# Empowering Educators: A Pilot Study on AI Literacy in K–12 Professional Development

Katelyn R. Nelson
Shuqi Du
David T. Marshall
Shawndra Bowers
Asim Ali
*Auburn University*

**Abstract**
As artificial intelligence (AI) continues to reshape modern society, there is an urgent need to equip K–12 educators with the skills and confidence to integrate AI tools into their instructional practice. This pilot study examined the preliminary effectiveness of an asynchronous professional development course designed to increase educators' comfort with AI, shift their perceptions, and expand access to instructional resources. A mixed-methods approach was used to analyze data from 30 participants, including K–12 teachers, preservice educators, and others in educational roles in K–12 schools, who completed pre- and post-course surveys. Quantitative results revealed statistically significant increases in comfort with AI, perceptions of AI, access to resources, and familiarity with AI tools. Correlational analyses found strong positive relationships between perceptions, resource access, and comfort. No significant differences were observed across demographic variables; while this does not establish equivalence, it suggests the course may be broadly accessible across participant groups. Qualitative findings, including participant reflections, highlighted the transformative impact of the course, with educators reporting a shift from skepticism to enthusiasm. The course's modular design, grounded in best practices for professional learning, was well-received and scalable. Recommendations include expanding the course to a larger and more mixed sample, integrating AI training into preservice teacher education, and updating content regularly to reflect the rapidly evolving AI landscape. This research demonstrates that thoughtfully designed, flexible professional development can build AI literacy and empower educators to adopt emerging technologies with confidence and purpose. As data collection is ongoing, these findings represent early trends that will inform future iterations and expanded implementation.

*Keywords*: AI; artificial intelligence; K–12; professional development; teacher preparation; teacher workload; teacher burnout

Nelson, K., Du, S., Marshall, D., Bowers, S., & Ali, A. (2026). Empowering educators: A pilot study on AI literacy in K-12 professional development. *Online Learning, 30*(3), 601–631. https://doi.org/10.24059/olj.v30i3.5251

The integration of artificial intelligence (AI) in K–12 education is more than a technological shift; it represents an opportunity to reimagine how teachers teach and how students learn (Luckin, 2025). As AI tools become increasingly prevalent across industries, their potential to enhance teaching and learning outcomes also grows. Students need to be prepared to be in a world where AI will play a central role in both professional and personal lives. As such, equipping them with the foundational knowledge and ethical awareness needed to understand and engage with AI technologies is essential.

Teachers are the frontline implementers of educational change, and their comfort, confidence, and competence are critical to the successful integration of new technologies, like AI, in classrooms (Shi et al., 2025). Currently, many educators express uncertainty about AI, including its applications, limitations, and ethical implications (Salloum, 2024). Along with these are barriers such as time constraints, a lack of targeted resources, and limited access to high-quality professional development that is both accessible and actionable (Roshan et al., 2024).

Historically, the integration of emerging technologies in schools, such as computers, the internet, and digital learning platforms, has followed a familiar pattern: early adoption by tech-savvy educators, followed by institutional support, and eventual broad adoption across educators (Yadegari et al., 2024). AI, however, presents new complexities due to rapid technological change, and its potential to disrupt existing pedagogical models demands a more deliberate and supported approach to professional learning. Teachers need more than just exposure to AI tools; they need sustained opportunities to develop AI literacy through hands-on application, ethical inquiry, support, and peer collaboration (Tan et al., 2025).

This is critical as policymakers and educational leaders begin calling for AI education at earlier grade levels. National initiatives, such as the AI4K12 framework, outline key concepts students should understand, including how AI systems work, the data they depend on, and the societal impacts they can generate (AI4K12, 2025). But for these efforts to be successful, K–12 educators must first be supported with practical, flexible training that demystifies AI and connects it meaningfully to classroom practice and provides recognition for their learning through innovative credentialing (Rajput & Sharma, 2025; Roshan et al., 2024).

To address this gap, an asynchronous professional development course for K–12 educators was developed. This paper introduces the course, which was designed to equip educators with foundational AI knowledge, promote ethical awareness, and provide practical strategies for classroom implementation. Developed collaboratively with librarians and grounded in instructional design best practices, the course is evidence-based, adaptable to meet various educator needs, and scalable across school systems. By evaluating the course's effectiveness through a mixed-methods research design, this study contributes to the growing body of knowledge on AI in education and offers a practical model for building AI literacy among educators at all levels of experience. This study presents findings from a pilot implementation of the course. As enrollment remains open and additional participants continue to engage with the program, the data reported here represent early trends that will inform iterative development and broader adoption.

# Review of Related Literature

In order to design effective professional development for educators, it is essential to first understand the current landscape of AI in education. The following review synthesizes recent scholarship to highlight how AI is being used in educational settings, the unique challenges and opportunities it presents for K–12 contexts, and the growing emphasis on AI literacy for both teachers and students. By examining existing tools, professional learning frameworks, and implementation barriers, this section provides the foundation for understanding the need for targeted, flexible training models, such as the asynchronous course examined in this study.

### *AI in K–12 Education and Teacher Professional Development*

AI has played a significant role in the digitalization of society (Cooper, 2023). The rapid evolution of AI technology in recent times has influenced individuals' productivity, and many now view AI as a force driving the fourth industrial revolution, with the potential to initiate transformative change in education through personalized training, adaptive curricula, and productive administrative processes (Alawneh et al., 2024; Zhai et al., 2021).

Over the past decade, there has been a significant shift towards data-driven machine learning (ML) techniques, which have outperformed traditional programming and rule-based AI methods across different domains (Darwiche, 2018). Rule-based refers to systems that rely on programmed, pre-established rules and logic, often implemented through if-then statements, regular expressions, and structured look-up tables, rather than learning patterns from data (Pappula & Rusum, 2024). This broader evolution from rule-derived approaches to adaptive ML systems has prompted educators to reassess instructional goals and pedagogical approaches (Pears et al., 2021; Shapiro & Fiebrink, 2019). In education, AI, commonly referred to as AIEd, encompasses technologies such as chatbots, automated grading systems, intelligent tutoring systems, and platforms designed to predict student performance, all of which are intended to enhance and support the educational process (Chiu et al., 2024).

Generative Artificial Intelligence (GenAI), for example, powered by Large Language Models (LLMs) such as ChatGPT, impacts teaching and learning by effectively generating responses to specific tasks (Magrill, 2024). Since OpenAI's public release of ChatGPT in November 2022, the educational landscape has experienced a rapid increase in AI adoption (OpenAI, 2022). Surveys from the 2024–2025 school year indicate that approximately 85% of teachers and 86% of students report using AI tools; however, only 48% of teachers have engaged in formal professional development on integrating AI into the classroom (Vilcarino & Langreo, 2025). This gap underscores the urgent need for targeted professional development to equip educators with the knowledge and ethical frameworks required for effective AI integration.

AI is increasingly integrated across four key areas of education: teaching, learning, assessment, and administration (Chiu et al., 2024). Researchers have adapted modeling and machine learning techniques from the business sector to enhance educational decision-making, including early alert systems to prevent dropout, visualization systems to track learning progress, recommender systems to personalize instruction, and adaptive systems that tailor content to learner needs (Allensworth, 2013; Marshall, 2022; Nistor et al., 2015; Wolff et al., 2013). These systems also leverage learner-behavior data to predict grades, recommend remedial actions, and link performance with future academic or employment opportunities (Berendt et al., 2020).

