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AI Literacy as a Foundation for Digital Citizenship in Education

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Abstract

AI is emerging as the defining feature of how people communicate, learn, and engage within online environments, which means that becoming a (digitally) AI literate individual is an essential part of modern education. With digital citizenship evolving past the understanding of digital literacy, the skills to assess, respond to, and use AI technologies responsibly are prerequisites. In this paper, I will discuss AI literacy as a building block of digital citizenship in education and how it can be used to promote ethical awareness, critical thinking, and responsible use of AI-driven systems. It underscores the main skills including awareness of AI capabilities and limitations, artificial intelligence bias, data privacy protection, and ethical choice making skills. In addition, it looks at how to include AI literacy in curricula and in teaching and learning practices to equip students to be informed and responsible in the digital age. The paper reveals how access coverage and policy involvement can initiate equitable access and output of AI literacy with the aim of ensuring equity in digital society participation among inclusive and democratic communities.

Keywords: AI literacy, digital citizenship, education, ethical awareness, data privacy, critical thinking, inclusive learning, algorithmic bias

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Introduction

The modern-day breakneck pace of the development of Artificial Intelligence (AI) has redefined the educational environment and further altered the way students perceive knowledge, technology, and society. Here, digital citizenship, or the capacity to ethically, responsibly, and productively engage in digital spaces, has emerged as a critical element of the 21st-century educational landscape (Lee, 2023; Milenkova and Lendzhova, 2021). Nevertheless, with the adoption of AI-based technologies that are already ubiquitous in the classroom, digital citizenship needs to be considered in the context of AI literacy, which involves the necessary skills, understanding, and mindsets to critically analyze, learn, and effectively interact with AI systems (Yi, 2021; Stolpe and Hallström, 2024).

AI literacy provides a foundation for digital citizenship by enabling learners to critically assess AI's role in shaping digital interactions, fostering ethical awareness, and encouraging responsible decision-making (Hristovska, 2023). For instance, students must learn to recognize algorithmic bias, navigate issues of privacy and data stewardship, and balance the benefits and risks of AI-mediated learning environments (Yingsoon et al., 2025; Pu et al., 2024). Without such competencies, the promise of digital citizenship risks being undermined by technological dependency, misinformation, and unequal access to AI-driven opportunities.

Science has highlighted the increasing need to integrate AI literacy in education to enable learners to learn how to operate effectively in an AI society. This integration is especially important to develop the transversal competencies in social-emotional skills, critical thinking, and moral reasoning that enhance awareness in being informed about participating in digital life (Licardo and Lipovec, 2024; Valenzuela, 2025). Research findings indicate that AI literacy training improves not only technical knowledge and skills but also students' capacity to approach wider social and cultural challenges related to becoming a digital citizen (김진석 & 장은숙, 2020; Oliveira et al., 2024).

Moreover, the concept of AI literacy is becoming associated with socio-environmentally conscientious and inclusive approaches to digital citizenship, since AI literacy enables learning individuals to engage in new socio-technical frameworks and actions responsible (Al Yakin et al., 2024). In the context of Society 5.0, at best, AI literacy is placed as the facilitator of fostering ethical interaction, socially responsible behavior, and sustainable innovation (Tariq and Sergio, 2025). Correspondingly, in their view, the interested scholars assert that fostering AI literacy plays a crucial role in reducing digital inequalities, as it must allow all learners to enjoy the advantages of AI, rather than exclusively technologically advantaged groups such as (Salopecki et al., 2017).

The expanding discourse of digital literacy also supports the importance of AI literacy as a subset and expansion of ample digital literacy (Ding, Chen, and Lu, 2023; Kim, 2024). Compared to the traditional digital literacy, which involves the capacity to access and use digital platforms, manage information, AI literacy brings in a requalitative dynamic to digital space knowledge and decision making, as well as identity (Milenkova and Lendzhova, 2021; Yi, 2021). Such a direction raises the urgency with which students need to be prepared for having the necessary digital competence, as well as with a critical awakening and an ethical underpinning as an effective digital citizen.

