amanah), and verify information before believing or sharing it (tabayyun), in line with the message of Qur'an 49:6. Shiddiq emphasizes honesty in using AI assistance and in communicating what one genuinely understands. Maslahah encourages the selection of technologies that benefit learning while taking into account risks such as inaccuracy, bias, privacy concerns, and dependency. Tawazun highlights the need to balance technological support with independent thinking, human interaction, and teacher guidance. In practice, students can be asked to compare AI-generated answers with textbooks or trusted sources, explain their own reasoning, and disclose their use of AI in accordance with classroom rules. AI thus becomes a learning aid, not the sole source of truth or a replacement for students' and teachers' responsibilities.

In AI-assisted learning, teachers guide students in using technology critically, ethically, and responsibly. They help students evaluate AI-generated information, encourage them to ask questions and develop their own reasoning, and integrate Islamic pedagogical values into learning activities. AI can therefore support learning without replacing the teacher's role in guiding both knowledge and adab.

An Integrated Conceptual Framework

The literature synthesis leads to a conceptual framework that positions AI not as the ultimate goal of education but as a supporting layer. AI technology provides capabilities used in AI-enhanced learning media, such as generative systems, adaptive systems, intelligent tutors, automated feedback, and interactive learning environments. These capabilities become pedagogically meaningful when embodied in media that offer personalized learning pathways, adaptive assistance, interactive activities, and feedback.

The next layer is cognitive scaffolding. At this layer, AI provides prompts, hints, feedback, alternative explanations, and temporary adaptive support, while students remain responsible for their own reasoning. The cognitive outcomes emphasized in the literature include critical thinking, reasoning, problem-solving, creativity, and metacognition. Student agency and independent learning cut across all components: students must remain active participants rather than passive recipients of AI-generated answers.

