AI Literacy in PK-12 Education



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This brief is part of a set sharing specific AI literacy recommendations for various audiences in education. *Return to the executive summary.*

For the purpose of this work:

AI literacy is a set of foundational skills and competencies that enable individuals to understand how AI works, responsibly evaluate AI systems, and use AI effectively as a human-centered tool across various contexts, including learning, work, and civic applications, while adapting to its ongoing evolution.

Note. The language used to define AI literacy is adapted from AI Learning Priorities for All K-12 Students (CSTA & AI4K12, 2025), Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education (OECD, 2025), The Blueprint for Action: Comprehensive AI Literacy for All (EDSAFE AI Alliance et al., 2025), AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology (Mills et al., 2024), and "What Is AI Literacy? Competencies and Design Considerations" (Long & Magerko, 2020).

The field of AI in education is rapidly evolving, with new research and resources emerging regularly. While this brief aims to provide comprehensive and current information, it may not capture every recent advancement or publication in this dynamic landscape. We recommend treating this as a foundational resource while staying informed about ongoing developments in the field.

Overview

AI literacy implementation has gained widespread support at the national, state, and local levels, with momentum building across both computer science courses and through interdisciplinary integrations. As reflected in Appendix A, the demand for AI literacy has developed rapidly over the last several years. The growing recognition of its importance has prompted bipartisan legislative action, including the 2023 Senate AI Insight Forum on Transparency, Explainability, IP, and Copyright and the 2025 "From Chalkboards to Chatbots: The Impact of AI on K-12 Education" hearing. In July 2025, the U.S. Department of Education issued guidance on AI use in schools, articulating principles of responsible use. The development of AI literacy policies across national, state, and local levels reflects the need for systematic approaches to better prepare citizens for an AI-integrated society. Without this, AI efforts risk being fragmented and reactive and will lead to students either missing out on key opportunities with AI or experiencing AI that interferes with their learning. Systems-level AI literacy must be treated as a foundational capability that supports coherent implementation across schools and districts. It enables leadership to make informed decisions on procurement, equity, infrastructure, data privacy, and the responsible use of AI in education.

Such systematic approaches need to be both comprehensive and inclusive. An essential part of developing AI literacy broadly is ensuring that everyone has access to AI systems and tools, as well as opportunities to learn with and from them. Federal laws, rules, and regulations such as the Americans with Disabilities Act (ADA), the Individuals with Disabilities Education Act (IDEA), and the 21st Century Assistive Technology (AT) Act require that services and programs include accessible options for people with disabilities. The Web Content Accessibility Guidelines (WCAG) set standards for improving accessibility, and the Universal Design for Learning (UDL) framework establishes accessibility as an evidence-based practice for creating effective learning experiences. Beyond compliance, true accessibility in AI means designing systems that work for educators and learners with diverse abilities, providing multiple modes of interaction and representation, and maintaining humans in the loop throughout the process.

To support educational leaders and policymakers in developing AI literacy policies and pathways, this brief provides guidance to make progress in the PK-12 education setting. We recommend a flexible, multi-level approach as it reflects the need for AI literacy guidance to be adaptable across learning contexts and environments, rather than prescribing specific tools or methods. While frameworks can provide essential guidance, successful implementations require adaptation to local contexts, resources, and community needs, with particular attention to addressing the gaps between learner and educator adoption, institutional readiness, and family buy-in, and involvement.

There is no one-size-fits-all approach to address the needs of PK-12 educators and learners. While we can't scale answers due to the complexities and demands of local contexts, we can scale questions to initiate productive conversations in school communities. We can identify the prerequisites of school and district-level policy guidance and infrastructure, along with professional learning for educators, to ensure effective implementation and learner success.

AI Literacy for Educators and Educational Leaders

Gaps	Recommendations
Varying institutional readiness, including policies, infrastructure, and funding for equitable AI integration	Ensure equitable access through strategic resource allocation. Co-create contextualized AI literacy policies and frameworks.
Inconsistent AI knowledge, comfort levels, and acceptance among educational leaders and educators	Establish educator support systems, including targeted professional learning opportunities.
Lack of high-quality, evidence-based professional learning and curricular resources for AI literacy implementation and effectiveness	Use evidence-backed curricula and instructional materials.

In a recent survey, 92% of superintendents agreed that AI will change the way we educate within the next five years. Yet, educational leaders often lack the foundational AI knowledge necessary to make informed decisions on procurement, equity, infrastructure, data privacy, and the responsible integration of AI in education. This knowledge gap is evident in institutional responses, where 57% of districts have integrated such guidelines into board-approved policies, while 43% continue to operate without formal guidance. District adoption rates reflect a gradual acceptance, with an increasing number of districts, from 22% in 2024 to 30% in 2025, reporting that their districts are embracing generative AI. Additionally, infrastructure development remains a critical gap. A 2025 SETDA (State Educational Technology Directors Association) report underscores the importance of directing resources toward infrastructure initiatives, noting that while 92% of school districts have used Elementary and Secondary School Emergency Relief (ESSER) funds for educational technology, only 27% of states have established plans to sustain long-term funding for these efforts.

At the same time, educator attitudes toward AI-enabled systems and tools remain varied, with some remaining hesitant while others are already integrating AI into their work. Educator resistance to AI adoption increases at higher grade levels, with educators of older students expressing greater concerns, suggesting the need for grade and subject-specific professional development that addresses unique pedagogical challenges across various grade bands. Equipping educators with foundational AI literacy skills that develop their ability to understand, use, monitor, and critically reflect on their use of AI systems and tools needs to go hand in hand with helping experienced teachers enhance their technological, pedagogical, and content knowledge while integrating AI. Educators also need to be prepared to help students understand how AI is designed and trained — not to become engineers, but to grasp how data and design choices affect fairness, transparency, and outcomes.

