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From Understanding to Creating: Bridging AI Literacy and AI Fluency in K-12 Education

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Abstract

This paper explores the distinctions and connections between AI literacy and AI fluency, drawing parallels with the historical development of other literacies such as computer literacy and digital fluency. The paper argues that while AI literacy focuses on understanding and evaluating AI technologies, AI fluency represents a higher-order competency encompassing innovation, ethical management, and creation with AI. Examining existing definitions reveals "creation" as a recurring theme that differentiates fluency from literacy, where fluency implies the ability to generate novel solutions and artifacts using technology. The paper proposes a conceptual framework for AI literacy and fluency in K-12 education, emphasizing the need to develop both concurrently rather than sequentially. By fostering AI literacy through comprehensive professional development, educators can equip themselves and their students to engage with AI in an ethical and effective manner. Simultaneously, cultivating AI fluency empowers students to utilize AI as a tool for innovation and problem-solving, going beyond passive understanding to actively shape the future of AI in education. The paper concludes that investing in teacher training and developing clear definitions of AI literacy and fluency are crucial steps toward integrating AI into K-12 education in a responsible and effective manner, thereby preparing students to navigate the complexities of an increasingly AI-driven world.

Introduction

Artificial Intelligence (AI) is one of the most disruptive technologies to be introduced into education. It can impact classroom instruction, assessment, educational technology policy and the relationships between educators and learners. Educators, academic institutions, and researchers are attempting to understand the short- and long-term implications of AI. While it is accepted that more information about AI in education is needed, there is a need for greater consensus on what specific knowledge is essential for using AI effectively and responsibly.

Survey results outline that there are challenges to AI in education regarding adoption and that training is required for a meaningful path forward. A survey conducted in December 2023 by the Alberta Teachers Association of 2,148 Alberta educators highlighted several areas of opportunity and concern among teachers. A larger percentage (37.2%) were concerned about potential negative impacts, with only 29.4% viewing a positive outlook for AI in education. The remaining surveyed teachers fell in the middle (14.5%) or were unsure (18.9%) (McRae, 2024). In the United States, a survey conducted around the same time revealed similar sentiments, with 32% stating that there is an equal mix of benefits and harms, 6% indicating that it does more good than harm, and 35% expressing uncertainty (Lin, 2024). Another study, conducted between November 30 and December 6, 2023, by the EdWeek Research Center, surveyed 498 K-12 educators. One topic was educators' reasons for not using AI in their classrooms. Popular answers ranged from other priorities (46%), not knowing how to use the tools (36%), lack of policy surrounding the tools (33%), and not knowing how to effectively use the tools (30%) (Langreo, 2024). From these results, it is clear that there is a need to equip educators on how to use or not use AI, so they, in turn, can better educate their students on the responsible use of AI.

This paper reviewed recent and contextually relevant academic literature to illustrate the current situation of AI in K-12 education as it relates to educator training. Following an initial search, "AI literacy" frequently appeared in the results. This term was used to narrow the parameters for relevant articles. Searching for articles surrounding AI literacy led to multiple definitions across several publications. Attention was given to historical examples of literacy and fluency in similar fields to create a holistic definition, leading to the differentiation between literacy and fluency as they relate to AI. This paper will explore the following questions: What is the relationship between AI literacy and AI fluency? How can the development of AI literacy and AI fluency be encouraged in a K-12 context?

Given the initial breadth and general nature, a narrative literature analysis was conducted (Baumeister & Leary, 1997). Academic and peer-reviewed articles were retrieved from multiple databases (NEOS Libraries catalogue, IEEE Xplore, Wiley Online Library, Google Scholar, Sage Publishing, Science Direct, Springer, ERIC, Education Research Complete, Directory of Open Access Journals, Scopus, the Education and Research Archive) using the following criteria: containing the keywords “Artificial Intelligence” AND “K-12” AND “Education” and published no earlier than 2020. Approximately 550 articles were found, and although some articles were informative, the search was deemed too broad and needed to be narrowed. An additional search, including the keyword “AI literacy,” was also conducted using the same databases and criteria as those present in several of the articles from the initial search that were relevant to K-12 contexts. This resulted in a more manageable list of 150 articles. From these two searches, 30 articles were selected based on their ability to provide context for AI in education and for AI literacy research specific to a K-12 setting. Definitions of AI literacy were collected into a table found in the Appendix of this paper. Common elements between definitions and other notes were recorded and compared to create a revised definition for AI literacy. Unique, more complex processes were

compared against existing definitions for previous literacies and fluencies in related fields. The discussion will explore the semantic distinctions between literacy and fluency in similar contexts.

This paper is grounded in established educational frameworks that provide a foundation for understanding the relationship between AI literacy and AI fluency. Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001) offers a helpful structure for distinguishing between levels of cognitive engagement, with "creation" representing the highest level of learning. This aligns closely with our framing of AI fluency, which emphasizes the ability to innovate and produce new applications of AI rather than understand or evaluate them. In addition, the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler et al., 2013) informs how AI knowledge can be meaningfully integrated into teaching practice. Together, these frameworks provide a theoretical foundation for this work, linking historical discussions of literacy and fluency with a practical approach to developing AI literacy and fluency in K–12 education.