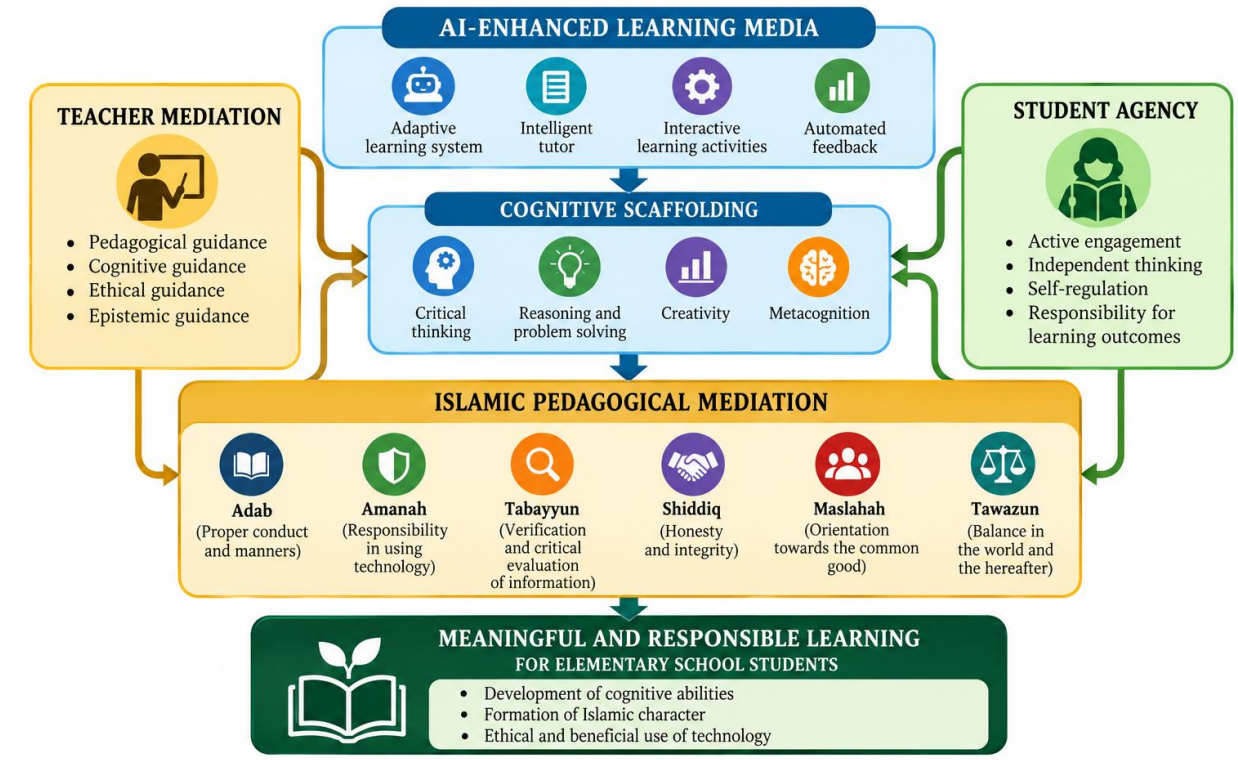


Figure 1. The HITL-IAL conceptual framework integrating AI-enhanced learning media, cognitive scaffolding, student agency, teacher mediation, and Islamic pedagogical values to support meaningful and responsible learning for elementary school students.

Table 1. Core dimensions of the proposed HITL-IAL framework

Dimension	Key Elements	Pedagogical Function
AI-Enhanced Learning Media	Adaptive learning systems, intelligent tutors, interactive learning activities, automated feedback	Provides responsive learning support tailored to students' needs
Cognitive Scaffolding	Critical thinking, reasoning, problem-solving, creativity, and metacognition	Supports productive cognitive effort and deeper understanding
Student Agency	Active engagement, independent thinking, self-regulation, and responsibility for learning outcomes	Keeps students active and responsible participants in their own learning
Teacher Mediation	Pedagogical, cognitive, ethical, and epistemic guidance	Guides AI use, monitors learning, and checks students' understanding
Islamic Pedagogical Mediation	Adab (proper conduct), amanah (responsibility), tabayyun (verification and critical evaluation of information), shiddiq (honesty and integrity), maslahah (orientation toward the common good), and tawazun (balance between worldly life and the hereafter)	Aligns technology use with Islamic ethical values, educational goals, and responsibility in acquiring and using knowledge
Learning Outcomes	Cognitive development, Islamic character formation, and ethical and beneficial technology use	Integrates cognitive development and character formation to support

		meaningful and responsible learning

Discussion

Interpreting the findings through cognitive scaffolding qualifies claims about AI effectiveness. If AI merely supplies answers, students may complete tasks without developing the reasoning processes those tasks are intended to cultivate. Conversely, evidence on adaptive metacognitive scaffolding in elementary programming suggests that timely, personalized support can improve contextual computational thinking and metacognitive regulation (Liu et al. 2026). AI should therefore structure and support productive cognitive effort rather than simply reduce it.

Islamic pedagogy adds a distinctive epistemic and moral layer to the HITL-IAL framework. AI ethics generally emphasizes privacy, transparency, fairness, accountability, and academic integrity (Holmes et al. 2022;. Islamic pedagogy does not replace these principles; rather, it extends them by asking how learners should relate to knowledge, who is responsible for validating knowledge, and how technological assistance should contribute to character formation. Adab, amanah, and tabayyun can therefore serve as complementary principles for responsible AI-supported learning. UNESCO 2023)

Teacher mediation connects these principles with practice. Teachers can decide when AI is appropriate, ask students to attempt a task before seeking assistance, require them to explain their reasoning or verify AI-generated answers, and direct them to authoritative sources when necessary. This is particularly important in Islamic learning because AI-generated religious explanations may be inaccurate or lack context. Recent research on Islamic religious education strongly supports human mediation and source verification and cautions against treating generative AI as a replacement for teachers or recognized religious authorities (Mat Yusoff et al. 2026).

Cognitive support and Islamic pedagogical values should be understood as mutually reinforcing. Tabayyun encourages students to examine evidence, and examining evidence strengthens reasoning and source evaluation. Shiddiq supports honesty when explaining one's thinking, while amanah emphasizes responsibility for the use of assistance. Tawazun reminds learners that education requires independent practice and direct interaction, while maslahah provides a basis for judging whether AI use genuinely benefits children. Islamic values are therefore not merely ethical constraints applied after technology has been adopted; they can inform the design of learning media and activities from the outset.