The development of educator AI literacy must therefore integrate direct instruction, tool

exploration, and case-based discussions and should be tailored to various grade levels and subject areas to facilitate intentional integration. This need presents an opportunity to engage the public and private sectors, higher education institutions, teacher preparation programs, and state and local education agencies in creating sustained capacity-building systems. Drawing inspiration from successful models like 100Kin10, where 28 organizations took up the charge to prepare 100,000 STEM teachers in ten years, effective partnerships require dedicated research components to evaluate and improve professional learning offerings continuously.

AI Skills and Competencies For Educators and Educational Leaders

To lead and adapt in the age of AI, educators must develop skills and competencies across multiple interconnected areas while maintaining their focus on educational goals and learner well-being. Educational leaders need to have the necessary skills and competencies to understand and implement successful AI literacy policies. Existing frameworks for educators emphasize the need to develop AI skills within a foundation of trust and safety, where educators feel supported in acknowledging their limitations while continually building competence. These skills are unique from the skills that learners need to develop, as educators also need to learn about appropriate use of AI systems and tools to do administrative work. While all of these skills are essential, educators and leaders should prioritize which competencies to develop depending on contexts such as grade level, subject taught, and community needs. Key skills include:

Table 1. Educator and education leader AI skills and competencies

Domain	AI Skills and Competencies
Technical Knowledge	• Understand how AI systems work, including datasets, algorithms, machine learning, and data processing fundamentals. • Recognize different types of AI applications and their underlying technologies. • Identify the role of data in training and operating AI systems.
Analytical Skills	• Evaluate new AI resources for pedagogical value and age-appropriateness. • Distinguish between AI capabilities and limitations in various applications. • Determine when AI use is appropriate and not appropriate both for self and learners.

Domain	AI Skills and Competencies
Interpersonal and Communication Skills	• Apply information literacy skills to AI-generated outputs. • Adapt media literacy strategies for AI-integrated outputs. • Identify AI-generated versus human-created content. • Navigate information ecosystems that include AI-mediated content. • Assess AI tools for their appropriateness and effectiveness in specific contexts.
Ethical Awareness	• Evaluate the quality, credibility, and bias of AI-generated content. • Question AI-generated recommendations and verify outputs against reliable sources. • Understand the social impacts and ethical dilemmas posed by AI systems. • Recognize the environmental impacts of AI development and deployment. • Apply data privacy and security principles when using AI tools.
Adaptive Skills	• Model continuous learning and adaptability for students in an AI-integrated world. • Integrate AI learning into existing professional development so the learning stays manageable and relevant. • Adapt instructional practices as AI technologies transform educational environments. • Respond to shifting district policies and guidelines for AI use in schools. • Balance AI assistance with human skill development and critical thinking.
Practical Implementation	• Maintain appropriate oversight of AI processes and outputs • Maintain and enhance learner agency. • Design high-quality, authentic learning experiences that incorporate AI literacy. • Integrate AI literacy across grade levels and subject areas (primarily for educational leaders). • Identify when AI use is not appropriate for specific tasks • Model responsible AI use for learners. • Develop pedagogical strategies that leverage AI while preserving learning objectives.

Sources: AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology (Mills et al., 2024), K–12 Generative AI Readiness Checklist (Council of the Great City Schools & CoSN, 2023), AI Competency Framework for Teachers (UNESCO, 2024), and Guidance on the Future of Computer Science Education in an Age of AI (TeachAI & CSTA, 2025).

Gaps in AI Literacy for Educators

Significant barriers continue to limit widespread adoption of AI literacy education across learning settings. Even when individual educators possess the necessary competencies for AI integration, systemic barriers at the institutional and policy levels often prevent effective implementation. The current conversation around AI in education is too narrowly focused on the classroom level. While professional learning around AI skills and competencies is important, it is also essential to prioritize systems-level change, including the district-level integration of AI and AI literacy policies into existing policies and building the necessary infrastructure for successful implementation.

Key Gaps Include

- Varying institutional readiness, including policies, infrastructure, and funding for equitable AI integration
- Inconsistent AI knowledge, comfort levels, and acceptance among educational leaders and educators
- Lack of high-quality, evidence-based professional learning and curricular resources for AI literacy implementation and effectiveness

Varying institutional readiness, including policies, infrastructure, and funding for equitable AI integration

Many institutions report being unprepared to support the use of AI among learners, faculty, and staff. Insufficient guidance, in the form of training and support infrastructure, remains a primary obstacle to effective AI literacy integration. Fairness concerns further complicate implementation efforts, as the cost associated with AI tools creates significant challenges for ensuring equitable access across all learners, educators, and staff, with institutions struggling to identify best practices for managing these expenses.

Educators face substantial challenges in accessing appropriate content and materials for AI literacy instruction. The limited availability of discipline-specific resources creates barriers to tailoring AI literacy across various educational levels and academic fields. Insufficient guidance makes it challenging for educators to establish effective course policies that balance learner needs with the availability of emerging technology supports. With the rapid evolution of AI technologies, educational leaders are increasingly reporting edtech fatigue, driven by intensified vendor marketing and insufficient evidence regarding the effectiveness of available tools. The incorporation of cultural diversity and multicultural perspectives in AI literacy development remains limited, despite the critical need for inclusive approaches that effectively cultivate these skills among diverse populations. These systemic barriers underscore the need for comprehensive institutional strategies that address both technical infrastructure, which includes broadband access, and the human capacity development necessary for successful AI literacy integration.

Inconsistent AI knowledge, comfort levels, and acceptance among educational leaders and educators

Educators' unfamiliarity and resistance to AI systems and tools remain a significant challenge to their implementation, with many lacking the foundational knowledge and confidence necessary for effective integration of AI. As of fall 2024, only about half of teachers reported having been trained on using AI. Although this represents a two-fold increase from the previous year, many educators lack a foundational understanding of how AI systems work, creating reluctance to adopt these technologies in their classrooms. Adding to the reluctance around AI, some teachers perceive AI integration as increasing their workload rather than reducing it. Additionally, some educators in our listening session expressed particular concerns about insufficient evidence supporting genuine learning gains from learner use of generative AI, and some noted risks of psychological addiction, anthropomorphizing of chatbots, and broader educational integrity issues. This concern comes in the context of broader resistance within the educational community regarding the adoption of generative AI systems and tools.