Information and digital literacy and fluency in K-12 education

In 1999, the National Research Council wrestled with the concept of fluency related to Information Technology (IT). Specifically, it determined that computer literacy "was too modest a goal in the presence of rapid change." The council explored the addition of the concept of fluency. Fluency, in this instance, requires the ability to respond or adapt to changes with the help of three key components: contemporary skills, foundational concepts, and intellectual capabilities (National Research Council, 1999). The committee that drafted the 1999 report elaborated further on fluency: "Fluency connotes the ability to reformulate knowledge, to express oneself creatively and appropriately, and to produce and generate information (rather than simply to comprehend it)" (National Research Council, 1999). This distinction is critical as it relies more on abilities than just knowledge. The council describes fluency with information technology (FITness) as "a process of lifelong learning in which individuals continually apply what they know to adapt to change and acquire more knowledge to be more effective at applying information technology to their work and personal lives." (National Research Council, 1999, p. 2). This ability to adapt is a higher level of thinking and requires a greater understanding than literacy can provide.

Another example of literacy and fluency involves the work surrounding computational thinking. Resnick & Rusk (2020), when speaking about computational thinking, suggest that, like literacy, being the ability to read, fluency is required for meaningful learning and creation in both the reading and writing domains and what they call computational fluency.

> Most students will not pursue careers as professional programmers or computer scientists but developing fluency with coding is valuable for everyone. As students create their own stories, games, and animations with code, they start to see themselves as creators, developing confidence and pride in their ability to create things and express themselves with new technologies. (Resnick & Rusk, 2020, p. 123).

Resnick and Rusk (2020) highlight an important component of fluency: the significance of creating artifacts using the technologies provided to students.

The desire to differentiate literacy and fluency also exists when discussing digital literacy and digital fluency. The differences can be described as "...digital literacy is an understanding of how to use the tools; digital fluency is the ability to create something new with those tools." (Sparrow, 2018, para. 3). This again draws attention to the importance of creation as it relates to the discussion of fluency. Spencer, 2020, para. 5 further suggests that "Someone who is digitally

fluent not only selects tools and knows what to do with them but can explain why they work in the way they do and how they might adapt what they do if the context were to change." Recent research has shown that the conversation surrounding digital fluency has continued with Cain & Coldwell-Neilson, 2024: "We define digital fluency as contextualised, knowledge-based behaviours that enable adaptive and successful engagement in dynamic digital worlds. Digital fluency relies on continual active engagement with digital cultures and spaces. It is possible to become more literate by lurking, but fluency requires active involvement with creation and flexible application" (Cain & Coldwell-Neilson, 2024, p. 5). This observation on adapting to new technologies reflects discussions about FITness and computational fluency. It also highlights creation as a crucial aspect of digital fluency.

Initially, the focus in these areas was on basic literacy. However, as technology evolved, it became apparent that simply knowing how to use these tools was insufficient. Individuals needed to adapt to rapid technological advancements, create new applications with these tools, and apply them effectively in dynamic contexts. This led to "fluency" as a higher-order competency that transcends basic understanding, emphasizing creation, innovation, and critical engagement with technology. In the case of the analyzed scenarios, fluency emerges as progress from basic literacy. This is often driven by the need for individuals to understand and use technology, as well as adapt, create, and innovate with it. This approach involves more transferable concepts and reduces the need for retraining as knowledge becomes obsolete. This historical context, along with the emphasis on creation as a key differentiator between literacy and fluency, sets the stage for examining AI literacy and AI fluency, and how they can be fostered in K-12 education. By understanding the evolution of these concepts in other areas, we can better appreciate the need for a similar progression in AI education.

What is AI literacy, and what is AI fluency?

The preceding discussion on digital literacy and fluency reveals key insights that inform our understanding of AI literacy and AI fluency. This section will define AI literacy and AI fluency, drawing on historical trends and analyzing current definitions to establish clear distinctions between the two concepts.

Firstly, the emergence of 'fluency' follows the establishment of 'literacy,' driven by the need to adapt and create in response to evolving technologies. While the conversation did not begin with fluency, it was introduced once literacy was no longer deemed sufficient. In the case of computer literacy, it was noted that the speed at which the technology was developed, and the lack of formal education (H. Lin, 2000), parallel the current situation with AI in education. As shown in Figure 1, each of these domains expanded to include the concept of fluency.

