Proceeding The ICON-INSIMA : International Conference Institut Agama Islam KH Sufyan Tsauri Majenang , Cilacap, Indonesia *2026*
ISSN : xxx-xxx; DOI: xx.xxxx

AI Literacy and Ethical Digital Learning in Primary Education: A Framework for Empowering Teachers and Students in the Society 5.0 Era

Slamet Pamuji[1*], Siti Uswatun Hasanah[2]
[12] STKIP Majenang; email: pamujislamet25@gmail.com

* *Corresponding author*

Abstract (10 pt)
Kemunculan era Society 5.0 menuntut transformasi mendasar dalam pendidikan dasar, yaitu menggeser paradigma pedagogis dari konsumsi digital pasif menuju keterlibatan teknologi secara kritis dan kewargaan digital yang beretika. Meskipun teknologi kecerdasan buatan menyajikan peluang besar untuk mempersonalisasi pembelajaran dan mengurangi beban administratif bagi para pendidik, integrasinya ke dalam lingkungan sekolah dasar menghadirkan tantangan krusial terkait bias algoritma, privasi data, serta kerentanan perkembangan siswa usia muda. Artikel ini mengusulkan sebuah kerangka kerja komprehensif berpusat pada manusia yang dirancang untuk menumbuhkan literasi AI dan pembelajaran digital beretika di pendidikan dasar. Berlandaskan sintesis tematik kualitatif dari penelitian terkini dan panduan kebijakan, kerangka kerja ini menetapkan strategi pemberdayaan ganda yang secara bersamaan meningkatkan agensi pedagogis guru dan kesadaran kritis siswa sekolah dasar. Bagi para pendidik, model ini menekankan pada integrasi pedagogis, evaluasi alat digital secara etis, dan perancangan bersama pembelajaran berbantuan AI. Bagi siswa, kerangka kerja ini menanamkan pemikiran komputasional yang sesuai dengan usia, kesadaran privasi data, dan penalaran moral di seluruh mata pelajaran inti melalui Pembelajaran Berbasis Proyek (Project-Based Learning) yang beretika. Pembahasan ini juga mengulas hambatan implementasi sistemik, termasuk kesenjangan digital yang masih bertahan serta praktik pengumpulan data komersial dalam teknologi pendidikan. Pada akhirnya, kerangka kerja ini menegaskan bahwa memupuk literasi AI selama pendidikan anak usia dini merupakan investasi kemasyarakatan yang esensial untuk memastikan bahwa kemajuan teknologi terus mengabdi pada pemberdayaan manusia dan keadilan sosial.

Keywords: Literasi AI, Pembelajaran Digital Beretika, Pendidikan Dasar, Pemberdayaan Guru, Society 5.0

Abstract
The emergence of the Society 5.0 era requires a fundamental transformation in primary education, shifting the pedagogical paradigm from passive digital consumption toward critical technological engagement and ethical digital citizenship. While artificial intelligence technologies present vast opportunities to personalize learning and reduce administrative burdens for educators, their integration into primary school environments poses critical challenges regarding algorithmic bias, data privacy, and the developmental vulnerabilities of young learners. This paper proposes a comprehensive, human-centered framework designed to cultivate AI literacy and ethical digital learning in primary education. Grounded in a qualitative thematic synthesis of contemporary research and policy guidelines, the framework establishes a dual-empowerment strategy that concurrently enhances the pedagogical agency of teachers and the critical awareness of primary students. For educators, the model emphasizes pedagogical integration, ethical tool evaluation, and AI-assisted instructional co-design. For students, it embeds age-appropriate computational thinking, data privacy consciousness, and moral reasoning across core academic subjects through ethical

Project-Based Learning. The discussion addresses systemic implementation hurdles, including the persistent digital divide and commercial data collection practices in educational technology. Ultimately, this framework underscores that fostering AI literacy during early childhood education is an essential societal investment to ensure that technological advancement continues to serve human empowerment and social equity.

***Keywords**: AI Literacy, Ethical Digital Learning, Primary Education, Teacher Empowerment, Society 5.0*

1. Introduction

The Society 5.0 era marks a revolutionary phase in human development, where cyber-physical integration, big data analytics, the Internet of Things, and artificial intelligence converge to address complex societal challenges. Within the educational sector, this paradigm shift transcends simple classroom digitization, requiring a thorough reconsideration of how knowledge is created, evaluated, and transmitted (UNESCO, 2021). Primary education constitutes the foundational stage where foundational cognitive habits, moral reasoning, and socio-emotional competencies are established. Consequently, embedding artificial intelligence literacy and ethical digital learning into primary school curricula has emerged as an urgent imperative rather than an optional pedagogical enhancement (World Economic Forum, 2022).