Beyond these system-level applications, AI is transforming how teachers and students interact with content in the classroom. For example, platforms like Google's Teachable Machine help students train simple models using labeled images or sounds, which helps them grasp foundational ideas such as training data (Vartiaien et al., 2020). Widely used K–12 tools like Google's Teachable Machine, IBM's Machine Learning for Kids, and Wolfram's ML for Middle Schoolers reflect educational technology's "low floor, high ceiling, wide walls" principle, promoting accessibility and adaptability (Pope, 2024, p. 105). Robotics tools like Bee-Bots and LEGO Mindstorms foster algorithmic thinking and problem-solving through iterative design and coding (Kandlhofer et al., 2016). Programming environments (e.g., Scratch extensions), along with *k*-means clustering activities, provide interactive simulations that facilitate the exploration of grouping and classification concepts. These practical experiences help deepen understanding of how AI systems generalize from data (Dhariwal & Dhariwal, 2020; Wan et al., 2020). Personalized platforms such as Knewton and Edmodo adapt learning materials to individual needs, while generative tools like ChatGPT provide real-time feedback that supports reflection and improvement (Chiu, 2024; Chounta et al., 2022; Kohnke et al., 2023). AI-powered dashboards further enable teachers to identify learning gaps, adjust instruction, and monitor progress (Holstein et al., 2018; van Leeuwen & Rummel, 2020). Together, these applications illustrate how AI supports interactive, differentiated, and authentic learning experiences that mirror real-world AI practices.

At the same time, researchers have emphasized the growing need for AI literacy among educators and students (Dai et al., 2020; Taguma et al., 2018; Touretzky et al., 2019). K–12 students must understand AI concepts, applications, and ethics to effectively engage with the technology (Kandlhofer et al., 2016; Pedro et al., 2019). Strengthening educators' knowledge and confidence through such professional development initiatives is foundational for cultivating AI literacy among students, as teachers' own understanding directly shapes how AI concepts are introduced and integrated in K–12 classrooms. Researchers have emphasized the need for formal K–12 education to prioritize AI literacy, teaching students to engage with AI critically (Zimmerman, 2018), with particular emphasis on three key domains: AI concepts, AI applications, and AI ethics and safety (Wong et al., 2020). However, survey research from October 2024 found that far fewer than half of colleges and schools of education offered coursework on AI integration or embedded this information in existing courses, fewer than two-thirds had AI policies of their own, and much of the training that did exist focused on preventing student cheating rather than improving teacher practice (Weiner et al., 2024).

Guidance on how to approach AI classroom integration does exist for teachers. The AI4K12 research community has released a set of Five Big AI Ideas, which they believe should be included in the K–12 curriculum (AI4K12, 2025). The AI4K12 framework, developed by the Association for the Advancement of Artificial Intelligence (AAAI), and now jointly sponsored by AAAI and the Computer Science Teachers Association (CSTA), provides a national structure for teaching AI concepts in schools (AI4K12, 2025). The Five Big AI Ideas, (1) perception, (2) representation and reasoning, (3) learning, (4) natural interaction, and (5) societal impact, cover topics from how machines learn from data to the broader societal impacts of AI (Touretzky et al., 2019). The framework promotes AI literacy through conceptual understanding, ethical reflection, and engagement with technology. It has increasingly guided curriculum design and teacher professional development initiatives, offering educators a foundation for integrating AI concepts into classroom practice. Educators have started using AI technologies to address a variety of educational tasks, as demonstrated by the expanding academic conversations occurring at the intersection of AI and education's interdisciplinary fields (Feng & Law, 2021; Luckin & Holmes, 2016).

As schools begin to adopt AI tools, the effectiveness of these technologies ultimately depends on teachers' ability and confidence in using them. Research has increasingly shifted toward understanding how professional development can prepare educators for integrating AI. Studies in this area emphasize the importance of training that combines both technical knowledge and pedagogical application, enabling teachers to effectively integrate AI into instruction while upholding ethical classroom practices. Empirical research has demonstrated the positive impact of structured AI professional development for K–12 educators. For instance, Unal and Unal (2025) reported that a two-session AI workshop significantly reduced workload perceptions, increased prompt-writing self-efficacy, and mitigated key implementation barriers. Similarly, Sun et al. (2023) found that participation in an AI integration program enhanced teachers' self-efficacy and the incorporation of AI tools in lesson planning. These studies demonstrate how targeted professional development can enhance teachers' knowledge, refine their instructional skills, and increase their comfort and confidence with AI tools, while promoting positive shifts in perception toward classroom integration. However, few studies have examined how such outcomes can be achieved through asynchronous professional development, particularly in terms of teachers' access to AI resources. The present study builds on this literature by investigating how an asynchronous AI professional development course affects educators' comfort, perception, and access, key constructs identified in emerging research on AI literacy in K–12 education.

The constructs examined in this study, comfort, perception, familiarity, and access, are well established in the literature as important to educators' technology adoption. Teachers' comfort with technology influences their likelihood of adopting new technology (Bove & Conklin, 2019), while perceptions of AI's value shape their openness and willingness to integrate it into the classroom (Mundy et al., 2012). Familiarity with technology, whether through previous experience or professional development, increases confidence and reduces barriers (Jääskelä et al., 2017; Khlaif, 2018). Access to resources, including professional learning opportunities and support from the school, remains a significant factor affecting technology use in schools (Francom, 2020; Freeman et al., 2017). These four variables provide a useful framework for understanding how professional development can influence teachers' integration of AI into the classroom.

AI can transform education by offering personalized learning experiences tailored to each student's unique needs and interests (Haristiani, 2019). In K–12 settings, generative AI can enhance learning by promoting self-regulated learning (Kong & Yang, 2024). Additionally, AI can support teachers in designing learning activities, scaffolding strategies, and interpreting performance data (Chounta & Avouris, 2016; Pardo, 2018; Roll & Wylie, 2016). Demanding workloads were a persistent issue for classroom teachers before the pandemic (Jennin et al., 2021) and were exacerbated during and following the crisis (Marshall & Pressley, 2024). A recent study found that teachers who used generative AI weekly saved up to six hours per week—the equivalent of six weeks per school year (Gallup Inc. & Walton Family Foundation, 2025). This matters because increased teacher workloads correlate with elevated levels of teacher stress (Bellibaş et al., 2024), lower morale (Marshall et al., 2024), and ultimately increased teacher attrition (Tompkins, 2023). Training teachers to effectively use AI in their classroom practice could improve each of these metrics.

To support teachers in delivering personalized education and boosting student outcomes, AI should be seen as a tool that enhances and complements their work and not as a replacement (Rukadikar & Khandelwal, 2023). From a middle school teacher's perspective, for example, AI can help provide individualized feedback and support to a classroom full of learners who are being introduced to new topics (Pörn et al., 2024). For K–12 students, maintaining engagement is important for fostering long-term enthusiasm for learning; teachers should create AI-assisted environments that promote exploration, curiosity, and interactive learning (Bozkurt & Sharma, 2023; Mogavi et al., 2024). As students increasingly interact with AI technologies, it is essential that they recognize AI, learn how its algorithms function, ethically apply these algorithms to solve relevant problems, and assess AI systems (Ali et al., 2019). To support the successful functioning of future society, teacher education must incorporate AI literacy, which is typically defined as a collection of skills that allow individuals to critically evaluate AI technologies, interact and collaborate effectively with AI, and use AI as a tool in various settings (Long & Magerko, 2020). As schools and educators navigate these complex opportunities and challenges, professional development emerges as a central mechanism for equipping teachers with the confidence, skills, and ethical frameworks required to use AI effectively. Given teachers' demanding schedules and varying levels of prior experience with educational technology, online and flexible professional learning formats are especially important.