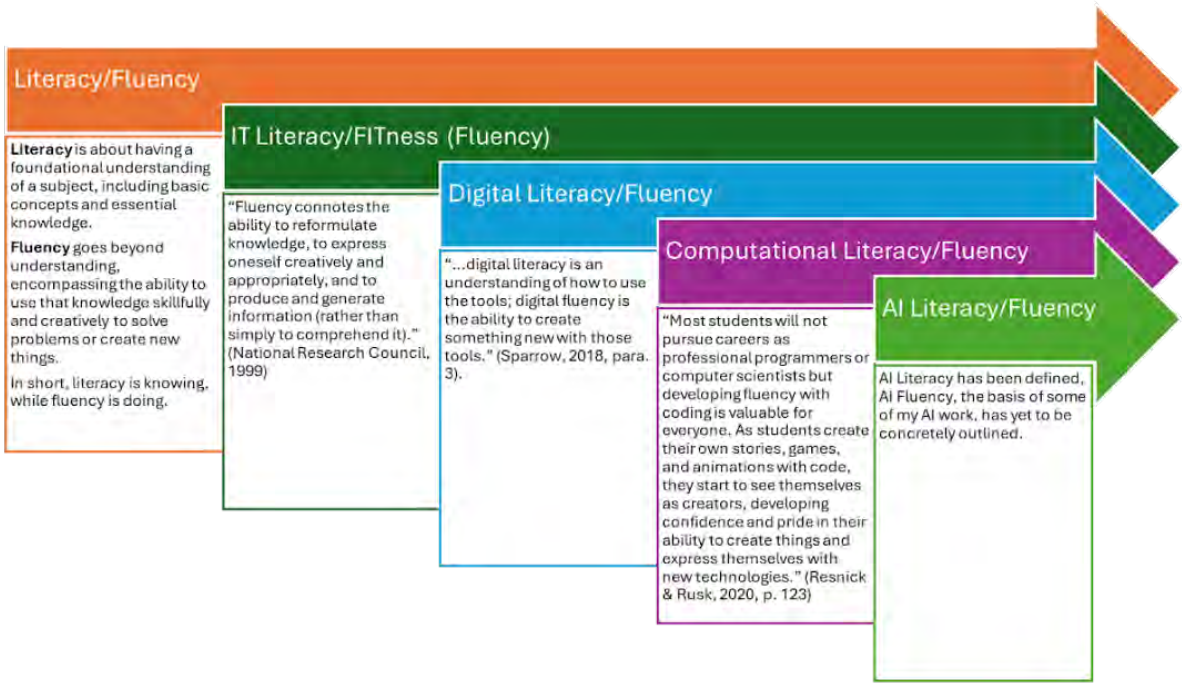

Figure 1: Literacies compared against fluency development in several fields.

Secondly, these literacies, such as digital and computational thinking, are interconnected and form building blocks for AI literacy. There are connections between these literacies and AI literacy. Ng et al. (2021) indicated in their review a connection between Brennan-Resnick's (2012) computational thinking, AI literacy and AI thinking (Ng et al., 2021, Table 5). It is argued that having AI literacy requires digital literacy as a prerequisite (Chiu et al., 2024), thereby strengthening the connection between these two literacies.

Building upon this foundation, we can now explore AI literacy, a relatively new term, with most scholarly articles emerging after 2019, as indicated by the searches conducted for this paper. The term's first use may date back to a 1982 Working Paper that listed several relevant resources in the field of AI (Agre, 1982). The term did not appear in Google Trends until November 2022 (Google, 2024). Given that the debate around the definition of digital literacy and, by extension, digital fluency is still ongoing (Cain & Coldwell-Neilson, 2024; Spante et al., 2018), it is unsurprising that several approaches have been suggested for AI literacy (UNESCO, 2024).

There is debate over what a "non-professional" should know about AI (Chiu & Sanusi, 2024). This debate is analogous to the conversation the National Research Council (1999) had regarding computer literacy and fluency, suggesting what everyone should know about information technology (IT) versus what would be expected for a fluent person to know. AI literacy is an emerging research topic across multiple fields, but its application in teacher professional learning remains limited (Sperling et al., 2024). This sets a challenging landscape for determining exactly what should be taught regarding AI literacy.

Several definitions for AI literacy are available from both organizations and researchers. These definitions, along with others, are included in the Appendix for reference. A selection of definitions has been examined in detail, and existing commentary from other sources has been provided.

Several policy documents crafted by the World Economic Forum, the Institute for Ethical AI in Education (IEAIED), UNESCO and the United Nations International Children's Emergency Fund (UNICEF) have included variations of a definition of AI literacy, which were identified as part of an inventory of AI ethical principles (Adams et al., 2023). Organizations such as Digital Promise describe AI literacy as the interrelated components of "use, understand and evaluate" (Mills et al., 2024, Figure 1). All four of these organizations, in their definitions, emphasize the importance of AI knowledge and address higher-level thinking in various ways, ranging from critical thinking (Mills et al., 2024; UNESCO, 2024; UNICEF, 2021) to project-based learning (WEF, 2022). Two sources recognize the importance of previous literacies as building blocks to AI literacy (Mills et al., 2024) or as a potential gateway to share AI literacy without overloading the curriculum (UNESCO, 2021). UNESCO's (2024) report emphasizes three levels of understanding: understand, apply and create, which, while not dissimilar to the efforts of Digital Promise, goes into greater detail and provides the term "create" as the highest level of understanding. This specific insight will become important for the analysis at the end of this section.

In the review by Sperling et al. (2024), three frequently used definitions for AI literacy within existing educational literature are cited: Long and Magerko (2020), Ng et al. (2021) and Luckin et al. (2022). Within these three definitions, different terms are used to describe similar approaches. Luckin et al. (2022) refer to "AI Readiness." Long and Magerko's (2020) use of the word competencies refers to how AI literacy is achieved through 17 competencies listed in the Appendix. Chiu et al. (2024) classify AI literacy as: "Literacy is about knowing (knowledge, what skills)" and suggest the concept of competency as being "...about applying the knowledge in a beneficial way (confidence, how well)" (p. 1). In Chiu et al. (2024), competency is used to describe a higher order of ability rather than how AI literacy is achieved (2024). This recognition of a higher order is key, even if the reuse of terms may lead to confusion. Sperling et al. (2024) also noted the similarities between Long and Magerko's definition and the ideas suggested by Luckin et al.'s AI Readiness. Chiu et al. (2024) further stated that Long and Magerko (2020) provided unsuitable competencies for a K-12 educational setting. Even between these three examples, while there are similarities, there are also significant differences in approach and language.