Taken together, these perspectives position AI literacy as an essential foundation for digital citizenship in contemporary education. By fostering awareness of AI's potentials and limitations, promoting ethical decision-making, and ensuring equitable participation, AI literacy empowers learners to navigate the digital world responsibly and inclusively. This paper argues that

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Table 1: Relationship Between AI Literacy and Dimensions of Digital Citizenship

Dimension of Digital Citizenship	AI Literacy Competencies	Educational Implications	Key References
Ethical Responsibility	Understanding AI ethics, bias, transparency	Embedding ethical AI case studies in curricula	Hristovska (2023); Yingsoon et al. (2025); Valenzuela (2025)
Digital Rights & Privacy	Knowledge of data protection, algorithmic accountability	Teaching privacy laws, GDPR/AI Act basics	Lyons et al. (2019); Pu et al. (2024)
Civic Engagement	Using AI responsibly in democratic participation	Encouraging debate on AI's role in governance	Lee (2023); Tariq & Sergio (2025)
Critical Thinking & Media Literacy	Identifying misinformation, recognizing deepfakes	Integrating AI/media literacy in subjects	Oliveira et al. (2024); Ding et al. (2023)
Equity & Inclusion	Addressing AI accessibility gaps	Ensuring equitable access to AI tools in schools	Milenkova & Lendzhova (2021); 김진석 & 장은숙 (2020)
Lifelong Learning & Adaptability	Continuous upskilling in AI competencies	Embedding AI literacy across all education levels	Kang (2022); Licardo & Lipovec (2024)

embedding AI literacy within educational systems is not optional but imperative for preparing future generations as informed, responsible, and empowered digital citizens.

Conceptual Framework

The integration of AI literacy into education represents a fundamental shift in how digital citizenship is understood and enacted in contemporary societies. Digital citizenship is no longer limited to basic digital literacy and responsible online behavior, but increasingly involves the capacity to understand, evaluate, and engage with AI-driven technologies that shape decision-making, social interactions, and learning processes (Lee, 2023; Milenkova & Lendzhova, 2021).

Defining AI Literacy in the Context of Digital Citizenship

AI literacy can be defined as the ability to understand AI concepts, critically evaluate AI applications, and use AI responsibly and ethically (Yi, 2021; Stolpe & Hallström, 2024). This includes both technical awareness (how AI works) and socio-ethical awareness (how AI affects individuals and societies). Unlike traditional digital literacy, AI literacy emphasizes algorithmic awareness, data stewardship, and the ethical implications of human-AI interactions (Pu et al., 2024; Oliveira et al., 2024).

Linking AI Literacy to Digital Citizenship

Digital citizenship involves responsible participation in digital societies, emphasizing values such as equity, inclusivity, and ethical engagement (Hristovska, 2023; Kim, 2024). AI literacy enhances digital citizenship by equipping learners to:

- Recognize and challenge algorithmic bias and misinformation.
- Safeguard data privacy and digital rights.
- Engage in ethical decision-making in AI-mediated environments.
- Develop critical thinking and adaptability in a world shaped by automation and computational intelligence (Valenzuela, 2025; Tariq & Sergio, 2025).

Thus, AI literacy is not an isolated competency but a core foundation that strengthens the practice of digital citizenship in the age of AI.

Educational Implications

Integrating AI literacy into educational frameworks supports learners in becoming responsible digital citizens who can critically navigate technological systems while upholding democratic values. This requires designing curricula that combine technical AI skills with media literacy, ethical reasoning, and social-emotional competencies (Licardo & Lipovec, 2024; Kang, 2022)

Synthesis

The conceptual framework shows that AI literacy is intertwined with every dimension of digital citizenship, from ethical responsibility and civic participation to equity and lifelong learning. By embedding