### *Asynchronous Online Professional Development*

Asynchronous online learning has become an essential model for educator professional development, offering flexibility, accessibility, and opportunities for educators to revisit content for continued reflection and ongoing learning (Picault, 2021). Unlike traditional face-to-face or synchronous online formats, asynchronous environments allow educators to engage with content and peers at their own pace, an advantage given the demanding workloads and schedules of teachers. Research on online learning demonstrates that asynchronous formats can foster deep engagement through reflective discussions, self-regulated learning, and the integration of new practices into teaching (Lin & Sun, 2024). In the context of AI integration, asynchronous professional development can further enhance educators' comfort and pedagogical strategies without the time pressures of synchronous participation.

While research highlights many advantages of professional development, it is not without challenges. Some studies have noted barriers related to technology access and feelings of isolation among participants. For instance, participation in online learning depends on consistent internet connectivity and access to digital tools, conditions that may not be universally available to educators (Mhlanga, 2024). Additionally, participants in asynchronous courses sometimes report a sense of isolation due to limited real-time interaction with peers and instructors (Gillett-Swan, 2017). This can be mitigated by incorporating features that intentionally foster a sense of instructor social presence among learners in the course (Garrison et al., 1999; Love & Marshall, 2022; Marshall & Love, 2025). Recognizing these challenges, the present study builds upon existing research by examining how a purposefully designed asynchronous professional development course can support K–12 educators in developing knowledge, skills, and self-efficacy related to AI while intentionally addressing barriers to engagement and connection.

### *Innovative Credentialing and Recognition in K–12 Professional Development*

As professional development evolves to meet the needs of educators, innovative credentialing systems such as digital badges and microcredentials have emerged as an increasingly popular form of recognition. Digital badges are visual credentials that signify the acquisition of specific skills or knowledge, verified by an issuing institution or organization. They are particularly well-suited to asynchronous and modular learning environments, offering a flexible way to validate competencies not typically captured through traditional certification (Gibson et al., 2015). In the context of AI professional development, digital badges provide immediate and motivating recognition for educators' learning, supporting engagement and reinforcing the value of microlearning. They also offer transparency through metadata, detailing the badge criteria, issuer, and associated competencies (Randall et al., 2013). This makes badges useful for showcasing skills to colleagues, school leaders, or broader professional networks, including potential employers (Carey & Stefaniak, 2018). This alignment between flexible training and visible recognition supports the broader movement toward competency-based professional learning, where educators are empowered to demonstrate growth in applied areas such as AI integration and digital literacy. While digital badges offer a promising way to recognize and incentivize educator learning, their implementation must be accompanied by systemic support to ensure access and meaningful use. Issues of access, training, and ethical adoption, particularly about AI tools, remain significant challenges for many districts. As such, credentialing innovations like digital badges should be viewed not merely as tokens of completion but as part of a sustained professional learning ecosystem that encourages reflective practice and continued engagement with emerging technologies.

### *Challenges in Integrating AI into K–12 Education*

Integrating AI into K–12 education presents several challenges, including limited collaboration and support, varying entry-level skills, unequal access to resources, and differing perceptions of AI among educators. Despite growing interest in student-AI collaboration, meaningful implementation of such practices remains limited because few teachers have sufficient guidance or examples of effective classroom use (Kim et al., 2023). One of the primary reasons for this difficulty is that many K–12 teachers lack the necessary knowledge and experience to teach and use AI effectively. To integrate these emerging technologies, teachers must overcome significant learning challenges related to unfamiliar subjects and often require substantial support from coaches and curriculum specialists (Ottenbreit- Leftwich et al., 2023). A comprehensive report on K–12 educational platforms (Ferguson et al., 2016) revealed that "intelligent" educational tools are seldom consistently used in classrooms, with potential explanations pointing to insufficient investment in resources or inadequate teacher training

(Freeman et al., 2017). For teachers to feel comfortable implementing a new technology in the classroom, they need access to a support system, including training and resources. Beyond access to training and resources, individual factors such as teachers' beliefs, comfort, and prior experiences also shape whether and how they choose to adopt AI technologies in their classrooms. The asynchronous professional development course examined in this study primarily addresses the challenges of entry-level AI skills and educators' perceptions and comfort, while broader issues related to collaboration and access are acknowledged but remain outside the scope of this pilot study.

Adoption of AI tools by teachers is influenced by multiple interrelated factors (Nelson et al., 2025), including ethical concerns, comfort level, prior experience, and perceptions of value. Teachers' concerns about the ethical use of AI in education often center on issues of privacy and data security, such as the implications of inputting student work into AI for grading or feedback purposes (Filiz et al., 2025). Additionally, educators express concerns about the accuracy of AI-generated information and its potential to diminish students' creativity, effort, and critical thinking skills. Teachers' comfort with new technologies also affects their likelihood of adoption; those who feel more confident and are supported are more inclined to integrate emerging tools into their teaching (Bove & Conklin, 2019). Prior experience plays a similar role; teachers with experience using similar technologies reported greater comfort and readiness when incorporating new ones (Jääskelä et al., 2017; Khlaif, 2018). Moreover, teachers' perceptions of the usefulness and instructional value of AI influence their willingness to adopt it. Mundy et al. (2012) found that teachers who not only learned about the technology but also how to effectively integrate it into their instruction were significantly more likely to use it than those who received only conceptual exposure. Collectively, these findings highlight the importance of addressing ethical awareness, technological comfort, and experiential familiarity when designing professional development initiatives to support the integration of AI in K–12 education. Because teachers' readiness and confidence directly influence classroom innovation, professional learning opportunities must move away from basic technical training to include ongoing mentorship and ethical reflection (Mouta et al., 2025). Beyond individual factors such as comfort, ethics, and prior experience, broader elements, including teaching experience, school type, and institutional policies, also influence teachers' readiness to integrate AI tools into their classrooms.

Educators' comfort with AI and other emerging technologies is shaped by multiple contextual factors, including teaching experience, school size and type, and district technology policies. Research indicates that pre-service and early-career teachers often demonstrate a higher willingness to adopt new technologies, although their pedagogical approaches may be less developed. In contrast, more experienced teachers may show lower confidence in integrating new technologies, despite having stronger instructional expertise (Forkosh-Baruch et al., 2021; Liu et al., 2015). School characteristics can also affect technology adoption: smaller schools often report greater access and administrative support than larger districts, while very small schools may face unique infrastructure barriers (Francom, 2020). Additionally, school type (e.g., public, private, charter, magnet) can impact the availability of resources and professional learning opportunities (Flavin, 2016). Finally, district technology-accessibility policies play a significant role in shaping teachers' opportunities to engage with AI tools. Federal initiatives such as the *National Education Technology Plan* (U.S. Department of Education, Office of

Educational Technology, 2023) and recent AI integration guidelines (U.S. Department of Education, Office of Educational Technology, 2024; Executive Office of the President of the United States, 2025) emphasize closing digital access divides and expanding educator training. However, implementation remains largely dependent on local resources and leadership (Patrick et al., 2021). Demographic and contextual factors are important in understanding the variability in teachers' comfort and readiness to use AI.