The proposed Human-in-the-Loop for Islamic AI-Enhanced Learning (HITL-IAL) framework describes a layered relationship: AI technology is embodied in learning media; the media provide cognitive scaffolding; student agency and teacher mediation ensure that the support continues to serve understanding; and Islamic pedagogical values guide the use of knowledge and technology. This relationship is a conceptual proposition derived from the literature synthesis. The HITL-IAL framework has not established causal relationships and requires testing in real learning settings.

The conceptual novelty of this study lies in integration rather than in introducing a new AI technology. The proposed HITL-IAL framework connects AI-based learning media, cognitive scaffolding, student agency, teacher mediation, and Islamic pedagogical values in a

single model for elementary education. This integration responds to the separation between technology-oriented studies, cognitive research, and Islamic educational ethics. The resulting design principle is that AI should help children think, not think in their place.

Conclusion

This literature review indicates that AI-based learning media have the potential to stimulate elementary school students' critical thinking, reasoning, problem-solving, creativity, and metacognition through adaptive support, feedback, and graduated hints. However, these benefits depend on appropriate instructional design. Providing instant answers without active student engagement may foster dependence on AI and reduce opportunities for independent thinking.

From the perspective of Islamic pedagogy, AI use should be guided by adab, amanah, and tabayyun. Adab emphasizes appropriate conduct in the pursuit of knowledge, amanah highlights responsibility in using technology, and tabayyun encourages students to verify the accuracy of AI-generated information. These values should be enacted through age-appropriate learning activities and teacher guidance.

Based on this synthesis, the study proposes the Human-in-the-Loop for Islamic AI-Enhanced Learning (HITL-IAL) framework, which integrates AI as cognitive support, student agency, teacher mediation, and Islamic pedagogical values within a single approach to learning. Within this framework, AI provides learning assistance, while teachers guide the learning process, support information evaluation, and cultivate ethical responsibility. The framework remains conceptual and requires empirical testing in elementary schools. Ultimately, AI should help students think and learn independently without replacing teachers or the formation of adab.

References

Al-Attas, S.M.N. (1980). *The concept of education in Islam: A framework for an Islamic philosophy of education*. Muslim Youth Movement of Malaysia (ABIM).

Almajdoub, Z., Fidalgo, P., Alramamneh, Y., AlHakmani, R. & Kasasbeh, N. (2026). 'Artificial intelligence in Qur'anic education: Pedagogical promise, practical challenges, and ethical concerns'. *Frontiers in Education*, 11, 1876380.

Almasri, F. (2024). 'Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review of empirical research'. *Research in Science Education*, 54, 977–997.

Atias, O. & Mawasi, A. (2025). 'Conceptualizing AI literacies for children and youth: A systematic review on the design of AI literacy educational programs'. *Computers and Education: Artificial Intelligence*, 9, 100491.

Baek, K. & Jeong, S. (2025). 'A Meta-Analysis of the Effectiveness of Artificial Intelligence Education Programs for Elementary School Students'. *Journal of Studies on Schools and Teaching*, 10(2), 99–119.

Bewersdorff, A., Nerdel, C. & Zhai, X. (2025). 'How AI literacy correlates with affective, behavioral, cognitive and contextual variables: A systematic review'. *Computers and Education: Artificial Intelligence*, 9, 100493.

Boulhrir, T. & Hamash, M. (2025). 'Unpacking artificial intelligence in elementary education: A comprehensive thematic analysis systematic review'. *Computers and Education: Artificial Intelligence*, 9, 100442.

Dong, L., Tang, X. & Wang, X. (2025). 'Examining the effect of artificial intelligence in relation to students' academic achievement: A meta-analysis'. *Computers and Education: Artificial Intelligence*, 8, 100400.

Farhood, H., Nyden, M., Beheshti, A. & Muller, S. (2025). 'Artificial intelligence-based personalised learning in education: A systematic literature review'. *Discover Artificial Intelligence*.

Grant, M.J. & Booth, A. (2009). 'A typology of reviews: An analysis of 14 review types and associated methodologies'. *Health Information & Libraries Journal*, 26(2), 91–108.

Han, X., Peng, H. & Liu, M. (2025). 'The impact of GenAI on learning outcomes: A systematic review and meta-analysis of experimental studies'. *Educational Research Review*, 48, 100714.