Two other definitions that appeared in the database search were those by Ng et al. (2021) and Wang and Lester (2023). Ng et al. (2021) describe four key areas in AI literacy: know and understand, use and apply, evaluate and create, and ethical issues, which are similar to the definitions suggested by UNESCO (2024) and Mills et al. (2024). Wang and Lester (2023) propose an alternative definition that emphasizes understanding, utilizing, and applying, which shares similar components with the previously mentioned definitions. More importantly, Wang and Lester (2023) acknowledge that while every K-12 student should have a basic understanding of AI, there is more information to be acquired in advanced coursework.

Lastly, the concept of 'creation' is a recurring element in definitions of fluency, suggesting a higher-order competency. The mention of creation throughout the definitions of AI literacy lays critical groundwork for clarity of AI literacy and the defining of AI fluency or concepts that may not apply to a basic literacy level. In the effort to craft a unified definition of AI literacy, it is important to note the concept of creation, which is highlighted by Ng et al. (2021) in the "evaluate and create" component of that AI literacy definition, relating to Bloom's Revised Taxonomy (2021), is unique. The concept of creation is also identified as the highest level in UNESCO's *AI Competency Framework for Students* (2024). Historically speaking, there is precedence for creation or to create (these words are present in Figure 1) to be part of

fluency, as it was prevalent in the previous examinations of literacy and FITness, computational fluency and digital fluency.

However, a crucial distinction arises when we examine AI fluency. AI fluency transcends basic understanding and encompasses the ability to innovate, adapt, and create with AI. Historical trends in other literacies support this distinction and are evident in the recurring emphasis on 'creation' within AI literacy definitions. Therefore, we propose that 'creation' be considered a defining characteristic of AI fluency, representing a higher level of competency in a K-12 context. To illustrate how creating signifies a higher level of competency, Figure 2 contrasts the concepts of generating and creating in the context of AI use.

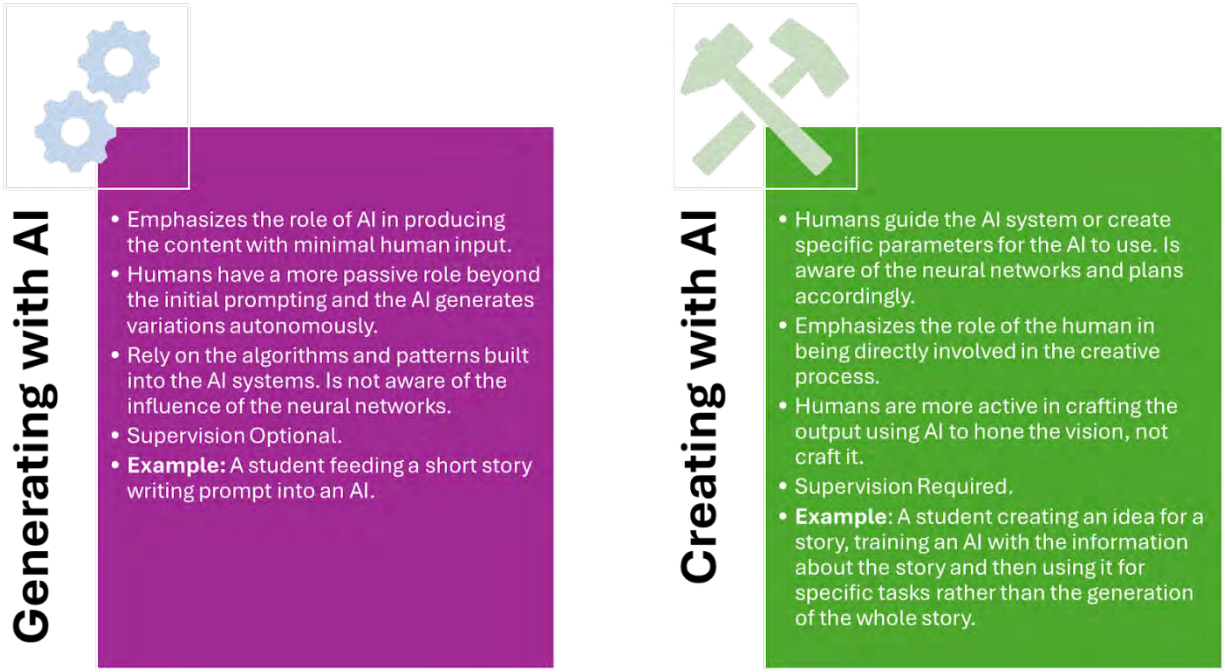

Figure 2: Differentiating Generating versus Creating as it relates to AI systems in a K-12 context.

Therefore, by drawing on research in similar fields and examining existing definitions of AI literacy, the terms AI literacy, including the definition of a new term — AI fluency —specifically in a K-12 Educational context, are suggested in Figure 3. This exploration into the historical context of literacy and fluency in information technology, computational thinking, and digital literacy provides a foundation for understanding AI literacy and AI fluency. As technology advanced in these fields, it became clear that basic literacy was insufficient. The need to adapt, create, and innovate with these rapidly evolving technologies led to the concept of fluency as a higher-order competency. This historical precedent and the emphasis on creation as a key differentiator between literacy and fluency set the stage for examining how these concepts apply to AI in the K-12 education context and the steps needed to develop these AI skills. As detailed in Figure 3, AI literacy in K-12 education refers to a foundational understanding of AI concepts and principles and the ability to use, evaluate, and critically assess AI technologies. AI fluency, however, represents a higher-order competency built upon AI literacy, encompassing the ability to innovate, adapt, and create with AI technologies to address emerging challenges in diverse and complex contexts.