Since teachers play a pivotal role in implementing new pedagogical innovations in the classroom, successfully integrating AI concepts into K–12 education requires an AI-focused curriculum, suitable teaching resources, and adequate teacher preparation (Lindner & Berges, 2020). However, AI remains a new and unfamiliar subject for most teachers, who often complain about AI concepts and their functions. This is primarily due to their lack of experience and familiarity with the subject (Ottenbreit-Leftwich, 2023; Vazhayil, 2019). Addressing teachers' concerns about their limited knowledge of AI is critical. As AI skills rapidly evolve into essential life skills, schools will play a key role in fostering them. Therefore, comprehensive and intensive teacher training in AI is necessary to ensure effective instruction and the development of AI competencies (Lindner & Berges, 2020).

### *Conceptual Framework*

This study is grounded in the Technology Acceptance Model (TAM), originally proposed by Davis (1985), which has undergone three iterations. The first iteration, TAM1, says that individuals' adoption of a technology is primarily shaped by perceived usefulness and perceived ease of use, which together influences attitudes and behavioral intention to use a tool. Building on this, TAM2 added social influence and cognitive instrumental factors that further explain perceived usefulness (Venkatesh & Davis, 2000), while TAM3 extended the model by specifying additional determinants of perceived ease of use, including output quality, job relevance, and result demonstrability (Venkatesh & Bala, 2008). Because AI adoption in K–12 settings depends on educators' beliefs about usefulness, ease, and contextual supports, TAM provides an appropriate lens for interpreting changes in teachers' comfort, perceptions, familiarity, and access following asynchronous professional development.

## Methods

Guided by the Technology Acceptance Model, this study employed a concurrent mixed-methods design to evaluate the impact of an asynchronous professional development course aimed at building K–12 educators' self-perceived knowledge, comfort, and practical capacity to use AI in educational settings, using a mixed-methods approach to analyze data collected from pre- and post-course surveys (Creswell et al., 2011). Quantitative and qualitative data were analyzed together through a triangulated mixed-methods approach, allowing statistical results on comfort, perception, and familiarity to be interpreted alongside participants' reflections, lesson plans, and peer discussions for a more comprehensive understanding of the course's impact. This work was guided by the following questions:

1. How does participation in an asynchronous professional development course impact educators' overall engagement with artificial intelligence in education?
    a. How does the course affect educators' comfort with using AI in their professional practice?

    b. How does the course influence educators' perception of the value and role of AI in education?
    c. How does the course impact educators' access to and awareness of AI-related resources?
2. How does participation in the course influence educators' familiarity with AI tools and their potential classroom applications?
3. How does participation in the asynchronous professional-development course influence educators' openness to learning about AI and their post-course comfort, and do these outcomes vary by demographic factors (e.g., role, experience, or school type)?
4. What evidence exists of educators' application of AI in practice following the course, and what does this usage reveal about the transfer of learning from professional development to classroom practice?

Both quantitative and qualitative data were collected between November 2024 and April 2025. Thirty participants completed both the pre- and post-course surveys with matching identifiers, allowing for paired statistical analysis. In addition to survey results, participants' reflections, lesson plans, and discussion responses were collected to provide deeper insight into the course's effects. This study specifically examined how participation in an asynchronous professional development course improved educators' knowledge and skills related to AI integration, as measured through self-perception surveys administered before and after the course. To provide context for the study, it is important to describe the design and structure of the asynchronous professional development course that served as the intervention.

### *Course Design and Development*

The asynchronous AI course was developed by an instructional design team within a university-based teaching and learning center that specializes in developing online professional development and academic courses. The development process was informed by a collaboration with a state librarians' association, which provided input on educators' needs and the types of AI training most relevant to K–12 contexts. This collaboration began during a pre-conference workshop in February 2024. This workshop brought together educational librarians who support K–12 teachers and technical systems. Through structured discussion and feedback, participants identified key gaps in AI understanding and outlined the types of training most needed to support widespread AI adoption in schools. These conversations highlighted varying levels of familiarity with AI concepts among educators, limited resources, and the necessity of a flexible training model that honors educators' time constraints.

Insights from this session directly shaped the development of a modular, research-aligned course tailored to K–12 educators. The workshop participants emphasized the need for an asynchronous format that allowed educators to engage at their own pace while offering practical tools, scenarios, and opportunities for reflection. The finalized course launched in November 2024 after a pilot at a state educational technology conference in June 2024.

The course includes eight modules: an introductory module, six content modules, and a concluding reflection module. The six core content modules were designed around themes that emerged from workshop data and research:

1. An overview of AI in education

2. Safety and ethical considerations
3. Information literacy and critical thinking
4. Utilizing AI for teaching and administration
5. Exploring AI tools for student learning
6. Assessment and evaluation

Each module follows a consistent structure: an opening overview, an instructional video featuring AI-generated personas, interactive readings, visuals, classroom scenarios, and practice opportunities. The personas—which include a fictional principal, librarian, two teachers, and a counselor—guide participants through the content in the context of a fictional K–12 school called the Innovation Academy. These characters were created to simulate peer dialogue and make complex topics more accessible.

Participants were placed in discussion forums based on grade level (e.g., PreK, elementary, middle, high school, special populations) to facilitate peer learning and shared lesson planning. Each module included hands-on activities, classroom implementation tasks, and reflection prompts. Participants earned microcredentials after each module and received a printable certificate and a digital "AI Educator Extraordinaire" badge upon course completion. This design supports professional learning best practices such as active engagement, sustained support, and direct application (Darling-Hammond et al., 2017; Guskey, 2002).

The course content was informed by national AI and computer science frameworks (e.g., AI4K12), legislative guidelines, and current scholarship in AI ethics and digital literacy. The development team prioritized accessibility, flexibility, and a clear connection to the classroom application. While the AI4K12 framework served as a curricular design guide for selecting AI-related concepts within the professional development course, it was not used as the theoretical framework for this study. Instead, the research is grounded in teacher professional learning, emphasizing how structured professional development influences educators' knowledge, comfort, and applications of emerging technologies.

***Participants and Data Collection***

Thirty participants completed both pre- and post-course surveys between November 2024 and April 2025 with matching identifiers, forming the initial sample for this pilot study. As the asynchronous professional development course remains open to new participants, these findings reflect data from the first cohort of teachers. Participants included current K–12 teachers ($n = 11$), preservice teachers ($n = 8$), and other educational professionals ($n = 11$), including administrators and homeschool educators. Although administrators are not classroom teachers, they were intentionally included in the professional development course because they support and oversee the integration of instructional technology within their schools. Including administrators alongside teachers ensured that both groups received consistent information about AI tools, ethics, and implementation strategies, promoting alignment between classroom practice and institutional decision-making. Of the 30 participants, 19 identified as female, 10 as male, and one selected "self-describe," though this response was excluded from gender-based statistical comparisons for privacy considerations.