A global coalition of education professionals has emerged that explicitly calls for the rejection of generative AI implementation in schools and colleges, citing fundamental concerns about learner agency, learning integrity, and ethical implications (see An Open Letter From Educators Who Refuse the Call to Adopt GenAI in Education, 2025). These educators argue that the core purpose of education is to guide learners in developing their own agency in the world, and current generative AI technologies corrode the agency of learners, educators, and professionals. The coalition also identifies what they consider unacceptable harms, including exploitative labor practices, copyright violations, harmful biases, misinformation production, and environmental damage. Creating an empathetic professional development culture that addresses educators' core concerns about competence, autonomy, and protection while acknowledging legitimate ethical concerns is necessary for reducing resistance to the integration of AI.

Lack of high-quality, evidence-based professional learning and curricular resources for AI literacy implementation and effectiveness

The rapid emergence of AI in education has outpaced the development of evidence-based professional learning and curricular resources for educators to build their technical knowledge. While more research is needed on effective strategies for specifically improving teachers' AI literacy, some early studies suggest that, as teachers are increasingly expected to use AI technologies proficiently, existing professional development programs often do not adequately address the evolving skill requirements associated with AI integration. AI literacy builds on existing digital literacies, but inequitable access to digital literacy training and varying levels of digital expertise have created gaps that carry over into AI literacy.

Additionally, the absence of a standardized AI curriculum that incorporates both technical knowledge and ethical considerations creates inconsistencies in educator learning across educational contexts, preventing systematic skill development. This curricular gap is compounded by limited frameworks for embedding AI literacy within existing disciplinary structures.

Furthermore, research on AI literacy implementation and effectiveness remains in early stages, with limited data available on the status and efficacy of AI curricular integrations. The lack of systematic tracking creates uncertainty about who is teaching with and about AI, in what subject areas, and at what grade levels. This evidence gap makes it difficult for educators to access and adopt promising strategies for AI literacy development.

Recommendations

Effective AI literacy implementation for educators and education leaders requires an inclusive, system-level approach, including collaborative policy creation and strategic investments in materials and capacity building.

Key Recommendations Include

- Ensure equitable access through strategic resource allocation.
- Co-create contextualized AI literacy policies and frameworks.
- Establish educator support systems, including targeted professional learning opportunities.
- Use evidence-backed curricula and instructional materials.

Ensure equitable access through strategic resource allocation.

Educators require significant resources to effectively implement responsible AI use. While millions of students and educators worldwide are starting to benefit from education technologies, millions more are not, due to the digital divide and other socioeconomic inequalities. For U.S. school systems, the inequity of digital access was brought to the forefront during the COVID-19 pandemic, when emergency remote learning exposed divides in access based on availability, affordability, and adoption. At this time, educators had urgent training needs regarding digital tools but faced barriers based on district funding, geographic location, and existing capacity. To prevent further exacerbating inequities, policymakers must consider strategic resource allocation, like the Universal Service Fund, to ensure equitable access to broadband and these emerging technologies.

States play a critical role in crafting policies and implementing programs that support equitable access to edtech tools and professional development as well as uphold the rights of learners and educators. With technology use becoming more central in PK-12 education, state leaders are increasingly positioned to support district leaders, especially in small and resource-challenged communities. State policymakers should assess whether resources align with educational priorities and determine how to build equitable access to training and instructional resources in schools and districts.

Co-create contextualized AI literacy policies and frameworks.

Addressing gaps in AI literacy requires comprehensive institutional strategies that prioritize both infrastructure and human capacity development. Effective AI literacy policies require input from those who will implement and be affected by them. Districts can support AI literacy development by enabling institutional conditions for systems-wide change. This involves building strong capacity by establishing comprehensive AI policies, governance structures, and nimble infrastructure. AI task forces that bring together educators, administrators, learners, and families can develop coherent and contextualized AI policies — including consideration of data privacy, security, bias mitigation, and tool evaluation standards — to address local needs and build community buy-in. These task forces should also develop institutional roadmaps that outline a clear vision, strategies, and phased implementation plans.

Establish educator support systems, including targeted professional learning opportunities.

Professional development should offer differentiated pathways based on teachers' existing experience levels and subject-area contexts, while leveraging the AI knowledge that many educators have already developed through informal experimentation and exploration. AI literacy can be integrated across all subjects, with stronger buy-in likely when educators recognize how these skills align with and build upon their existing domain expertise (See Appendix D for a list of examples). As AI tools evolve rapidly, teachers need dedicated time and opportunities to experiment with new features and share practical applications with colleagues through collaborative professional learning approaches, similar to how they adapt to updates in learning management systems or educational software. This suggests that effective AI literacy development requires ongoing, collaborative professional learning, akin to the approaches that help teachers stay current with evolving technologies. Districts can nurture this development by creating institutional conditions rather than relying solely on individual initiative and motivation, while maintaining teacher agency and ensuring that human direction, oversight, and quality assurance remain central to AI implementation. We must keep humans in the loop as AI is designed, adopted, and used.

Implementation efforts require robust educator support systems, including needs assessments, ongoing training and coaching opportunities, communities of practice for sharing best practices, and train-the-trainer programs with micro-credentialing opportunities to cultivate AI literacy among faculty, staff, and learners. This collaborative approach can alleviate the uncertainty and resistance from educators in learning and adopting AI literacy in the classroom and ultimately build sustainable learning communities.