Although the deployment of artificial intelligence applications offers remarkable educational benefits including personalized learning trajectories, automated diagnostic assessments, and adaptive instructional content (Luckin et al., 2016) its implementation at the primary level introduces complex ethical and developmental dilemmas. Children in primary grades undergo critical stages of cognitive and emotional growth, leaving them particularly vulnerable to the unintended side effects of digital technologies, such as digital dependency, commercial data profiling, and exposure to algorithmic misinformation (Yang, 2022). Concurrently, a substantial proportion of primary school educators experience a pronounced professional confidence gap, characterized by limited technical understanding of artificial intelligence systems and uncertainty regarding how to integrate ethical discussions into daily instruction (Chai et al., 2021).

Conventional digital literacy initiatives in primary schools often overemphasize technical device operation and software usage while neglecting the critical, ethical, and societal dimensions of artificial intelligence (Ng et al., 2021). Without a clear and structured framework, the adoption of artificial intelligence tools in primary education risks reducing educators and students to passive consumers of commercial technologies rather than empowering them as critical, discerning, and ethically responsible digital citizens (Chiu, 2021).

This paper formulates a holistic, multi-dimensional framework for artificial intelligence literacy and ethical digital learning specifically tailored to primary education contexts. The primary objective of this framework is to empower the two principal stakeholders within the primary school ecosystem: teachers as digitally literate pedagogical leaders and primary students as critical, ethical learners capable of navigating the complexities of the Society 5.0 era (Long & Magerko, 2020; Southworth et al., 2023).

2. Method

This study utilizes a qualitative thematic synthesis and conceptual framework analysis methodology to construct the proposed framework for artificial intelligence literacy and ethical digital learning in primary education. Conceptual synthesis is particularly effective for

bridging interdisciplinary domains, integrating insights from educational technology, child development, computer science education, and digital ethics (UNESCO, 2021). The methodology followed three sequential phases: systematic literature retrieval, thematic coding and synthesis, and conceptual framework formulation.

The literature retrieval process involved comprehensive searches across leading academic databases, including Scopus, Web of Science, and Google Scholar, targeting peer-reviewed journal articles, conference proceedings, and policy reports published between 2016 and 2023. Search queries combined keywords such as artificial intelligence literacy, primary education, elementary school, digital ethics, teacher empowerment, and Society 5.0. The inclusion criteria focused on studies addressing foundational artificial intelligence competencies for young learners, pedagogical approaches for teachers, and policy guidelines from international educational organizations (Holmes et al., 2019; Long & Magerko, 2020; UNESCO, 2023).

During the data analysis phase, qualitative thematic coding was applied to categorize recurring findings, pedagogical gaps, and structural requirements for early artificial intelligence education. Extracted data were organized into core thematic dimensions, including teacher professional development needs, age-appropriate student learning objectives, ethical safeguard mechanisms, and institutional governance (Laupichler et al., 2022; Ng et al., 2021).

3. Results and Discussion

The findings of this conceptual synthesis demonstrate that introducing artificial intelligence literacy into primary education demands an approach that is distinct from higher education models. In secondary and tertiary institutions, artificial intelligence instruction frequently concentrates on technical skill acquisition, programming languages, and mathematical algorithm design. In contrast, primary education requires a model centered on intuitive conceptualization, critical questioning, socio-emotional development, and moral reasoning (Long & Magerko, 2020; Ng et al., 2021). The framework establishes that sustainable technological adoption in the Society 5.0 era depends on a dual-empowerment strategy that simultaneously develops teacher pedagogical agency and student critical digital citizenship within a supportive institutional ecosystem.

Regarding teacher empowerment, the results indicate that educators serve as the essential gatekeepers for ethical technology integration in early learning environments. Primary school teachers often express anxiety regarding artificial intelligence, driven by self-efficacy concerns, fears of professional displacement, and legitimate worries about data privacy violations and algorithmic bias (Chai et al., 2021; UNESCO, 2023). The framework directly addresses these challenges by framing artificial intelligence not as an autonomous substitute for human instruction, but as an interactive co-pilot under direct human oversight. When teachers are trained to ethically apply generative artificial intelligence applications, they can streamline routine administrative duties, generate differentiated learning tasks, and adapt instructional content to varying student learning profiles (Luckin et al., 2016). This operational efficiency recovers critical instructional time, allowing educators to focus on human-centric aspects of teaching, such as character building, emotional support, and individual mentoring.