Demographic information was gathered through the pre-course survey. The majority of participants held a master's degree (n = 13), while others reported having a bachelor's (n = 5), associate's (n = 5), or a doctoral degree (n = 1); six participants preferred not to respond. Most participants identified as White or Caucasian (n = 26), with limited representation from other racial and ethnic backgrounds. Employment status varied: 16 participants were employed full-time, six part-time, and eight reported "other," which primarily included preservice teachers not yet working in K–12 settings. Participants represented a range of school types, including public schools (n = 11), virtual or online schools (n = 6), micro or hybrid schools (n = 1), and "other" (n = 12), which again included preservice teachers. Eleven participants reported working in Title I schools. The participants had an average age of 27 years (M= 27.33; SD = 10.49), with notable variation across groups: K–12 teachers averaged 33.91 years (*SD* = 11.35), preservice teachers averaged 20.63 years (*SD* = 2.45), and other participants averaged 25.64 years (*SD* = 9.95). Among current K–12 teachers, the average number of years teaching was 9.36 (*SD* = 9.82).

In addition to quantitative survey data, qualitative data were collected through participants' written reflections, lesson plan submissions, and peer feedback discussions completed within the asynchronous course platform. Participants were encouraged to apply course concepts by designing AI-integrated lesson plans and commenting on peers' submissions to foster collaborative reflection and idea exchange. These qualitative activities provided insight into educators' evolving comfort, perceptions, and strategies for implementing AI in educational settings.

Example prompts included: "What additional steps might you take to teach your students to critically evaluate AI-generated information themselves?" and "How can K–12 teachers effectively integrate AI tools into the classroom while maintaining the crucial elements of human interaction and creativity in education?" These questions were designed to encourage reflection on both the opportunities and challenges of AI integration, connecting directly to the constructs of comfort, perception, and access explored in the study.

### *Survey Instrumentation*

Pre- and post-course surveys were developed by the university's teaching and learning center to evaluate the effectiveness of an AI-focused professional development course for K–12 educators. They were designed to measure changes in participants' self-perceived AI-related knowledge, self-reported skills for classroom integration, perceptions, comfort levels, and access to AI-related resources using structured, closed-ended items. The goal was to capture measurable shifts in the key areas of AI integration in education through reliable, standardized data collection.

Both surveys incorporated Likert-type scales and multiple-choice descriptive questions. Items were grouped into several key constructs aligned with the course objectives: (1) familiarity with AI, which served as an indicator of participants' AI-related knowledge and understanding of AI concepts and tools; (2) openness to learning; (3) perceived value and relevance of AI in education and professional practice; (4) comfort using AI in various settings; and (5) access to and satisfaction with AI-related training resources. These constructs were informed by current literature on educational technology adoption and teacher professional development, particularly in emerging technology contexts (Nazaretsky et al, 2022).

Participants rated their familiarity with AI and their willingness to learn about it on a 10-point scale ranging from 1 (“not familiar/open”) to 10 (“extremely familiar/open). Perceptions of AI’s value were measured using a 6-point Likert scale, where 1 indicated *strongly disagree*, and 6 indicated *strongly agree.* Example statements included “AI could enhance my productivity” and “AI technologies will affect my career in the next year.” Comfort with AI was evaluated through a series of items assessing comfort levels in five areas: daily use, professional responsibilities, instructional applications, workplace integration, and general proficiency. Each was rated on a 6-point scale where a 1 indicated *very uncomfortable*, and a 6 indicated *very comfortable*, with an additional “not applicable” option to accommodate varying job roles.

To assess access to and engagement with training, participants responded to statements addressing the availability, clarity, and variety of AI training materials, as well as their confidence in seeking out such resources. Additional multiple-choice items captured participants’ preferred methods for learning about AI (e.g., social media, websites, colleagues), frequency of engaging in AI-related training, and perceived barriers to implementation, such as cost, complexity, or lack of institutional support. These data points offered insights into the professional development courses surrounding AI adoption in K–12 settings.

The post-course survey retained all core constructs from the pre-survey to enable comparative analysis and added items specific to the course experience. These included measures of satisfaction, perceived relevance of course materials, increased confidence in using AI, and likelihood of integrating AI into future teaching or professional practice. All survey items were reviewed by subject matter experts in instructional design and educational technology to ensure content validity. To preserve anonymity while allowing for pre-post data matching, participants generated a unique identifier, typically a combination of their birthdate and street number digits, to use consistently for both surveys.

To evaluate internal consistency across the measured constructs, Cronbach’s alpha was calculated for each construct, with the pre- and posttest combined for each construct. The resulting alphas indicated strong internal consistency for comfort ($\alpha = .818$) and access to resources ($\alpha = .876$). For perception, three incomplete cases were removed that did not complete all the perception questions, and the resulting alpha indicated strong internal consistency ($\alpha = .761$). This suggests stable construct measurement over the course duration.

Overall, the pre- and post-surveys provided a reliable and replicable framework for assessing changes in educators’ readiness to engage with AI. Reliability was strengthened through consistent administration of identical items at both time points, careful construct alignment with course objectives and established technology-adoption research, and verification of internal consistency using Cronbach’s alpha across the combined pre/post dataset. The use of standardized Likert-type, matrix, and 10-point rating scales supported replicability by enabling straightforward reuse of the instrument and comparison across groups. Because these measures reflect self-perception, complementary qualitative data were gathered separately through in-course discussions and participant reflections to triangulate findings and add depth. These qualitative artifacts served as practical demonstrations of evolving understanding and confidence, allowing the research team to compare participants' reported growth with evidence of transfer into teaching. The following constructs formed the basis of the survey and guided the analysis of changes observed between the pre- and post-course measures.

### *Key Constructs and Measures*

This study examined four primary constructs: comfort, perception, familiarity, and access to AI resources. Each construct was operationalized through items in the pre- and post-course surveys designed to assess changes in educators' confidence, attitudes, and resource awareness. Comfort refers to an educator's self-reported level of ease or confidence when using AI tools in education. Perception is defined as an educator's attitudes, beliefs, or opinions regarding the value, relevance, and potential impact of AI in education. Familiarity measures the degree to which educators understand AI concepts, tools, and classroom applications. Access to AI-related resources includes both the availability and usability of tools, training, and support necessary for effective AI use. While the professional development course itself is considered a resource, access may still be limited by external factors such as paywalls (e.g., requiring a subscription for tools like ChatGPT), institutional policies that restrict or ban AI tools, or lack of infrastructure or support within a school or district.

### *Data Analysis*

Quantitative data were analyzed descriptively first. To determine whether statistically significant changes existed in participants' comfort with AI, perception of AI, familiarity with AI tools, and access to AI-related resources, paired-sample $t$-tests were conducted. Changes were considered significant at the $p < .05$ level, and effect sizes ($d$) were calculated to assess the magnitude of these changes. In addition, Spearman's rho correlations were conducted due to the non-normal distribution of some variables. These analyses were used to explore relationships between key constructs, particularly between participants' perceptions of AI and their comfort levels, as well as between resource access and comfort. To investigate potential differences in outcomes based on participant characteristics, independent-sample $t$-tests and factorial analysis of variance (ANOVA) tests were conducted to examine variables such as gender, school type, Title I status, and employment role. SPSS version 30 was used to analyze all quantitative data. Qualitative data were analyzed using ATLAS.ti version 25. Participant reflections, lesson plans, and peer feedback posts were analyzed using inductive coding to identify recurring themes in participants' experiences with AI tools and pedagogical applications. Two researchers independently coded a subset of responses and reached consensus through discussion. Triangulation was achieved by comparing qualitative themes with quantitative results from the pre- and post-course surveys, examining how participants' reported comfort, familiarity, and perceptions aligned with their written reflections and lesson plan evidence. This mixed-methods approach strengthened the credibility of findings by linking educators' self-perceptions with authentic demonstrations of knowledge and skills development.