Use evidence-backed curricula and instructional materials

Educational leaders and educators should utilize existing evidence-backed resources and curriculum for professional learning. These resources offer educational leaders strategies to implement a straightforward approach to AI literacy, providing educators with awareness and agency to learn and model AI literacy in the classroom. The lack of systematic tracking of AI literacy implementation highlights the need for frameworks like CAPE (Capacity, Access, Participation, and Experience), which emphasize collecting and analyzing data to understand who has access to computer science and AI education and who is teaching these subjects.

Appendix B provides a sampling of AI literacy resources and curricula for educator professional learning—including established frameworks, university-developed curricula, and state-level implementation guidance—that are rooted in learning sciences and education research. Appendix C offers a sample set of reports, frameworks, toolkits, and guidelines to support navigating the integration of AI in education. As with any resource or curriculum, evaluation prior to adoption is critical to ensuring effectiveness in local contexts. Key evaluation criteria include alignment with learning sciences research, demonstrated effectiveness data, and adaptability to local needs and student populations.

AI Literacy for Learners

Gaps	Recommendations
Lack of educator readiness for implementing and teaching about AI	Invest in educator professional learning on experiential AI pedagogies.
Limited access to quality AI-enabled tools and structured, age-appropriate AI learning opportunities, and policies	Develop comprehensive and age-appropriate AI literacy standards, hands-on tools, and cross-disciplinary curriculum integration.
Inadequate support and feedback mechanisms for learners as they learn with and about AI tools	Facilitate critical evaluation of AI use through structured assessment and feedback systems.

AI literacy is not a new set of skills that learners must acquire from scratch; instead, it builds upon foundational digital competencies that learners already need for academic success, civic participation, and navigating today's information landscape. These skills are already embedded in PK-12 curricula across multiple subjects and are increasingly crucial in the context of preparing learners to engage with generative AI tools.

For example, early data literacy lessons help elementary learners learn to gather, sort, display, and discuss information, which are skills that are foundational to understanding how AI systems work and make decisions. Similarly, existing digital literacy and citizenship education can be enhanced to include an understanding of AI usage, benefits, and potential risks. Learners who can critically evaluate sources, understand data interpretation, and engage thoughtfully with digital tools are better positioned to understand the capabilities of AI and its limitations.

For learners to achieve AI literacy, educators must take deliberate steps to embed it into teaching and learning. While this section focuses on AI literacy for learners, it is educators' support and actions that are required for implementation and the development of impactful learner experiences. Evidence shows that learners can meaningfully engage with these concepts when instruction is developmentally appropriate. Early exposure enhances learners' self-efficacy and persistence in AI learning while preparing them for future AI-related careers, making it essential to provide young learners with a proper foundational understanding to avoid misconceptions about technology they are eager to engage with. AI literacy can be implemented across disciplines, rather than limited to computer science courses, engaging learners across backgrounds to engage with AI in meaningful contexts. Project-based and experiential learning approaches are most effective for AI literacy education, supporting hands-on exploration and critical thinking development while enhancing skills like creativity, collaboration, and computational thinking.

Appendix D provides an overview of how a selection of foundational skills and competencies can prepare learners for meaningful, ethical, and informed use of AI.

AI Skills and Competencies for PK-12 Learners

As educational systems work to prepare students for an AI-integrated future, educators and policymakers are actively developing age-appropriate AI literacy frameworks that incorporate foundational understanding as well as the critical thinking skills necessary for today's learners. While the field is still developing evidence-based recommendations, Table 2 highlights a sample of foundational skills and competencies that learners should develop to understand, evaluate, and effectively use AI tools as appropriate.

Table 2: PK-12 Specific AI Skills and Competencies for Learners

Domain	AI Skills and Competencies
Technical Knowledge	• Acquiring basic knowledge of what data is and how it is used within the context of AI • Understanding what AI can and cannot do • Recognizing everyday applications of AI • Explaining age-appropriate key technical terms, such as large language model, machine learning, and generative AI
Practical Implementation	• Using age-appropriate AI tools effectively for learning tasks • Interacting, creating, and problem-solving with AI as a progression of use for distinct contexts and purposes
Ethical Evaluation	• Centering human judgment and justice to critically consider the benefits and/or costs of AI to individuals, society, and the environment. • Understanding the implications of sharing personal data about other humans and one's self with AI systems
Analytical Skills	• Recognizing AI-generated content • Cross-referencing AI outputs with reputable and validated sources
Interpersonal and Communication Skills	• Explaining when AI was used for an assignment or task and why • Collaborating with humans and leveraging computers effectively on tasks and assignments
Adaptive Skills	• Developing human-based skills that cannot be replicated by AI • Navigating rapidly evolving AI technologies and changing use policies • Committing to ongoing learning to remain current with AI advancements and emerging applications

Sources: Blueprint for Action: Comprehensive AI Literacy for All (EDSAFE AI Alliance et al., 2025), AI Learning Priorities for All K-12 Students (CSTA & AI4K12, 2025), ISTE Standards (ISTE, 2024), Responsible AI & Tech Justice: A Guide for K-12 Education (Kapor Foundation, 2024), and AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology (Mills et al., 2024).

Gaps in AI Literacy Development for Learners

For AI literacy to be effectively implemented, learners must first be set up for success. Meeting foundational needs, such as safe and secure housing, reliable food access, comprehensive healthcare, affordable childcare, dependable transportation, and access to technology, is essential to ensure that learners can fully engage in any learning, including AI literacy. When these basic needs are unmet, learners face significant obstacles that limit their ability to participate in and benefit from AI in education. Beyond inconsistent access to these needs, several systemic barriers prevent them from developing comprehensive AI literacy skills and accessing quality AI learning experiences.