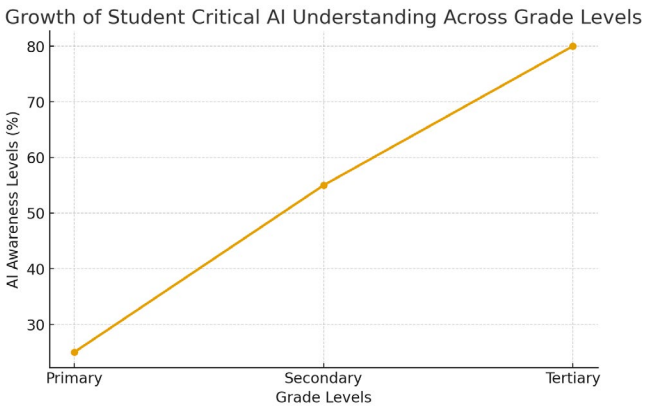

Fig 1: The line chart comparing student critical AI understanding across primary, secondary, and tertiary levels.

Table 2: AI Literacy Skills and Competencies for Responsible Digital Citizenship

AI Literacy Skill	Corresponding Competency
Critical Understanding	Ability to analyze AI systems, question outputs, and recognize biases or limitations.
Ethics	Awareness of fairness, accountability, and transparency in AI use and decision-making.
Privacy & Security	Competence in protecting personal data, managing digital footprints, and ensuring safety.
Social-Emotional Awareness	Skill in using AI responsibly in communication, showing empathy, and reducing harm online.

AI literacy into education, learners are not only equipped with technological competencies but also guided to become ethical, critical, and responsible digital citizens in an AI-mediated society (Al Yakin et al., 2024; Yingsoon et al., 2025).

AI Literacy Skills for Students

The integration of Artificial Intelligence (AI) in education requires students to develop specific literacy skills that enable them to engage responsibly and critically with AI-driven systems. These skills are foundational to preparing learners for digital citizenship, where ethical, informed, and participatory engagement in digital spaces is paramount (Hristovska, 2023; Lee, 2023). AI literacy, therefore, is not only technical but also ethical, social, and critical in nature.

Critical Understanding of AI Systems

Students need to comprehend the capabilities, limitations, and biases inherent in AI technologies. This involves distinguishing between what AI can and cannot do, understanding how algorithms process data, and recognizing potential biases in decision-making systems (Stolpe & Hallström, 2024; Yi, 2021). Such critical awareness fosters informed digital citizenship by equipping learners to challenge misinformation and avoid blind reliance on AI outputs (Pu et al., 2024).

Ethical Awareness and Responsible Use

AI literacy must extend to the ethical domain, where students understand issues of algorithmic bias, fairness, and inclusivity. Learners should be able to evaluate the ethical implications of AI use in areas such as assessment, surveillance, and content recommendation systems (Yingsoon et al., 2025; Valenzuela, 2025). By embedding ethical reasoning into AI literacy, students develop the capacity to make responsible choices that align with democratic values and digital rights (Tariq & Sergio, 2025).

Data Privacy, Security, and Digital Rights

Understanding data flows, consent, and digital footprints is central to AI literacy. Students should be able to identify risks associated with personal data misuse and practice strategies to safeguard their privacy (Al Yakin et al., 2024; Lyons et al., 2019). Such awareness strengthens their role as digital citizens by ensuring active participation in protecting individual rights and advocating for secure and transparent digital ecosystems (Milenkova & Lendzhova, 2021).

Social and Emotional Intelligence in AI Contexts

AI literacy also intersects with socio-emotional competencies, where students develop empathy and adaptability in interacting with AI systems and peers in digitally mediated environments (Licardo & Lipovec, 2024). By promoting awareness of human-AI interaction and emotional responses, students become better prepared to use AI in ways that reinforce inclusion, respect, and equity in digital learning environments (Oliveira et al., 2024).