### *Validity and Rigor*

Validity and rigor were addressed through design and analytic strategies. First, internal validity was supported by using a paired pre/post-test survey design with matching identifiers, which allowed each participant to serve as their own comparison. Second, construct validity was strengthened by aligning survey items to clearly defined constructs grounded in prior technology-adoption and AI professional development, and by confirming internal consistency through Cronbach's alpha for each construct. Third, methodological triangulation increased credibility by comparing quantitative change scores with qualitative evidence from reflections, lesson plans, and peer discussion posts. Despite these strategies, the small pilot sample limits external validity and may overrepresent early adopters who were already open to AI, creating potential selection bias. This limitation is acknowledged in the discussion and recommendations, and future studies will incorporate larger samples.

## Results

The findings are presented in alignment with the four research questions. Quantitative results address RQs 1-3 using pre- and post-survey comparisons, correlations, and demographic analyses. Qualitative findings address RQ4 by summarizing patterns in participants' reflections, lesson plans, and peer discussion posts.

### RQ1. How does participation in an asynchronous professional development course impact educators' overall engagement with artificial intelligence in education?

Paired-sample *t*-tests showed statistically significant improvements across all three core constructs: comfort with AI, perceptions of AI, and access to AI resources. See Table 1 for means, *p*-values, and effect sizes.

**Table 1**

*Effect of Course Completion on Key Constructs*

| Construct | Pre-Test Mean | Post-Test Mean | *p*-value | Cohen's *d* |
|---|---|---|---|---|
| Comfort with AI | 3.320 | 4.824 | <.001** | 1.07 |
| Perception of AI | 5.447 | 6.087 | .011* | .50 |
| Resource Access | 3.667 | 4.706 | .003** | .60 |

*Notes.* Scale is from 1–7 for each construct.
$p < .01$ = significant at the .01 level (**), $p < .05$ = significant at the .05 level (*).

### *RQ1a. How does the course affect educators' comfort with using AI in their professional practice?*

Participants' comfort with AI increased from a pre-test mean of 3.32 to a post-test mean of 4.82 ($p < .001$, $d = 1.07$), indicating a large effect**.** These results suggest that the course substantially strengthened educators' confidence and ease in using AI tools for professional and instructional purposes.

### *RQ1b. How does the course influence educators' perception of the value and role of AI in education?*

Perceptions of AI improved from 5.45 to 6.09 ($p = .011$, $d = 0.50$), indicating significantly more positive perceptions following the course. Participants left the course with stronger beliefs about AI's usefulness and relevance in K–12 settings.

***RQ1c. How does participation in the course influence educators' familiarity with AI tools and their potential classroom applications?***

Access to AI-related resources rose from 3.67 to 4.71 ($p = .003$, $d = 0.60$), showing significant improvement in access to and awareness of AI resources. This suggests the course helped educators identify, locate, and feel more capable of using AI-related tools and support.

**RQ2. How does participation in the course influence educators' familiarity with AI tools and their potential classroom applications?**

Participants reported a significant increase in familiarity with AI, moving from a pre-test mean of 5.20 to 7.17 post-test ($p < .001$, $d = 0.74$). This indicates that participants perceived themselves as substantially more knowledgeable about AI tools and how these tools could be applied in educational contexts following the course.

**Table 2**

*Significance of Course on Familiarity*

| Question | Pre-Test Mean | Post-Test Mean | *p*-value | Cohen's *d* |
|---|---|---|---|---|
| Familiarity with AI | 5.200 | 7.167 | <.001** | .74 |

*Note. Scale is from 1-10 for each question.*
*p < .01 = significant at the .01 level (**), p < .05 = significant at the .05 level (*).*

**RQ3. How does participation in the asynchronous professional development course influence educators' openness to learning about AI and their post-course comfort, and do these outcomes vary by demographic factors?**

Openness to learning about AI showed no statistically significant change (7.83 to 7.97, $p = .762$), likely due to a ceiling effect, as participants already reported high levels of openness before the course. See Table 3 for means, *p*-values, and effect sizes.

**Table 3**

*Significance of Course on Openness to Learn*

| Question | Pre-Test Mean | Post-Test Mean | *p*-value | Cohen's *d* |
|---|---|---|---|---|
| Openness to Learn | 7.833 | 7.967 | .762 | .06 |

*Note. Scale is from 1-10 for each question.*
*p < .01 = significant at the .01 level (**), p < .05 = significant at the .05 level (*).*

***Relationships Among Openness, Comfort, Perception, and Access (Exploratory)***

To better understand how key constructs relate to educators' willingness to engage with AI, correlations were examined. Statistically significant correlations were found between participants' comfort with AI and both perception of AI and access to AI resources. At pre-test, comfort was positively correlated with perception ($\rho$ = .538, $p$ = .002) and with access ($\rho$ = .549, $p$ = .002). These relationships remained significant at post-test: perception ($\rho$ = .446, $p$ = .014) and access ($\rho$ = .525, $p$ = .003). These findings suggest that favorable attitudes toward AI and awareness of resources are strongly linked with comfort in applying AI.

### *Demographic Differences in Post-course Comfort*

Independent-sample *t*-tests revealed no significant differences in comfort with AI based on gender ($p$ = .395, $d$ = .10), education level ($p$ = .479, $d$ = .30), or Title I status ($p$ = .793, $d$ = .10). Education level was operationalized as having a graduate degree (i.e., master's, doctorate, professional) or not. See Table 4 for results.

**Table 4**

*Independent Samples t-Test Results: Gender and Title I Status*

| Variable | Group Comparison | $t$(df) | $p$-value | Cohen's $d$ |
|---|---|---|---|---|
| Gender | Male vs. Female | -.864(27) | .395 | .10 |
| Education Level | Grad Degree vs. No | -.720(22) | .479 | .30 |
| Title I Status | Yes vs. No | .264(28) | .793 | .10 |

*Note.* Given the small sample sizes, Mann-Whitney U tests were also conducted for each of the variables, yielding similar results.

Spearman correlations with continuous variables also revealed no significant associations. Age ($\rho$ = .007, $p$ = .971) and years of teaching ($\rho$ = –.200, $p$ = .308 and comfort with AI did not reach statistical significance. See Table 5 for results.

**Table 5**

*Comfort with AI by Age and Years of Teaching*

| Variable | Spearman's $\rho$ | $p$-value | N |
|---|---|---|---|
| Age (in years) | .007 | .971 | 30 |
| Years of Teaching | -.200 | .308 | 28 |

These results indicate that demographic variables had little to no effect on participants' post-course confidence using AI, suggesting the course's effectiveness was consistent across professional contexts.

### RQ4. What evidence exists of educators' application of AI in practice following the course, and what does this usage reveal about the transfer of learning?

Qualitative analysis of participants' end-of-course reflections, lesson plan submissions, and peer discussion responses revealed clear evidence of transfer from professional development into practice-oriented thinking. Because reflection and discussion prompts varied across modules, participants did not respond to a single uniform set of questions; therefore, findings are reported thematically rather than quantified by frequency. Across data sources, participants consistently described applying course concepts to instructional planning, student learning supports, ethical literacy, and administrative work. Many participants reported using AI tools to assist with lesson design and instructional preparation, noting that platforms such as Canva, Edpuzzle, and Lumio could streamline the development of visually engaging or interactive class materials. These reflections often emphasized that AI-supported design reduced planning time while expanding the variety of instructional resources educators felt able to create.