Key Gaps Include

- Lack of educator readiness for implementing and teaching about AI
- Limited access to quality AI-enabled tools and structured, age-appropriate AI learning opportunities, and policies
- Inadequate support and feedback mechanisms for learners as they learn with and about AI tools

Lack of educator readiness for implementing and teaching about AI

As discussed in the previous section, educator readiness remains a critical challenge. When educators possess knowledge of AI, they are better equipped to incorporate relevant AI technologies into their teaching. And when they model responsible AI tool usage, they improve learner outcomes, including learners' development of AI literacy. While most teachers believe that AI can support their instruction, significant knowledge gaps persist. As evidenced by a recent survey, 88% of computer science teachers desire more support for teaching about and with AI, but less than half of middle and high school teachers and just over a third of elementary school teachers feel equipped to teach about AI. This highlights the urgent need for comprehensive professional learning approaches that address the pedagogical uncertainties surrounding the rapid emergence of AI and its varied impacts on different learners.

Limited access to quality AI-enabled tools and structured, age-appropriate AI learning opportunities, and policies

There is a lack of access to both tools and learning experiences related to AI systems and tools. In addition to age limitations for the use of AI tools, not all users have the access they need to fully incorporate AI into their learning environment, for instance, a lack of internet access or appropriate tools. While there are some tools available to support AI education (e.g., Google's Teachable Machine and MIT RAISE Playground; or, for older students, Neuron SandBox or TensorFlow Playground), there is a need for more high-quality tools.

At the same time, with technologies coming to market so rapidly, many learners are using AI before engaging in any AI curriculum and without clear policy guidance. Many schools lack comprehensive policies addressing when and how students should use AI tools, creating inconsistency in expectations and learning opportunities. Learners likely come into classrooms with varying levels of knowledge and misunderstanding. AI and the related regulatory policies are typically designed for older users and often lack specific needs and ethical considerations for younger learners. Researchers from MIT suggest that the lack of AI education for younger learners who are eager to engage with AI tools can lead to misunderstandings and assumptions about the technology.

Inadequate support and feedback mechanisms for learners as they learn with and about AI tools

Compounding these developmental challenges is the critical need for ongoing feedback and guidance. Youth demonstrate a range of attitudes about the usage of AI tools that differ across ages and contexts. A 2024 survey revealed that youth who do not use generative AI (GenAI) cited concerns about helpfulness (34%), academic integrity (24%), lack of knowledge (23%), privacy (22%), and awareness (20%). Upper elementary learners in the fourth grade recognized both positive aspects, including helping those with greater needs, and negative concerns, like cyber-hacking and surveillance. Importantly, youth seek guidance from educators on responsible AI use that fosters understanding rather than simply imposing restrictions, along with clear frameworks and resources for strategic and responsible AI integration in learning.

Educators and families need to provide continuous feedback to learners on their use of AI systems and tools, enabling them to better understand the appropriate applications, limitations, and ethical considerations. Without this ongoing support and reflection, learners may develop problematic usage patterns or misconceptions about AI capabilities that persist into adulthood, making early intervention and consistent guidance fundamental to effective AI literacy development.

Recommendations

Addressing these gaps will require strategic action by educational leaders, policymakers, and developers. Collaborative and integrative approaches are key to informing responsible adoption and implementation. Through systems-level policies and guidance, learners can be provided pathways for safe and effective AI use.

Key Recommendations Include

- Invest in educator professional learning on experiential AI pedagogies.
- Develop comprehensive, age-appropriate AI literacy standards, hands-on tools, and cross-disciplinary curriculum integration.
- Facilitate critical evaluation of AI use through structured assessment and feedback systems.

Invest in educator professional learning on experiential AI pedagogies.

As detailed in "The Blueprint for Action: Comprehensive AI Literacy for All," federal policymakers need to invest in educator professional learning by leveraging existing funding streams to create pathways for AI literacy training for educators nationwide. Policymakers should utilize Title II, Part A grants to fund educator training and support credentials in AI and related fields. They should also harness established federal funding streams, such as the Teacher Quality Partnership (TQP), Supporting Effective Educator Development (SEED) grant programs, and the use of formula and discretionary grant funds on AI, to create and sustain high-quality educator training and development. Policymakers also need to build upon the National Science Foundation's (NSF) existing investments in foundational research related to the application of AI, focusing on educational efforts at the PK-12 level to explore age-appropriate AI literacy, the use of technologies in AI education, and the National Artificial Intelligence Research Resource Operations Center (NAIRR-OC) to develop and sustain a national AI ecosystem. Additionally, policymakers should expand NSF's AI-focused career and skill-building learning opportunities for high school students, strengthening the U.S. AI workforce pipeline and providing learners with hands-on, innovative learning experiences.

Develop comprehensive, age-appropriate AI literacy standards, hands-on tools, and cross-disciplinary curriculum integration.

In practice: Develop more accessible and age-appropriate AI learning tools.

Evidence-based implementation example: Designed by MIT researchers and taught by trained teachers to middle school and early high school learners, the DAILy (Developing AI Literacy) curriculum significantly improved learners' AI literacy compared to control groups, demonstrating the value of validated curricula in building educator confidence and learner outcomes. The DAILy curriculum includes key AI concepts from basic introductions to advanced machine learning topics.

Experience AI is an educational program that offers cutting-edge resources on artificial intelligence and machine learning for teachers and students ages 11-14. Developed in collaboration by the Raspberry Pi Foundation and Google DeepMind, the program supports teachers in the exciting and fast-moving area of AI and gets young people passionate about the subject.

AI literacy skill-building requires integrated curriculum approaches that extend beyond traditional computer science courses to incorporate AI-related content and competencies across all disciplines. Rather than focusing solely on technical components, educators should create learning experiences that emphasize ethical considerations and practical applications while making explicit connections to AI literacy within existing lesson plans and curricula. Effective teaching requires educators to assess what learners already believe and know about AI and related concepts, then build instruction from that foundation. This approach ensures that learning experiences address existing gaps while correcting misunderstandings that learners may have developed through informal exposure to AI tools.

The development of accessible and age-appropriate tools represents another critical need for supporting effective AI literacy education. Current research emphasizes the importance of developing platforms that are developmentally appropriate, enabling young learners to interact safely and effectively with AI through hands-on experiences. Researchers have identified promising approaches using age-appropriate technological tools such as well-designed Blockly programming interfaces like Scratch and simple machine learning model builders that enable learners to access speech and object recognition capabilities. These advances create opportunities for educators to adopt effective pedagogical approaches that foster learners' AI literacy through direct engagement with appropriately scaffolded tools.