Lifelong Learning and Self-Regulated Engagement with AI

In an era of rapidly evolving technologies, AI literacy requires a mindset of continuous learning. Students should be equipped with metacognitive strategies to self-regulate their learning, adapt to new AI tools, and critically reflect on their use (김진석 & 장은숙, 2020; Kang, 2022). This competency supports not only academic growth but also professional resilience and informed participation in society 5.0 (Tariq & Sergio, 2025).

Educational Strategies

The integration of AI literacy into education is critical for cultivating responsible digital citizens who can engage ethically and effectively in technology-driven environments. Educational strategies must

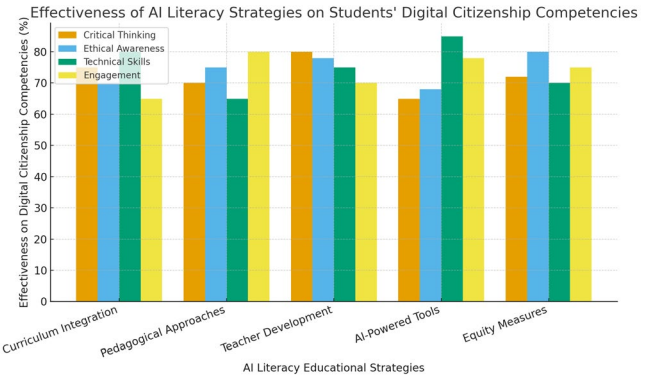

Fig 2: The bar chart comparing the effectiveness of different AI literacy educational strategies on improving students' digital citizenship competencies.

Table 3: Summary of Key Educational Strategies for AI Literacy and their Expected Outcomes

Strategy	Description	Expected Outcomes	Supporting References
Curriculum Integration	Embedding AI skills and ethics into core subjects	Technical skills, ethical awareness	Pu et al. (2024); 김진석 & 장은숙 (2020)
Pedagogical Approaches	Inquiry-based, project-based, and cross-disciplinary learning models	Critical thinking, resilience to misinformation	Oliveira et al. (2024); Milenkova & Lendzhova (2021)
Teacher Professional Development	Training programs with hands-on AI applications and ethical frameworks	Teacher confidence, improved student guidance	Kang (2022); Lee (2023)
AI-Powered Tools	Use of adaptive platforms, AI tutoring, and gamification for awareness	Engagement, deeper understanding of AI systems	Valenzuela (2025); Yingsoon et al. (2025)
Equity and Accessibility	Providing low-cost, inclusive, multilingual AI literacy resources	Inclusive participation, reduced digital divides	Lyons et al. (2019); Hristovska (2023)
Policy and Institutional Support	Establishing AI ethics frameworks, evaluation metrics, and institutional backing	Sustainability, measurable impact on digital citizenship	Tariq & Sergio (2025); Kim (2024)

address curricular design, pedagogical approaches, teacher professional development, and equitable access, ensuring that AI literacy is not just an add-on but a core competency within digital citizenship education (Yi, 2021; Lyons et al., 2019).

Integrating AI Literacy into Curricula

Embedding AI literacy into school curricula allows students to build fundamental knowledge about how AI systems function, their limitations, and their societal impact. Research emphasizes that curriculum design should cover technical skills (basic coding, data interpretation), ethical competencies (awareness of algorithmic bias and privacy), and critical thinking (evaluating AI-generated information) (Pu et al., 2024; Stolpe & Hallström, 2024). For instance, models developed for primary education demonstrate that AI literacy can enhance global digital citizenship by equipping learners with the ability to navigate diverse cultural and technological contexts (김진석 & 장은숙, 2020).

Pedagogical Approaches and Learning Models

Pedagogical strategies for AI literacy education should emphasize active learning, inquiry-based approaches, and cross-disciplinary integration. According to Oliveira et al. (2024), combining AI with media literacy frameworks enables learners to critically analyze AI-driven information ecosystems while fostering resilience against misinformation. Similarly, project-based learning encourages students to engage with real-world AI applications, promoting both technical proficiency and ethical reasoning (Milenkova & Lendzhova, 2021). Integrating social-emotional learning alongside AI literacy also helps students develop empathy and responsible decision-making, aligning with broader goals of digital citizenship (Licardo & Lipovec, 2024).