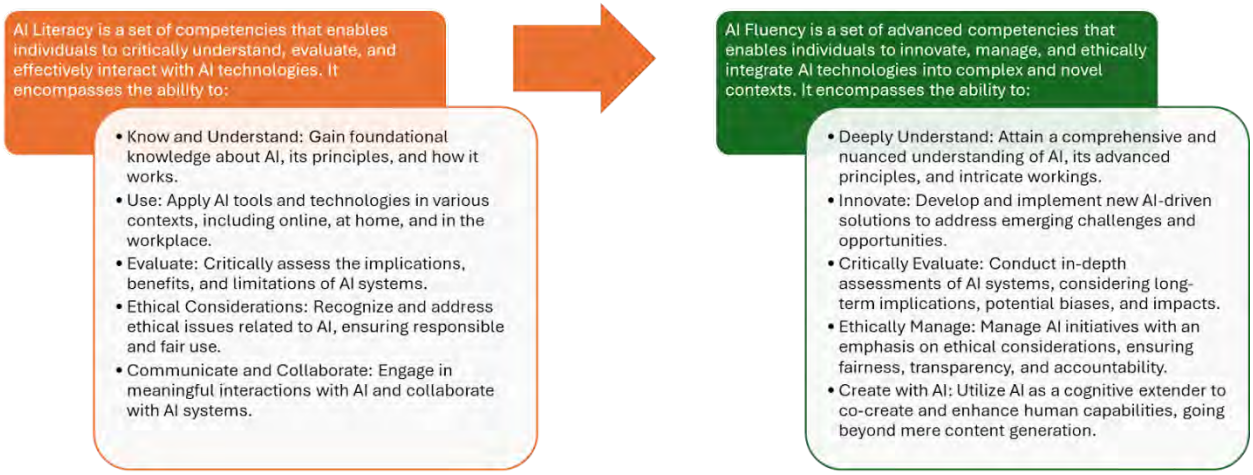

Figure 3: AI literacy and AI fluency definitions in a K-12 context.

AI literacy and AI fluency in a K-12 context

While the goal is to cultivate AI fluency in K-12 students, this must be built upon a solid foundation of AI literacy. As individuals gain a deeper understanding of AI concepts and principles, they can progress toward fluency, becoming capable of innovating and creating with AI technologies. Integrating AI technologies into K-12 classrooms necessitates equipping students with the knowledge and skills to navigate this evolving landscape. This section will explore strategies for cultivating both AI literacy and AI fluency within a K-12 context, examining the roles of professional development, curriculum resources, and ongoing research in promoting the responsible and effective integration of AI in education.

A foundational understanding of AI concepts is crucial for both educators and students. Educators need to be literate in AI systems to effectively evaluate the impact of AI tools on their teaching and their students' learning. There is a need to define the terms used to describe AI in order to facilitate the integration of instruction about AI into the curriculum (UNESCO, 2024). Without these terms being clear and defined, it leaves room for assumptions to be made: “In other words, although there still does not exist an agreed definition of what AI literacy entails concerning teachers’ theoretical, practical, and ethical knowledge, research initiatives assume this knowledge to be of a specific type.” (Sperling et al., 2024, p. 9). Educators must be literate in AI systems to evaluate the tools' impact on the profession and the learners in their care (UNICEF, 2021). Educators are also facing challenges related to their limited AI literacy, ranging from discomfort with the technology to difficulties in integrating it effectively into their classrooms (Ding et al., 2024). Training involving AI literacy has been shown to impact people's perception of AI systems and improve AI literacy skills (Markus et al., 2024). This information, through AI literacy, is a necessary and required step to any move forward. If AI literacy is absent, AI in education cannot move forward and be better understood, and AI fluency will not be achieved. Building a more complete definition of AI literacy will require further research that involves both educators and learners in the process (Sperling et al., 2024). It is also essential to co-design resources with subject experts and educators (Chiu et al., 2024; Yim & Su, 2024) to support AI literacy and AI fluency.

Professional development plays a critical role in achieving AI literacy and AI fluency. Through workshops and training, educators can gain the necessary knowledge and confidence to implement AI in their classrooms responsibly. According to UNESCO (2024),

professional learning and curricular resources are significant in addressing AI in education. Educators require professional learning opportunities to be fully equipped and confident in their ability to adequately use AI or teach their students about its responsible use (Crompton et al., 2022). This deficiency can lead to a negative perspective and ineffective or irresponsible technology implementation unless timely professional learning and curriculum resources are provided (Crompton et al., 2022). Training and knowledge in these areas become even more important as the lack of these may lead to the refusal to use any technology that markets the inclusion of AI, limiting potential positive learning experiences for students or the mismanagement of teacher resources attempting to ban or control the technology (Ottenbreit-Leftwich et al., 2023). This tactic is further ill-advised as the accusations of plagiarism that cannot be substantiated can harm the relationship between teachers and students (Gorichanaz, 2023). One of the methods that can be utilized for a constructive approach is pre-existing professional learning models.