In addition to lesson design, participants frequently discussed plans for using AI to personalize or scaffold student learning. Teachers described AI as a tool for generating differentiated activities, supporting individualized feedback, or adapting content to meet various learner needs. Several reflections linked these uses of AI in instruction to workload relief, suggesting that time saved through the use of AI could be used with students. Further, a strong emphasis emerged around ethical AI use and critical thinking. Teachers described strategies for verifying outputs generated by AI, identifying potential bias, and ensuring accuracy, and many teachers extended these ideas into how they could teach students how to use AI. Educators outlined plans to explicitly teach learners how to evaluate AI-generated information, check credibility, and reflect on responsible use.

Finally, participants recognized AI as a support tool beyond simply using it in the classroom. Many participants described administrative uses such as summarizing information, drafting communications, organizing tasks, or automating repetitive professional responsibilities. These applications of AI were often framed as realistic, near-term uses that could reduce burnout. Together, these patterns show that educators moved from an overall awareness of AI toward specific, practice-oriented applications. Their reflections and lesson plans demonstrate that course participation not only supported changes in mindset but also the development of strategies for integrating AI into K–12 education.

### *Summary of Key Findings*

This pilot study explored the impact of an asynchronous professional development course on K–12 educators' engagement with AI in education. Participation in the course led to statistically significant improvements in educators' comfort with AI, perceptions of its value, and awareness of AI-related resources, with medium to large effect sizes. Educators' familiarity with AI increased significantly, while openness to learning about AI remained stable, likely due to already high pre-course scores. Demographic variables, including gender, years of teaching, and whether a teacher taught at a Title I school, were not significantly associated with post-course comfort with AI, suggesting the course was broadly effective across participant profiles. Evidence from participant reflections revealed a wide range of practical applications, from instructional design and student engagement to time-saving strategies and critical evaluation of AI outputs. Many educators developed lesson plans, instructional activities, and classroom policies that incorporated AI in thoughtful and pedagogically sound ways. Overall, the course positively influenced both mindset and practice, supporting educators in building the knowledge, confidence, and capacity needed to integrate AI responsibly in educational settings.

## Discussion

The results of this pilot study provide preliminary evidence that an asynchronous, modular professional development course can significantly enhance educators' self-perceived knowledge and comfort with AI, positively influence their perceptions, and increase their awareness of available AI resources. These outcomes align with those of Lindner and Berges (2020), who emphasize the importance of targeted professional development for effectively integrating AI into educational practice. Gains were found across all three key constructs: comfort with AI, perceptions of AI, and access to resources. These findings suggest that the course effectively addressed barriers often associated with technology adoption in K–12 environments, including unfamiliarity, limited access, and skepticism. This supports the work of Nazaretsky et al. (2022), who identify these constructs as central components in AI-focused educator training programs. These patterns are also consistent with TAM, which states that perceived usefulness and perceived ease of use are important factors in educators' willingness to adopt new technologies (Davis, 1985; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). In this study, perception aligns with perceived usefulness, comfort aligns with perceived ease of use, and access reflects facilitating opportunities that support adoption.

One of the strongest insights emerged in the relationship between participants' perceptions of AI and their comfort levels. Correlational analyses found moderate to strong positive relationships at both pre- and post-test, indicating that those who perceived AI more favorably also reported greater comfort using it. This relationship held after course completion, suggesting that the course not only improved skills but also shifted attitudes. Similarly, participants who were more aware of AI resources were significantly more comfortable using AI, both before and after the course. These findings reinforce the importance of providing teachers with both practical resources and opportunities to build confidence, aligning with Long and Magerko (2020), who argue that for educators to effectively integrate AI, they must first be equipped with the necessary skills and support. An important caveat to consider is that the pilot findings may reflect the attitudes of *early adopters*—those more open to exploring emerging technologies in the first place.

Interestingly, the study found no statistically significant differences in comfort with AI based on demographic factors such as age, gender, race, education level, school type, or employment status. While these results do not provide statistical evidence of equivalence, the absence of significant differences suggests that the course may have been broadly accessible and relevant across participant groups. This assumption should be interpreted cautiously, as the small and relatively homogenous sample may have limited the detection of group-level variation. The lack of demographic differences may also reflect a common trait among participants: they were likely early adopters of educational technology, already predisposed to engaging with innovative tools such as AI.

Qualitative findings also demonstrated how educators translated course learning into practice. Across reflections, lesson plan submissions, and peer discussions, participants described concrete applications of AI for classroom planning, student support, and ethical AI literacy. Several educators reported shifting from uncertainty or limited awareness of AI use to identifying specific strategies such as generating learning supports, designing AI-integrated activities, and teaching students how to think critically with AI. Participants also emphasized the value of the asynchronous format, peer learning, and scenario-based design in lowering intimidation and increasing confidence. These themes suggest that gains in comfort and perception were connected to emerging practical capacity, supporting the argument that effective professional development must include both conceptual foundations and applied experiences (Zimmerman, 2018).

The findings outlined here are promising; however, it is worth noting that not all teachers in the U.S. are finding AI to be as useful. Phi Delta Kappan's annual survey of teacher opinions found that teachers' acceptance of AI for tasks ranging from lesson planning to personalizing learning to student test prep fell from the 2024 survey to 2025 (Hendron, 2025). As previously noted, many teachers already experience elevated workloads. Any new tool they are asked to learn must demonstrate value—underscoring the need for effective training. As data collection continues, future analyses will provide a more comprehensive understanding of the course's long-term impact and scalability.

### *Limitations*

There are several limitations that must be addressed in future studies. Among them is the small sample size, which limits the generalizability of the findings. Though meaningful correlations and statistical significance were achieved, future studies should include more robust samples. Additionally, future studies should intentionally recruit educators at varying stages of the technology adoption curve, including those categorized as *late adopters* or *laggards*, to better understand the course's impact across all educators. Finally, this pilot relied primarily on self-perception survey measures; although reflections and lesson plans provided supportive evidence of application, future work would benefit from additional performance-based or observational indicators.

### *Recommendations for Future Research*

Longitudinal studies should follow participants after course completion to assess how AI integration evolves. Follow-up interviews or focus groups would allow for deeper insights into the specific instructional and administrative uses of AI and provide feedback for course refinement. Future studies should intentionally recruit educators at varying stages of the technology adoption curve, including those categorized as late adopters or laggards, to better understand the course's impact across all educators. Future work should also explore the impact of such professional development on student outcomes and ethical practices related to AI use in classrooms. For broader impact, findings should be disseminated beyond academic circles to reach district leaders, policymakers, teacher education programs, and professional learning providers. Doing so would help shape future professional development efforts not only for AI but for other emerging technologies such as virtual and augmented reality.

## Conclusion

This pilot study demonstrates that targeted, well-designed professional development can significantly enhance educators' confidence and readiness to integrate AI into their classrooms. The asynchronous AI course offered not only knowledge acquisition but also practical tools, real-world applications, and community engagement, factors that collectively contributed to its success. The consistent improvement in comfort, perception, and access across all demographic groups suggests that such programs can meet the needs of today's K–12 educators. This initiative serves as a model for supporting educators through the rapidly evolving landscape of educational technology. As AI tools continue to change educational environments, supporting teachers in adopting them responsibly and effectively is important, not only for instructional improvement but also to help reduce teacher burnout and promote retention. Through intentional course design and alignment with established principles of professional learning, the course supported the development of greater confidence and ethical awareness in the use of AI tools. These early findings offer valuable insight for future iterations of this specific course, as well as for the design of other AI professional development initiatives.