Teacher Professional Development

Teachers play a central role in advancing AI literacy. Training programs should enhance educators' own understanding of AI while equipping them with resources to teach students effectively. Kang (2022) highlights that professional development must move beyond basic digital literacy, incorporating hands-on AI applications and ethical frameworks to prepare teachers for rapidly evolving digital classrooms. Lee (2023) also emphasizes the role of teachers as facilitators of critical discourse on digital citizenship, particularly in K-12 education contexts where early habits of responsible technology use are formed.

Leveraging AI-Powered Tools for Awareness

AI-powered tools themselves can be integrated into learning to demystify AI systems. Adaptive learning platforms, AI-driven tutoring systems, and gamified applications provide students with direct interaction with AI technologies while simultaneously raising awareness of their functioning and limitations (Valenzuela, 2025; Yingsoon et al., 2025). This approach transforms AI from an abstract

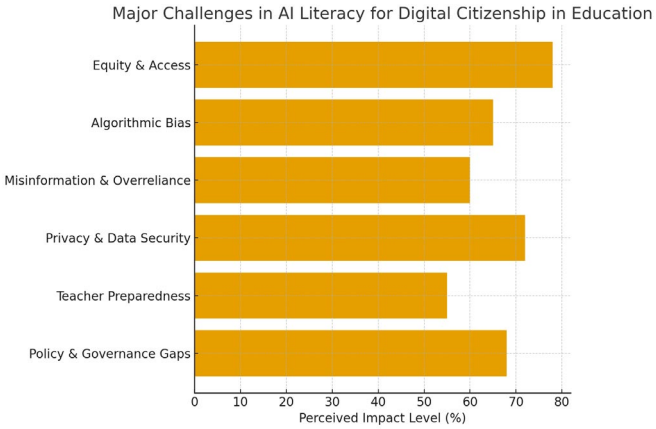

Fig 3: The graph shows the major challenges in AI literacy for digital citizenship and a table summarizing them.

concept into a tangible learning companion, making students not just users but critical evaluators of technology (Al Yakin et al., 2024).

Ensuring Equity and Accessibility

A critical element of AI literacy strategies is ensuring equitable access. Without targeted interventions, marginalized groups risk being left behind, exacerbating existing digital divides (Lyons et al., 2019; Milenkova & Lendzhova, 2021). Strategies must therefore include low-cost AI literacy resources, multilingual learning materials, and community-based programs. This not only democratizes AI literacy but also strengthens inclusive digital citizenship, where all learners regardless of background can participate meaningfully in AI-driven societies (Hristovska, 2023).

Policy and Institutional Support

Finally, the successful integration of AI literacy into education requires robust policy support and institutional commitment. Policymakers must establish frameworks for AI ethics in education while supporting research and innovation in AI-based learning models (Tariq & Sergio, 2025; Kim, 2024). Institutions should also adopt evaluation metrics to track how AI literacy initiatives impact student outcomes, digital citizenship behaviors, and long-term social engagement.

Challenges and Considerations

Despite the promise of AI literacy as a foundation for digital citizenship, several challenges complicate its implementation in education.

Equity and Access

Access to AI-driven tools and digital literacy programs remains uneven across socioeconomic groups, creating a risk of widening the digital divide. Learners in under-resourced contexts may face barriers to acquiring AI literacy skills, leading to unequal participation in digital citizenship (Lyons et al., 2019; Milenkova & Lendzhova, 2021).

Algorithmic Bias and Fairnes

AI systems often reproduce existing biases, and without proper literacy, students may accept algorithmic outputs as neutral truths. This challenge calls for integrating critical perspectives into AI literacy programs to help learners identify and question biases (Hristovska, 2023; Stolpe & Hallström, 2024).