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Buckingham Shum, S., Santos, O.C., Rodrigo, M.T., Cukurova, M., Bittencourt, I.I. & Koedinger, K.R. (2022). 'Ethics of AI in education: Towards a community-wide framework'. *International Journal of Artificial Intelligence in Education*, 32, 504–526.

Holmes, W. & Tuomi, I. (2022). 'State of the art and practice in AI in education'. *European Journal of Education*, 57(4), 542–570.

Ibrohim, W.M., Aziz, A. & Sahrodi, J. (2026). 'Islamic Ethical Pedagogy for Artificial Intelligence Use: Insights from Islamic Religious Education Teachers in Indonesia'. *Journal of Islamic Education Research*, 7(4), 593–610.

Liu, J., Zhang, Y., Li, W., Wang, Q., Niu, P. & Zhang, X. (2026). 'Adaptive vs. planned metacognitive scaffolding for computational thinking: Evidence from generative AI-supported programming in elementary education'. *Computers and Education*, 241, 105473.

Liu, X. & Zhong, B. (2024). 'A systematic review on how educators teach AI in K-12 education'. *Educational Research Review*, 45, 100642.

Long, D. & Magerko, B. (2020). *What is AI literacy? Competencies and design considerations*. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, vol. 1.

Luckin, R., Holmes, W., Griffiths, M. & Forcier, L.B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson Education.

Mat Yusoff, S., Mohamad Marzaini, A.F., Zynuddin, S.N., Mat Jusoh, A.M., Basal, M.H., Alias, N.R. & Saad, N. (2026). 'Ethical integration of generative artificial intelligence in Islamic religious education involves human mediation and source verification'. *Discover Artificial Intelligence*.

Ng, D.T.K., Leung, J.K.L., Chu, S.K.W. & Qiao, M.S. (2021). 'Conceptualizing AI literacy: An exploratory review'. *Computers and Education: Artificial Intelligence*, 2, 100041.

Snyder, H. (2019). 'Literature review as a research methodology: An overview and guidelines'. *Journal of Business Research*. 104, 333–339.

Su, J., Ng, D.T.K. & Chu, S.K.W. (2023). 'Artificial intelligence (AI) literacy in early childhood education: The challenges and opportunities'. *Computers and Education: Artificial Intelligence*. 4, 100124.

Tagare, D., Karki, T. & Yu, W. (2025). 'K-12 teachers' ethical competencies for AI literacy: Insights from a systematic literature review'. *Computers & Education*, 239, 105435.

Tao, S. (2025). 'Aligning technology with cognitive development: A five-tiered framework to generative AI in K-12 education'. *AI, Brain and Child*. 1, 20.

Tian, Q. & Zheng, X. (2025). 'The impact of artificial intelligence on students' 4C skills: A meta-analysis'. *Educational Research Review*. 49, 100728.

Ubaidah, H.H. & Haris, A. (2026). 'From Ta'lim to Ta'dib: Reorienting Scientific Authority in Islamic Education in the Era of Artificial Intelligence'. *Intiqad: Jurnal Agama dan Pendidikan Islam*. 18(1).

UNESCO. (2021). *AI and education: Guidance for policy-makers*.

UNESCO. (2023). *Guidance for generative AI in education and research*.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*.

Wiese, L.J., Patil, I., Schiff, D.S. & Magana, A.J. (2025). 'AI ethics education: A systematic literature review'. *Computers and Education: Artificial Intelligence*. 8, 100405.

Wood, D., Bruner, J.S. & Ross, G. (1976). 'The role of tutoring in problem solving'. *Journal of Child Psychology and Psychiatry*. 17(2), 89–100.

Yang, W. (2022). 'Artificial intelligence education for young children: Why, what, and how in curriculum design and implementation'. *Computers and Education: Artificial Intelligence*. 3, 100061.

Yeter, I.H. (2024). 'Global initiatives and challenges in integrating artificial intelligence literacy in elementary education: Mapping policies and empirical literature'. *Future in Educational Research*. 2(4), 382–402.

Yim, I.H.Y. & Su, J. (2025). 'Artificial intelligence literacy education in primary schools: A review'. *International Journal of Technology and Design Education*. 35, 2175–2204.