Having the confidence and knowledge to engage with AI in an effective, safe, and informed manner allows learners to navigate everyday interactions with AI while preparing for a future where AI continues to play a critical role. Early learning experiences focused on data science, computational thinking, and machine learning can demystify AI, promoting learners' comfort and ability to make decisions about whether and how to apply AI-based recommendations in different contexts. AI literacy can increase confidence in using AI systems and tools, which supports learners' self-efficacy around AI learning and gives them opportunities to engage, evaluate, and create with these technologies as they become increasingly integrated components of learning, life, and work.

Facilitate evaluation of AI literacy skills through assessment and structured feedback systems.

AI literacy development for learners needs to be continually monitored to understand progress and adjust course. Districts can do this by identifying students' baseline understanding of AI knowledge and skills, implementing formative assessments embedded within learning activities to track progress in real-time, and creating summative evaluations. AI literacy assessment tools are essential for evaluating the effectiveness of AI literacy interventions across educational settings.

Education leaders also need to establish review processes to examine the effectiveness of AI policies through multiple data sources (academic outcomes, digital citizenship, parent/community feedback, teacher implementation). These should include early warnings that can identify issues with AI misuse or policy gaps before they become more problematic. Learners should be provided with structured opportunities to engage in discussions about their AI use with peers and educators through classroom discussions, digital portfolios to document their AI learning journey, or cross-grade mentoring.

Finally, district and school leaders should explicitly clarify when and why AI use is allowable or prohibited. They should foster conversations about privacy, environmental impact, transparency, and oversight, deepening learners' understanding of essential learning concepts, human agency, and ethics. Leaders should communicate accountability measures for AI misuse while remaining transparent about enforcement. To ensure policies remain effective and relevant, education leaders should actively solicit feedback from learners on AI use policies and use this input to foster continuous improvement and broader adoption.

Appendix A: Timeline of AI Literacy Efforts

Year	Milestone
1971	**Origins of AI Literacy Curricula** Papert and Solomon used Logo, an educational programming language, to control a robotic turtle and engaged primary students in active learning to understand abstract computer science concepts.
2017	**Teaching AI: Exploring New Frontiers for Learning by Michelle Zimmerman** First published guide on how to incorporate AI Literacy into K-12 curricula.
2018	**AI4K12 Initiative** The Advancement of Artificial Intelligence (AAAI) and the Computer Science Teachers Association (CSTA) formed the AI4K12 working group to develop K-12 national standards for each grade band including what learners should know about AI, machine learning, and robotics.
2019	**AI4ALL Stanford Summer Initiative** The AI4ALL initiative created a pathway for high school students to be informed and involved in AI. The program included a high school AI curriculum and resources for teachers, impacting over 9,252 young people around the world with approachable AI education.
2020	**MIT DAILy Curriculum** MIT published one of the first curricula designed to explicitly teach lessons on AI concepts, including ethics, creativity, and relationship to students' futures.
2020	**What is AI Literacy? Competencies and Design Considerations** Long and Magerko developed one of the first comprehensive AI literacy frameworks: the framework presented 17 AI design considerations that focused on pedagogical and learning methods.
2021	**Microsoft Machine Learning for Beginners Curriculum** Microsoft published an open-source curriculum aimed at providing access for high school and early college learners to core machine learning concepts. The 12-week, 26-lesson curriculum served as a project-based foundation for bringing AI literacy education into diverse classrooms.
2021	**National Security Commission on Artificial Intelligence (NSCAI) Recommendations** The National Security Commission on Artificial Intelligence published a report recommending that Congress pass a National Defense Education Act II to address deficiencies across education that are critical to the AI future, including restructuring educational curriculum to include AI literacy components.

Year	Milestone
2022	**Generative AI Boom** Generative AI tools were first released in 2020 with 15.ai, a free web application, but the boom in generative AI tools began with the late 2022 public release of ChatGPT, which led to increased access to generative AI tools.
2022	UNESCO K-12 AI Curricula: A Mapping of Government-Endorsed AI Curricula The United Nations Educational, Scientific, and Cultural Organization (UNESCO) analyzed existing international AI literacy efforts and curricula: key findings concluded that little is being done to formally integrate AI literacy skill building into K-12 education.
2023	Release of the AI Literacy Act The House of Representatives introduced a bipartisan act providing for grants under the Digital Equity Competitive Grant Program to support training and programming on artificial intelligence in schools, colleges, and other community institutions.
2024	Microsoft Education AI Toolkit Microsoft introduced an AI Toolkit to equip K-20 education leaders with background, strategies, and international examples necessary to responsibly launch AI initiatives in educational settings. The toolkit is updated annually to stay up-to-date with the rapid changes in AI technology.
2024	AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology Digital Promise published a position paper containing a framework and strategies for educational leaders to design and implement a safe, effective, and clear approach to AI literacy for learners, educators, and other educational audiences.
2024	U.S. Department of Education Toolkit for Safe, Ethical, and Equitable AI Integration The United States Department of Education released a report for educational leaders that outlines core principles for AI literacy to be implemented safely throughout schools nationally. This builds off of the "AI and the Future of Teaching and Learning" report published in 2023 with a specific focus on AI literacy.
2024	National Education Technology Plan (NETP): A Call to Action for Closing the Digital Access, Design, and Use Divides The Office of Educational Technology and the United States Department of Education released a plan that addresses key divides limiting the transformational potential of educational technology to support teaching and learning, which included AI.
2024	U.S. Department of Education OCR released "Avoiding the Discriminatory Use of Artificial Intelligence" The United States Department of Education's Office of Civil Rights addressed the intersection of AI and federal civil rights in schools. The report provides examples on how to use AI in a nondiscriminatory manner as they align to existing civil rights laws.