Misinformation and Overreliance on AI

Overdependence on AI tools risks diminishing critical thinking and discernment, while the rapid spread of AI-generated misinformation threatens informed digital citizenship (Valenzuela, 2025; Oliveira et al., 2024).

Privacy and Data Security

The widespread use of AI in education raises ethical and legal concerns around personal data. Students need to develop competencies in protecting their privacy and understanding how their data is collected and used (Yingsoon et al., 2025; Ding, Chen & Lu, 2023).

Teacher Preparedness

Many educators lack the training to teach AI literacy effectively. Without sufficient professional development, teachers may struggle to integrate AI into digital citizenship curricula (김진석 & 장은숙, 2020; Kang, 2022).

Policy and Governance Gaps

Policies on AI integration into education are often fragmented or underdeveloped, leaving schools without clear guidelines to address ethical, pedagogical, and technical considerations (Lee, 2023; Kim, 2024).

Implications for Future Education

The integration of AI literacy as a foundation for digital citizenship carries profound implications for the future of education. As educational systems adapt to AI-driven transformations, the role of schools, teachers, and policymakers will extend beyond traditional teaching to cultivating responsible, ethical, and critically informed digital citizens.

First, AI literacy should be integrated into curricula to accomplish educating the responsible use of AI systems. That includes competencies related to learning how AI works, identifying biases, managing privacy concerns, and making moral choices (Yi,

Table 4: Challenges and Considerations in AI Literacy for Digital Citizenship

Challenge	Description
Equity & Access	Uneven distribution of AI tools and resources among learners
Algorithmic Bias	Risk of reproducing systemic biases through AI systems
Misinformation & Overreliance	Spread of AI-generated misinformation and reduced critical thinking
Privacy & Data Security	Concerns around data use, consent, and protection
Teacher Preparedness	Lack of training for educators to teach AI literacy effectively
Policy & Governance Gaps	Absence of comprehensive policies guiding AI literacy in education

Table 5: Key Implications of AI Literacy for Future Education and Digital Citizenship

Domain	Implications	Supporting Sources
Curriculum Innovation	Integration of AI literacy across subjects to strengthen critical thinking, ethics, and responsible digital engagement.	Yi (2021); Hristovska (2023); Valenzuela (2025)
Equity and Access	Ensuring inclusive access to AI education to prevent widening digital divides.	Lyons et al. (2019); Milenkova & Lendzhova (2021)
Teacher Role	Transitioning teachers into facilitators of AI ethics and responsible citizenship while leveraging AI for adaptive learning.	김진석 & 장은숙 (2020); Lee (2023)
Policy Development	Creating national and institutional policies for curriculum design, teacher training, and ethical AI use in education.	Kang (2022); Kim (2024); Tariq & Sergio (2025)
Lifelong Learning	Extending AI literacy education beyond formal schooling to adult learning and professional training.	Licardo & Lipovec (2024); Pu et al. (2024); Al Yakin et al. (2024)
Global Citizenship	Promoting ethical decision-making, sustainability, and participation in Society 5.0 contexts.	Yingsoon et al. (2025); Valenzuela (2025)

2021; Hristovska, 2023). These skills will no longer be optional, as algorithmic decision-making continues to enter daily student and professional life.

Second, AI literacy in relation to digital citizenship suggests that educational institutions should encourage favorable access to AI education. In the absence of equal opportunities the online divide can deepen, leading to more knowledge, participation, and employability disparities (Lyons et al., 2019; Milenkova and Lendzhova, 2021). Inclusion involving gender, socioeconomic status, and regional differences will be very important.

Third, education of the future will be a hybrid system relying on AI-based personalised and adaptive learning but maintain humanized learning styles. Educators will be the facilitators between technology and students toward a directive to critical and ethical interaction (김진석 & 장은숙, 2020; Lee, 2023). This duality reinforces learning outcomes as well as democratic participation.