Consideration must be made for the next generation of educators, and integrating AI literacy into pre-service teacher education programs (Ayanwale et al., 2024) will be vital. Researchers have suggested the TPACK framework to support AI literacy and education (Ayanwale et al., 2024; Crompton et al., 2022; Ng et al., 2021; Su et al., 2023). "AI literacy is trying to close the gap between research and practical knowledge transfer of AI-related skills. Teachers' AI-related technological, pedagogical and content knowledge (TPACK) are important factors for AI literacy." (Velander et al., 2024, p. 4085).

Furthermore, curriculum resources specifically designed to support AI literacy and AI fluency are essential. Lane (2023) noted that our demand for curriculum relating to AI surpasses the research available to support its development. A comprehensive approach will involve education across all levels of formal education (Kajiwara et al., 2023; Wang & Lester, 2023). These resources should include pedagogical approaches, learning objectives, and assessment strategies. Creating this AI curriculum would allow co-designing by experts in the field and experienced educators. This ensures that the developed curriculum is grounded in research (Kahila et al., 2024; UNESCO, 2022; Yau et al., 2022).

AI in a K-12 context is still under-researched (Karan & Angadi, 2023). This makes it difficult to predict the impact AI will have on education. Several significant and interdependent factors are at play, from the tools and curriculum available to the training available to educators to use the tools themselves and with their learners. We remain in the early days of this journey of AI being introduced into the education profession; the most important work is yet to come (Mintz et al., 2023). Both "AI + education" and "education for cultivating AI talents" have room for more research across all fields (Gong et al., 2020, para. 2). The stage is set for a new and significant wave of academic research that provides practical studies of AI implementation is needed to guide more structured policies, frameworks, professional learning and curriculum (Lane, 2023). A framework exists to support this research (Miao & Holmes, 2023). This will continue to feed into a larger body of research and knowledge that will be taken and used to make more effective and informed decisions.

The successful integration of AI in education requires continuous research, development, and implementation. This cyclical process, explored in the next section, highlights the interconnected nature of AI technology introduction, professional learning, classroom deployment, research, and the development of next-generation AI resources. AI literacy and fluency play a critical role in driving this cycle forward, as a foundational understanding of AI concepts (literacy) enables informed implementation.

Education Cycle of AI Integration

K-12 learners and educators are not utilizing AI due to insufficient information, inadequate training, and the limited availability of AI tools tailored for educational purposes. The research highlights a need for knowledge and professional learning that impacts educators' abilities to respond meaningfully and educate learners about responsible use. This, in turn, affects the AI literacy and AI fluency of both groups. The academic community has the opportunity to research a constantly changing and evolving technology to support curriculum development, as using a curriculum not grounded in research is problematic (Wang & Lester, 2023). The absence of AI adoption by educators diminishes opportunities for research, forming conclusions, and creating future frameworks.

Based on the analytical review conducted in this paper, a trend is suggested, as illustrated in Figure 4, which is referred to as the “Education Cycle of AI Integration.” The introduction of AI technologies often precedes comprehensive professional learning and research, marking the initial step in a cyclical process. Educators who become knowledgeable about AI through lectures or interactions with colleagues can move forward constructively, while those who remain unaware might perceive AI's integration as an invasion rather than an invitation. Once AI is deliberately introduced into classrooms, it creates a structured environment conducive to academic research, allowing for the study of various components, such as specific tools, their impact, and curriculum integration. The practical usage of AI technology reveals both benefits and drawbacks, guiding educational technology companies, policymakers, and other stakeholders to develop next-generation AI resources, thereby driving further advancements in the ongoing cycle of AI integration in education.