Year	Milestone
2024	First Annual National AI Literacy Day The EDSAFE AI Alliance, The AI Education Project, The Tech Interactive, and Common Sense Media organized a national event where attendees participated in planning curricula, lessons, and events explaining AI to grades K-12. This is the first annual event of its kind dedicated to promoting AI Literacy.
2025	AI Literacy with Minecraft Minecraft, Microsoft Education, and Prodigy Learning released a set of materials for classroom and household use to understand how AI works and how to use AI tools responsibly. The lessons and application in the Minecraft-immersive worlds bring AI literacy lessons to young people through one of the most popular entertainment gaming systems for children.
2025	Microsoft Education AI for Educators Training Microsoft Education and Prodigy Learning launched free professional learning materials for K-12 and higher educators in their lessons and for their own learning.
2025	Artificial Intelligence 2025 Legislation Tracking The National Conference of State Legislatures published a webpage covering key state legislation related to general AI issues.
2025	Empowering Learners for the Age of AI - An AI Literacy Framework for Primary and Secondary Education The European Commission (EC) and the Organization for Economic Cooperation and Development (OECD) developed a framework outlining competences and learning scenarios to inform learning materials, standards, school-wide initiatives, and responsible AI policies for use by educators, educational leaders, and learning designers.
2025	AI Learning Priorities for All K-12 Students The AI4K12 Initiative published a report articulating AI learning priorities within computer science to support the revision of CSTA standards to incorporate appropriate AI learning outcomes.
2025	From Urgent to Future: Charting a Course for AI in K-12 Education The Learning Center published a white paper setting a vision shifting from reactive decisions about AI toward proactive, student-centered systems change.
2025	Blueprint for Action EdSafe AI outlined policy actions at the federal, state, and local levels based around learning experiences, social and ethical responsibility, and economic and civic readiness to ensure universal access to AI literacy.

Appendix B: Professional Learning Resources for Educators

Resource	Components
Digital Promise - AI Literacy: A Framework to Understand, Evaluate, and Use Emerging Technology	• The framework defines three interconnected modes of engagement to support robust engagement in AI literacy: understand, evaluate, and use. • It provides five strategies to promote AI literacy in PK–12 education, with examples and guidance for implementing each strategy.
Stanford University - CRAFT AI Literacy Resources	• CRAFT offers professional development sessions for educational systems ranging from school districts to states (in-person and live web events). • They offer professional learning suitable for educators in all grade levels and disciplines.
Massachusetts Institute of Technology - MIT RAISE	• MIT Raise creates and shares educational technologies, materials, and experiences to advance innovation and empower everyone to engage with AI responsibly. • The Day of AI Professional Development provides professional learning opportunities on AI literacy for schools and school districts for their administrators, teachers, students, and families.
UCI Teacher Academy - AI in Education Certificate Program	• The three-course certificate program supports educators in understanding and applying AI for teaching and learning. • Its research-based curriculum integrates evolving best practices and provides opportunities to engage with experts and colleagues in K-12 education.
UCI Digital Learning Lab - Generative AI in Education	• The UCI Digital Learning Lab carries out research and development to provide tools, including an instructional AI platform, to enhance use and understanding of AI literacy. • They provide a human-driven generative AI instructional framework.
ISTE - Artificial Intelligence Explorations for Educators	• The self-paced online course enables educators to understand how AI technologies can be leveraged to facilitate learning and practical applications. • Educators are able to learn the varying types of AI, explore emerging technologies, and build tools for classroom use.
Massachusetts Department of Elementary and Secondary Education - Guidance on AI in Schools	• State collaboration with ISTE andASCD created a Task Force and Multi-Year AI Road Map to support AI use in the school community. • They developed a guide based on the needs of Massachusetts educators to build AI literacy skills for their own understanding.
Oregon Department of Education - Generative AI in K-12 Classrooms	• The Oregon Department of Education has developed general guidance for educators to plan, implement, and evaluate GenAI tools into school culture. • The guidance provides strategies to address the effect of GenAI on equity, student data privacy, and policy development.
UNESCO - AI Competency Framework for Teachers	• The framework details 15 competencies across five dimensions for teachers to master in the age of AI. • These competencies consider the principles of protecting teachers' rights, enhancing human agency, and promoting sustainability.

Appendix C: Additional Resources Supporting AI Integration in Education

Resource	Components
AI for Equity and Hendy Avenue Consulting - AI Literacy Curriculum Hub	• A dynamic list of over 25 AI literacy resources provides author recommendations for implementation and sample objectives. • The resource includes information about open access.
Council of the Great City Schools and CoSN - K-12 Generative AI Readiness Checklist	• A checklist was designed for K-12 district leaders to understand key factors before implementing GenAI technologies. • Domains include operational readiness, data readiness, technical readiness, security readiness, and legal/risk management.
CRPE - AI Early Adopter Districts: The Promises and Challenges of Using AI to Transform Education	• A report identified key patterns in districts adopting AI-enabled tools. • Recommendations are provided for: • District Leaders • Funders • State Policymakers • Edtech Developers
CSTA and AI4K12 - AI Literacy Priorities for All K-12 Students	• This report articulates priorities for AI in education based on input from teachers, researchers, administrators, and curriculum developers. • The priorities are organized into four goals: • Identify priorities for AI learning across each K-12 grade band. • Suggest updates to the AI4K12 Guidelines. • Advance the research agenda for K-12 AI education. • Share promising practices across the AI and CS education communities.
EdSAFE Alliance - Blueprint for Action: Comprehensive AI Literacy for All	• A report co-developed by educational, research, philanthropic, and industry leaders provides practical recommendations for policymakers and system leaders. • Policy recommendations are organized around three domains: learning experiences, social and ethical responsibility, and economic and civic readiness.
ISTE Standards	• The framework guides educators, leaders, and coaches in using technology to create high-impact, sustainable, scalable, and equitable learning experiences. • ISTE revisits and adopts the 20+ year framework to stay relevant for emerging technologies in education, including AI.
Kapor Foundation - Responsible AI and Tech Justice: A Guide for K-12 Education	• The guide for educators and students prioritizes the need for critical interrogation of AI use and its implications. • It explains the need for a justice-centered approach to AI in education for a diverse and robust workforce.
MIT Teaching Systems Lab - A Guide to AI in Schools: Perspectives for the Perplexed	• The guidebook, designed by educators, supports fellow educators on what AI policies and guidelines to develop. • It presents case studies and interviews that provide educator experiences and feedback.