Fourth, policy writing plays a key role in anchoring AI literacy in multiple contexts of digital citizenship. Curriculum standards, teacher training, ethical considerations, and long-term tracking of the educational effect of AI will require national and institutional solutions (Kang and Kim 2022). Unambiguous principles make AI literacy not just technical capability but also about moral sensitivity, civic duty, and world citizenship (Tariq and Sergio, 2025).

Lastly, since AI literacy crosses into lifelong learning, education should evolve beyond the K-12 and College institution environment. Adult and professional programs will be required to support a continuous upskilling in the era of new technologically-advanced AI-based solutions (Licardo and Lipovec, 2024; Pu et al., 2024). This vision aligns with the broader goals of Society 5.0, where humans and AI co-create knowledge for sustainable and inclusive futures (Al Yakin et al., 2024).

Synthesis

In essence, the future of education lies in balancing technological adoption with human-centered values. AI literacy equips learners with the critical, ethical, and adaptive skills necessary to thrive as responsible digital citizens in a world where AI increasingly mediates social, educational, and professional domains. By embedding AI literacy into curricula, fostering inclusive access, and aligning with lifelong learning goals, education can move toward a model that is both technologically advanced and ethically grounded (Oliveira et al., 2024; Stolpe & Hallström, 2024; Valenzuela, 2025).

Conclusion

The claim of integrating Artificial Intelligence (AI) literacy as the basis of digital citizenship in education not only highlights the urgent need to ensure learners are ready to engage in AI-mediated societies but also justifies such education. Digital citizenship is expanding upon classic concepts of online safety and etiquette, extending to include ethical interaction with intelligent systems, understanding of critical data, and making informed decisions in intricate digital contexts (Hristovska, 2023; Lee, 2023). AI literacy will prepare students with the ability to engage with AI-based tools critically, identify algorithm biases, navigate the social and moral aspects of automated decision-making, and be responsible and active as digital citizens (Yi, 2021; Valenzuela, 2025).

Studies have also demonstrated that AI literacy encourages the multidimensional nature of digital literacy, such as critical thinking, ethical responsibility, and media literacy (Lyons et al., 2019; Ding, Chen, and Lu, 2023). It also fosters inclusivity by providing learners with different backgrounds with non-discriminatory chances to interact with and utilize AI technologies (Milenkova and Lendzhova, 2021). At least in this meaning, AI literacy can be understood as a democratic facilitator, one that does not only enables students to view and consume digital knowledge systems but also challenges and participates in their co-creation (Kim, 2024; Oliveira et al., 2024).

Pedagogical paradigms highlight interdisciplinary methodology use to introduce AI literacy through ethics, critical, and problem-solving alongside digital skills (김진석 & 장은wook, 2020; Licardo and Lipovec, 2024). The role of educators is important to assist learners in establishing a necessary balance between technical expertise and human values that are instrumental to self-managed learning and social-emotional cognizance in unison with technological proficiency (Pu et al., 2024; Stolpe and Hallström, 2024). Additionally, teacher professional development and

institutional policies are critical to continue to support systemic actions that simultaneously foster AI awareness in digital citizenship (Kang, 2022; Al Yakin et al., 2024).

Between the larger frames of reference, AI literacy enhances the thrust into more multicultural socio-technical conditions, i. e. those projected in the Society 5.0 rhetoric, where digital citizens will play an active role in the creation of new ethical and sustainable futures (Tariq and Sergio, 2025; Yingsoon et al., 2025). This involves technical expertise, but an ecological and morally inclined approach which grants the long-term perspective of society. Education systems will be able to develop innovators and responsible adults by enabling these skills in learning environments.

To conclude, AI literacy does not represent an extra feature of digital education but is more of a requirement to raise responsible, fair, and active citizens of the digital age. With sophisticated educational approaches, equity-oriented measures, and a careful approach to AI technologies, educational establishments and schools can equip students to be morally- and ethically-responsible members of AI-driven settings. This understanding is all-encompassing and thereby renders ensuring digital citizenship in AI times as not simply characterized and determined by the plurality of technological capability, but rather as an implausible, long standing communication by actively engaging and inquiring.

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