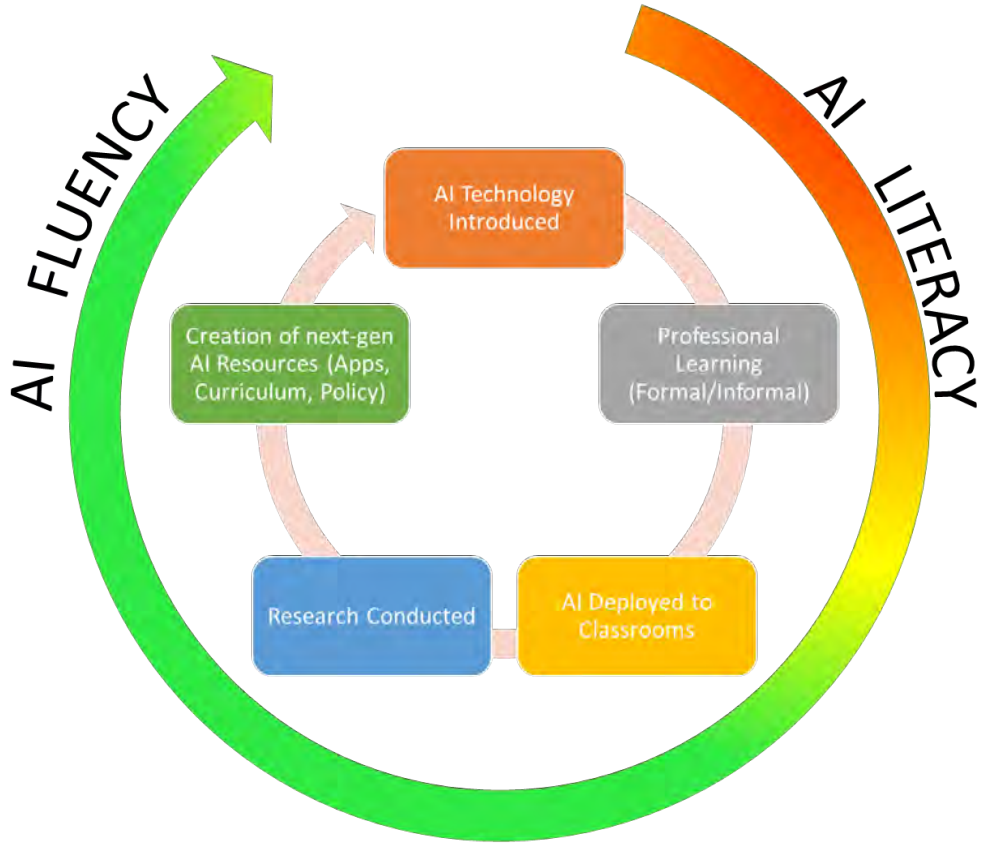

Figure 4: Education Cycle of AI Integration.

AI literacy provides a foundational understanding of AI concepts, allowing educators and students to recognize and understand AI applications. Currently, the 'Education Cycle of AI Integration' is hindered by insufficient AI literacy among educators and students, which limits informed implementation and slows down the progress of AI integration in K-12 education. The absence of basic knowledge means the cycle progresses at a reduced pace, as participants need more time to grasp and apply AI concepts. In contrast, AI fluency represents a deep, intuitive understanding and application of AI concepts creatively and effectively. This fluency accelerates the cycle, as participants can quickly adapt, innovate, and implement AI solutions, leading to faster progress and more significant impact. As this cycle completes revolutions, educators and learners will be better equipped for the AI-enabled future that lies ahead.

Conclusion

This paper has explored the crucial distinction between AI literacy and AI fluency, arguing that both are essential for effectively integrating AI into K-12 education. By drawing parallels with the historical development of other literacies, we have demonstrated that fluency represents a higher-order competency built upon a solid foundation of literacy. While AI literacy equips individuals with the knowledge and skills to understand and interact with AI systems, AI fluency empowers them to innovate, adapt, and create with AI.

The analysis of existing AI literacy definitions reveals a recurring emphasis on 'creation' as a distinguishing characteristic of fluency. This highlights the need for K-12 education to move beyond simply teaching students about AI and toward fostering their ability to shape and contribute to the development of AI technologies. Grounding this discussion in Bloom's Revised Taxonomy and the TPACK framework reinforces AI literacy and AI fluency as theory-informed constructs that build on historical understandings of literacy and fluency while offering practical guidance for educators seeking to integrate AI meaningfully into K–12 learning environments.

To advance AI in education, it is essential to foster both AI literacy and fluency simultaneously. This goal requires a multifaceted approach, starting with comprehensive professional development to equip educators with the knowledge, skills, and confidence necessary to integrate AI effectively into their teaching practices. Additionally, developing curricula that promote AI literacy and fluency across all subjects and grade levels is crucial. Finally, ongoing research is necessary to explore the impact of AI on education and guide the creation of next-generation AI resources.

Investing in teacher training and fostering a clear understanding of AI literacy and AI fluency are crucial steps toward preparing students for an increasingly AI-driven world. By embracing both understanding and creation, we can ensure that K-12 education empowers students to not only navigate the complexities of AI but also to shape its future.

Author Bios

Thomas Rogers has recently completed his Master of Education in Educational Studies at the University of Alberta's Faculty of Education. His studies concentrated on educational technology, particularly artificial intelligence and assessment. With ten years of experience in education as both a classroom teacher and school administrator, Thomas currently serves as an assistant principal.

Dr. Mike Carbonaro is a professor at the University of Alberta's Faculty of Education. His research intersects several areas, including curriculum design, digital games in schools, blended delivery, robotics, computational modelling, computer science education, and health sciences interprofessional education.

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Appendix

AI Literacy Definitions

Source	AI Literacy Definition	Notes
UNESCO, 2021	"In fact, if the world is to ensure that AI does not exacerbate existing inequalities, it will be increasingly important for every citizen to have the opportunity to develop a robust	UNESCO stresses the importance of AI literacy and gives a broad definition in the first statement.

	understanding of AI – what it is, how it works, and how it might impact on their lives. This is sometimes called 'AI literacy'." (UNESCO, 2021, p. 26) "Take institutional actions to enhance AI literacy across all sectors of society: Provide basic AI education to all citizens, educating them on thinking critically and responsibly about their choices, rights and privileges in the context of AI and its impact on their day-to-day lives. Inform them on how to protect their privacy and control their own data and decisions. Dismantle the myths and hype around AI by educating the population about its limitations, as well as the differences between AI and human intelligence. Carefully integrate emerging AI literacy skills with existing foundational skills such as media and information literacies, and identify ways of merging the different required literacies to prevent overloading the curricula." (UNESCO, 2021, p. 39)	They provide some further clarity in the second statement and provide some specific examples of what should be included in AI literacy. While they mention the importance of foundational skills, many of the points relate to knowledge about AI. Their last section does mention a connection to other literacies as a method to deliver AI literacy.
UNICEF, 2021	"In an AI context, knowledge includes basic AI concepts and data literacy, skills such as basic AI programming, and attitudes and values to understand the ethics of AI. AI literacy, which is currently not very common in digital curricula, should also involve educating children on their rights as users, so that they can become conscious users of AI-based systems. Children also need to develop critical thinking and emotional intelligence skills, which current AI systems are not capable of, within a lifelong learning approach to support their resilience to thrive in and adapt to a changing world. Special attention should be given to ensure girls are included in AI literacy programmes, given their underrepresentation in digital literacy programmes in general." (UNICEF, 2021, p. 41)	AI literacy is described here as primarily a need for knowledge to be responsible and safe users. They do mention critical thinking skills and adapting to a changing world in more general terms.
WEF, 2022	"First, when teaching about AI, meet people where they are in terms of their knowledge level, learning format, and access to infrastructure such as connectivity, power, and devices."	Locating a document from the WEF that had a detailed description of AI literacy led to the article cited here.