Resource	Components
An Open Letter From Educators Who Refuse the Call to Adopt GenAI in Education	• A global community of educators penned and signed a letter opposing the use of GenAI in education. • The letter raises concerns about legal, ethical, and environmental harms; threats to student learning and well-being; and replacement and automation of human effort.
OECD - Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education	• A joint European Commission and OECD initiative, supported by Code.org, establishes AI literacy standards for K-12 education. • The draft framework aligns with major EU digital education policies and complements existing frameworks like DigComp 2.2 and ethical AI guidelines for educators.
TeachAI - AI Guidance for Schools Toolkit	• The toolkit provides educational leaders and educators with guidance on AI incorporation. • It offers district-level resources that include sample policies, principles, and communication tools for leaders.
University of Florida - A Framework for Inclusive AI Learning Design for Diverse Learners	• Their framework guides the design of inclusive AI learning experiences and an example of application in practice. • Appendix D resents the framework.

Appendix D: Connections Among Foundational and AI Literacy Skills and Practices

Foundational Skills and Competencies	Definition and Key Skills	In Practice	Relevance to AI Literacy
21st Century Skills	Broad, transferable skills needed for success in a rapidly changing world. Includes: • Critical thinking • Creativity • Collaboration • Civic engagement • Problem solving	**Team-based problem solving:** Learners work in teams to design solutions for reducing cafeteria food waste, with each member researching different aspects (costs, environmental impact, learner preferences) and combining findings. Community engagement: Learners interview local residents about challenges they face, then they propose solutions and present findings to the city council.	In the context of AI, learners need flexible creativity to work alongside AI tools, enhanced collaboration skills to work with diverse teams of people leveraging AI in different ways, and strong critical thinking to evaluate if AI outputs are complete, accurate, and free of bias.
Computer Science and Computational Thinking	Computational ways of thinking and problem-solving skills. Includes: • Abstraction • Algorithmic thinking • Decomposition • Pattern recognition	**Step-by-step planning:** Learners break down a research project into phases: identifying reliable sources about climate change, evaluating evidence quality, synthesizing findings, and creating a visual presentation. **Pattern recognition:** Learners analyze historical events to identify recurring patterns, such as comparing causes and effects across different revolutions.	Understanding how AI systems break down complex tasks can help learners both use AI tools more effectively and recognize the limitations of relying on these tools.
Data Literacy	Skills for analyzing, interpreting, and making decisions using data in various formats including text, numbers, visuals. Includes: • Explaining trends • Identifying biases in data • Using evidence to inform actions	**Trend analysis:** Learners survey classmates about technology dependence, create charts showing patterns, and draw conclusions about effective strategies while noting limitations in their sample size. **Bias identification:** Learners examine demographic data from different regions or time periods to understand how collection methods and missing populations affect conclusions.	Data literacy skills help learners understand how AI systems process data and consider the importance of the quality and representativeness of datasets used to train AI models to critically assess AI outputs and recommendations.

Foundational Skills and Competencies	Definition and Key Skills	In Practice	Relevance to AI Literacy
Digital Literacy	Skills for responsibly and critically navigating digital tools and platforms. Includes: • Using devices effectively • Evaluating sources • Protecting privacy	**Source evaluation:** Learners compare multiple websites about the same research topic, checking author credentials, publication dates, and cross-referencing claims with academic sources. **Privacy awareness:** Learners research data collection practices and consider which personal information to share when creating accounts for educational and personal platforms.	In the context of AI, digital literacy skills now encompass the abilities to access and use AI tools appropriately, recognize AI-generated content, and cross-reference AI outputs with rigorous sources.
Media Literacy	Skills for critically consuming, analyzing, and producing messages in print, digital, or visual media. Includes: • Identifying media biases • Evaluating credibility • Interpreting meaning of media	**Perspective analysis:** Learners review how different news outlets cover the same political event and identify word choices, image selections, and information emphasis that reveal potential biases. **Content creation:** Learners create their own video or audio content and consider how their choices will influence audience interpretation.	Media literacy skills are key for distinguishing between human- and AI-generated content across formats, understanding how AI-generated text, images, or other media may reframe messages for different audiences or spread misinformation/ disinformation, and responsibly utilizing AI tools to create media when appropriate.
Social Emotional Learning/ Literacy (SEL)	Skills for managing emotions, building relationships, and making ethical, empathetic decisions. Includes: • Self-awareness • Empathy • Emotional regulation • Perspective- taking	Perspective-taking: Learners engage in role-playing exercises, taking on viewpoints of characters from novels they are reading, and building empathy for various perspectives. **Digital communication awareness:** Learners reflect on how their tone and word choice in online discussion boards may affect peers' emotional response or willingness to engage further.	SEL skills enable learners to recognize when AI outputs may cause harm through biased or discriminatory language, understand that appropriate interaction differs between AI chatbots and human relationships, and critically examine the impact of AI-tool reliance for emotional support on building authentic human connections.

Recommended Citation: Ruiz, P., Pattenhouse, M., Shell, A., Dallas, D., Liberman, B., & Karim, S., (2025). AI Literacy in PK-12 Education. In Ruiz, P. et al. (Eds.), *Implementing AI literacy across learning environments: A series of briefs.* Digital Promise. https://doi.org/10.51388/20.500.12265/269



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