Additionally, teacher empowerment within this framework requires the development of critical software evaluation capabilities. Educators must be equipped with diagnostic tools to evaluate educational applications before introducing them to young learners. This evaluation

includes auditing software for algorithmic transparency, demographic bias, commercial data harvesting practices, and alignment with pedagogical standards (Chiu, 2021; UNESCO, 2021). Empowered educators move beyond passive technology adoption to become active curators who safeguard the digital classroom environment, ensuring that technology serves educational growth rather than commercial interests.

For student empowerment, the research emphasizes the necessity of age-appropriate, inquiry-based learning experiences that foster critical thinking without overwhelming young students with complex computer science theory. Children growing up in the Society 5.0 era live surrounded by artificial intelligence applications, including voice-activated assistants, automated recommendation engines, and adaptive gaming environments (Southworth et al., 2023; Yang, 2022). However, young children frequently form anthropomorphic views, attributing living human characteristics and omniscience to digital systems. The student empowerment pillar resolves these misconceptions through four progressive learning dimensions: conceptual demystification (understanding that machines process data rather than feel or think), critical usage (questioning how outputs are generated), data ethics awareness (recognizing privacy boundaries and digital footprints), and human agency assertion (understanding that humans construct, train, and control artificial intelligence systems) (Kandlhofer et al., 2016; Long & Magerko, 2020).

The practical execution of student-centered artificial intelligence literacy is best realized through cross-disciplinary, ethical Project-Based Learning rather than isolated academic subjects. Rather than creating a standalone subject that further crowds primary school schedules, the framework advocates for embedding ethical artificial intelligence concepts across established curricula (Chiu, 2021; Zhai et al., 2021). For instance, during language lessons, students can analyze story outputs from generative text tools to spot illogical narrative turns or subtle cultural stereotypes. In mathematics and science lessons, students can explore pattern recognition and data classification by training simple machine learning models to sort objects or identify animals. In social studies and civics, structured discussions can address digital fairness, online honesty, and how algorithms influence local communities (Holmes et al., 2019; World Economic Forum, 2022). This cross-disciplinary integration ensures that computational understanding develops alongside moral reasoning and civic awareness.

The discussion also highlights critical systemic barriers that must be resolved to successfully translate this framework into educational policy and practice. The most significant obstacle is the persistent digital divide, which manifests in unequal access to hardware, reliable high-speed internet, and qualified pedagogical support across different regions (OECD, 2021; UNESCO, 2021). Implementing advanced artificial intelligence curricula without correcting these infrastructure gaps risks amplifying existing socio-economic inequalities, creating a disparity where privileged students become critical creators of technology while under-resourced students remain passive consumers.

Furthermore, commercial EdTech practices present ongoing risks to child data privacy and psychological health in early childhood settings. Many digital platforms deploy behavioral tracking mechanisms to maximize user engagement, creating long-term data profiles on minors without transparent parental consent (OECD, 2021; Yang, 2022). Continuous exposure to persuasive algorithmic design can also diminish attention spans, undermine creative confidence, and foster technological dependency during critical windows of child development. Overcoming these risks requires strong institutional governance,

transparent privacy standards, and legislative protections that mandate child data safety in educational environments (UNESCO, 2023).

To guarantee the successful implementation of this framework, a collaborative ecosystem involving government agencies, school administrators, technology developers, and family communities is essential. Policy makers must establish national educational standards that explicitly mandate ethical digital citizenship and artificial intelligence literacy from the primary grades onward (Miao et al., 2021; UNESCO, 2021). Concurrently, technology developers must work with educational researchers to design child-safe, privacy-focused educational tools that prioritize pedagogical value over commercial monetization. School leaders must build a supportive school culture that offers educators continuous professional learning, coaching, and time to experiment with ethical technology integration (Southworth et al., 2023).

Ultimately, the results confirm that embedding artificial intelligence literacy and ethical digital learning in primary education is far more than an incremental technical update to modern schooling. It represents a fundamental realignment of early childhood pedagogy with the societal realities of the Society 5.0 era. By cultivating critical inquiry, ethical reasoning, data privacy awareness, and human agency during the formative primary school years, educational systems can protect young learners from digital harms while empowering them to become active, compassionate, and responsible leaders in a technology-driven global society (Holmes et al., 2019; UNESCO, 2023).