	"It is also important to make learning about AI accessible and relevant by contextualizing technology benefits, limitations, and risks with practical examples and case studies. This should cover what the benefits and opportunities of AI are, what can go wrong, how to mitigate risks and how to redress harm. This should be done while centering the needs and contexts of those most marginalized." "Build capacity for AI while solving real-world problems. Project-based learning, like that provided by NetHope's Africa chatbots, can be a powerful and efficient way to build capacity while developing tools and programs that can address immediate needs." "Finally, catalyze conversations between governments and citizens, non-profits and businesses, researchers and communities. Engage everyone in envisioning the future that is representative of all of our needs and contexts." (WEF, 2022, Section How to build AI literacy)	It references several knowledge pieces through information and contextual examples. The discussion of real-world problems and project-based learning are the higher-level concepts that they suggest should encompass Ai literacy.
Mills et al., 2024	"AI literacy builds on years of work in digital readiness, media literacy, and computational thinking. Just like these more familiar domains, AI literacy applies common 21st century skills such as communication, collaboration, critical thinking, and creativity. Building on definitions of AI and generative AI from the U.S. government, Digital Promise defines AI literacy as follows: AI literacy includes the knowledge and skills that enable humans to critically understand, use, and evaluate AI systems and tools to safely and ethically participate in an increasingly digital world. Our AI Literacy framework, pictured below, includes three components: Understand, Use, and Evaluate." (Mills et al., 2024, Section What is AI Literacy?)	This definition acknowledges the building of AI literacy on previous literacies. While it does mention knowledge as a key component, it mentions higher-order skills including creativity.

UNESCO, 2024	Key aspects of AI competency are identified: • Human-centred mindset • Ethics of AI • AI techniques and applications • AI system design AI Competencies are divided into three levels: Understand, Apply and Create (UNESCO, 2024, Table 2)	The three levels are similar to Ng et al., 2021. Table 2 is very comprehensive and covers many areas, too many to list them all.
Long & Magerko, 2020	"We define AI literacy as a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace." (Long and Magerko, 2020, p. 2) 17 Competencies make up AI literacy: Competency 1 (Recognizing AI) Competency 2 (Understanding Intelligence) Competency 3 (Interdisciplinarity) Competency 4 (General vs. Narrow) Competency 5 (AI's Strengths & Weaknesses) Competency 6 (Imagine Future AI) Competency 7 (Representations) Competency 8 (Decision-Making) Competency 9 (ML Steps) Competency 10 (Human Role in AI) Competency 11 (Data Literacy) Competency 12 (Learning from Data) Competency 13 (Critically Interpreting Data) Competency 14 (Action & Reaction) Competency 15 (Sensors) Competency 16 (Ethics) Competency 17 (Programmability)	These competencies are heavily based on knowledge (knowing) and understanding to describe them. The terms "understand" (n=8) and "recognize" (n=4) are common. The exception to this is Competency 16 (Ethics) which asks to identify and describe. Competency 2 (Understanding Intelligence)
Ng et al., 2021	"Grounded in literature on 30 existing peer-reviewed articles, this review proposed four aspects (i.e., know and understand, use and apply, evaluate and create, and ethical issues" (Ng et al., 2021, p. 1)	The key component added in this framework is the "evaluate and create" component which is absent in other commonly cited definitions.
Luckin et al., 2022	The term "AI Readiness" was identified as… "The concept of AI Readiness is a way to describe the transition that those working in education and their students need to make from not understanding what AI is and what AI can do, to being able to understand, in non-	

	technical terms, what AI is capable of achieving." (Luckin et al., 2022, p. 1)	
Wang & Lester, 2023	"AI literacy is the ability to readily engage with AI by leveraging AI tools, systems, and frameworks to effectively and ethically solve problems in a wide range of sociocultural contexts." (Wang and Lester, 2023, p. 229)	This definition contains three major components: Understanding AI Capabilities, Utilizing AI for problem-solving, and Applying AI in a sociocultural context.
Chiu et al., 2024	"AI literacy is defined as "an individual's ability to clearly explain how AI technologies work and impact society, as well as to use them in an ethical and responsible manner and to effectively communicate and collaborate with them in any setting. It focuses on knowing (i.e. knowledge and skills)."." (Chiu et al., 2024, p. 4) "AI competency is defined as "an individual's confidence and ability to clearly explain how AI technologies work and impact society, as well as to use them in an ethical and responsible manner and to effectively communicate and collaborate with them in any setting. They should have the confidence and ability to self-reflect on their AI understanding for further learning. It focuses on how well individuals use AI in beneficial ways."." (Chiu et al., 2024, p. 4)	This definition of AI literacy encompasses a generalized term of how AI works and includes several elements in the Long and Magerko (2020) definition. It introduces the concept of collaboration with AI. It also introduces the concepts of self-confidence and self-reflection.