4. Conclusion

Integrating artificial intelligence into primary education within the Society 5.0 era represents a transformative shift that extends far beyond the mere adoption of modern classroom hardware. As intelligent systems increasingly permeate daily life, early childhood and primary education must evolve from teaching basic device usage to cultivating comprehensive AI literacy grounded in critical thinking, human agency, and ethical responsibility (UNESCO, 2023). This study demonstrates that empowering young learners to navigate an algorithmic world requires a balanced, dual-centered framework that simultaneously builds teacher pedagogical agency and student critical digital citizenship (Long & Magerko, 2020).

Teacher empowerment serves as the foundational pillar of this framework. By equipping educators with AI-integrated pedagogical skills and critical tool evaluation frameworks, teachers transform from anxious observers of technological change into confident facilitators and ethical guardians of the learning environment (Luckin et al., 2016). When routine administrative and instructional design tasks are supported by child-safe AI co-pilots, educators regain vital capacity to deliver personalized mentoring, foster socio-emotional development, and model moral reasoning human qualities that no algorithm can replicate (UNESCO, 2021).

Simultaneously, student empowerment must focus on demystifying artificial intelligence through age-appropriate, cross-disciplinary learning experiences. By embedding ethical Project-Based Learning across language, mathematics, science, and civics, primary school students learn to recognize AI as a human-made mathematical tool rather than an infallible, living entity (Yang, 2022). Fostering early awareness of data privacy, algorithmic bias, and human decision-making ensures that young learners develop the cognitive and

moral tools needed to resist passive digital consumption and resist persuasive algorithmic influences (World Economic Forum, 2022).

However, achieving the full potential of this framework requires addressing persistent systemic hurdles, particularly the digital divide and the commercial exploitation of student data. Policy makers, educational leaders, technology developers, and local communities must collaborate to establish strict regulatory safeguards for child data privacy, ensure equitable infrastructure distribution, and fund continuous professional development for teachers (UNESCO, 2021). Without intentional governance and inclusive resource allocation, technological advances in education risk widening existing socio-economic inequalities.

In summary, instilling ethical digital learning and AI literacy during the formative years of primary education is a critical investment in the future of human-centered societies. By prioritizing human agency, ethical reasoning, and critical inquiry over mere technical fluency, educational systems can safeguard young learners against algorithmic risks while empowering both teachers and students to actively shape a technological landscape that serves the common good in the Society 5.0 era (UNESCO, 2023).

References

Chai, C. S., Lin, P. Y., Jong, M. S. Y., Dai, Y., Chiu, T. K., & Qin, J. (2021). Perceptions of Artificial Intelligence (AI) among primary school students. Educational Technology & Society, 24(3).

Chiu, T. K. F. (2021). A holistic approach to the design of Artificial Intelligence (AI) education for K-12 schools. TechTrends, 65(5). https://doi.org/10.1007/s11528-021-00637-1

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Kandlhofer, M., Steinbauer, G., Hirschmugl-Gaisch, S., & Schmuck, C. (2016). Artificial intelligence relevant topics in the school curriculum. Proceedings of the 11th IFIP World Conference on Computers in Education.

Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2022). Artificial intelligence literacy: A systematic review of definitions and competencies. Computers and Education: Artificial Intelligence, 3. https://doi.org/10.1016/j.caeai.2022.100066

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. https://doi.org/10.1145/3313831.3376727

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

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. https://doi.org/10.1016/j.caeai.2021.100041

OECD. (2021). OECD Digital Education Outlook 2021: Pushing the frontiers with AI, blockchain and robots. OECD Publishing. https://doi.org/10.1787/58923021-en

Southworth, J., Pesaro, K., Leiriao, R., Grant, G., & Woltz, A. (2023). Developing a curriculum for AI literacy: Challenges and opportunities in K-12 education. International Journal of Artificial Intelligence in Education, 33(2).

UNESCO. (2021). AI and education: Guidance for policy-makers. United Nations Educational, Scientific and Cultural Organization.

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

World Economic Forum. (2022). Education 4.0: Transforming Learning Environments and Systems for the Future of Work. World Economic Forum.

Yang, W. (2022). Artificial Intelligence education for young children: Why, what, and how in early childhood education. Computers and Education: Artificial Intelligence, 3, 100061. https://doi.org/10.1016/j.caeai.2022.100061

Zhai, X., Chu, X., Wang, C. S., Sim, L., & Li, Y. (2021). A review of Artificial Intelligence in K-12 education: Positioning and roadmap. Computers and Education: Artificial Intelligence, 2, 100038. https://doi.org/10.1016/j.caeai.2021.100038