**Ethics Board Statement**
This research was approved as exempt by Auburn University's Institutional Review Board (approval # 24-948).

**Funding Statement**
There is no funding associated with this work.

**AI Use Statement**
Generative AI was not used in the creation of this manuscript.

**Conflict of Interest Statement**
There are no conflicts of interest to report associated with this work.

**Data Access Statement**
Data are available upon reasonable request to the corresponding author.

# References


Alawneh, Y. J., Radwan, E. N., Salman, F. N., Makhlouf, S. I. J., Makhamreh, K., & Alawneh, M. S. (2024). Ethical considerations in the use of AI in primary education: Privacy, bias, and inclusivity. In *2024 International Conference on Knowledge Engineering and Communication Systems (ICKECS)* (Vol. 15, pp. 1–6). IEEE. https://doi.org/10.1109/ickecs61492.2024.10616986

Ali, S., Payne, B. H., Williams, R., Park, H. W., & Breazeal, C. (2019). Constructionism, ethics, and creativity: Developing primary and middle school artificial intelligence education. In *International Workshop on Education in Artificial Intelligence K–12 (EduAI'19)* (Vol. 2, pp. 1–4). MIT Media Lab. https://doi.org/ 10.1109/VL/HCC53370.2022.9832963.

Allensworth, E. (2013). The use of ninth-grade early warning indicators to improve Chicago schools. *Journal of Education for Students Placed at Risk, 18*(1), 68–83. https://doi.org/10.1080/10824669.2013.745181

Bellibaş, M., Gümüş, S., & Chen, J. (2024). The impact of distributed leadership on teacher commitment: The mediation role of teacher workload stress and teacher well-being. *British Educational Research Journal, 50*(2), 814–836. https://doi.org/10.1002/berj.3944

Berendt, B., Littlejohn, A., & Blakemore, M. (2020). AI in education: Learner choice and fundamental rights. *Learning, Media and Technology*, *45*(3), 312–324. https://doi.org/10.1080/17439884.2020.1786399

Bove, L. A., & Conklin, S. (2019). Using the technology adoption model to assess faculty comfort with the learning management system. *Online Journal of Distance Learning Administration*, *22*(3), n3.

Bozkurt, A., & Sharma, R. C. (2023). Generative AI and prompt engineering: The art of whispering to let the genie out of the algorithmic world. *Asian Journal of Distance Education, 18*(2), i–vii.

Carey, K. L., & Stefaniak, J. E. (2018). An exploration of the utility of digital badging in higher education settings. *Educational Technology Research and Development, 66*, 1211–1229. https://doi.org/10.1007/s11423-018-9602-1

Celik, I. (2023). Towards intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior, 138*, 107468. https://doi.org/10.1016/j.chb.2022.107468

Chiu, T. K. F., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2024). Teacher support and student motivation to learn with artificial intelligence (AI) based chatbot. *Interactive Learning Environments*, *32*(7), 3240–3256. https://doi.org/10.1080/10494820.2023.2172044

Chiu, T. K. F. (2024). Future research recommendations for transforming higher education with generative AI. *Computers and Education: Artificial Intelligence, 6*, 100197. https://doi.org/10.1016/j.caeai.2023.100197

Chounta, I.-A., & Avouris, N. (2016). Towards the real-time evaluation of collaborative activities: Integration of an automatic rater of collaboration quality in the classroom from the teacher's perspective. *Education and Information Technologies, 21*, 815–835. https://doi.org/10.1007/s10639-014-9355-3

Chounta, I.-A., Bardone, E., Raudsep, A., & Pedaste, M. (2022). Exploring teachers' perceptions of artificial intelligence as a tool to support their practice in Estonian K–12 education.

*International Journal of Artificial Intelligence in Education, 32*(3), 725–755. https://doi.org/10.1007/s40593-021-00243-5

Cooper, G. (2023). Examining science education in ChatGPT: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology, 32*(3), 444–452. https://doi.org/10.1007/s10956-023-10039-y

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda (Maryland): National Institutes of Health*, *2013*, 541–545.

Dai, Y., Chai, C.-S., Lin, P.-Y., Jong, M. S.-Y., Guo, Y., & Qin, J. (2020). Promoting students' well-being by developing their readiness for the artificial intelligence age. *Sustainability, 12*(16), 6597. https://doi.org/10.3390/su12166597

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. https://learningpolicyinstitute.org/sites/default/files/product-files/Effective_Teacher_Professional_Development_REPORT.pdf

Darwiche, A. (2018). Human-level intelligence or animal-like abilities? *Communications of the ACM, 61*(10), 56–67. https://doi.org/10.1145/3271625

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* [Doctoral dissertation, Massachusetts Institute of Technology]. MIT Open Scholarship. http://hdl.handle.net/1721.1/15192

Dhariwal, M., & Dhariwal, S. (2020). Let's Chance: Playful probabilistic programming for children. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1–7). ACM. https://doi.org/10.1145/3334480.338307

Executive Office of the President of the United States. (2025, July). *Winning the race: America's AI action plan.* https://www.whitehouse.gov/wp-content/uploads/2025/07/Americas-AI-Action-Plan.pdf

Feng, S., & Law, N. (2021). Mapping artificial intelligence in education research: A network-based keyword analysis. *International Journal of Artificial Intelligence in Education, 31*(2), 277–303. https://doi.org/10.1007/s40593-021-00244-4

Ferguson, R., Brasher, A., Clow, D., Cooper, A., Hillaire, G., Mittelmeier, J., Rienties, B., Ullmann, T., & Vuorikari, R. (2016). *Research evidence on the use of learning analytics: Implications for education policy*. The Open University. https://oro.open.ac.uk/48173

Filiz, O., Kaya, M. H., & Adiguzel, T. (2025). Teachers and AI: Understanding the factors influencing AI integration in K–12 education. *Education and Information Technologies*, 1–37. https://doi.org/10.1007/s10639-025-13463-2

Finkelstein, J., Knight, E., & Manning, S. (2013). *The potential and value of using digital badges for adult learners: Final report*. American Institutes for Research. https://lincs.ed.gov/publications/pdf/AIR_Digital_Badge_Report_508.pdf

Flavin, B. (2016, July 4). *The Ultimate Guide to 13 different types of schools across America*. Rasmussen University. https://www.rasmussen.edu/degrees/education/blog/types-of-schools/

Forkosh-Baruch, A., Phillips, M., & Smits, A. (2021). Reconsidering teachers' pedagogical reasoning and decision making for technology integration as an agenda for policy, practice and research. *Educational Technology Research and Development*, *69*(4), 2209–2224. https://doi.org/10.1007/s11423-021-09966-7

Francom, G. M. (2020). Barriers to technology integration: A time-series survey study. *Journal of Research on Technology in Education*, *52*(1), 1–16. https://doi.org/10.1080/15391523.2019.1679055

Freeman, A., Adams Becker, S., & Cummins, M. (2017). *NMC/CoSN horizon report: 2017 K–12 edition*. The New Media Consortium. https://www.learntechlib.org/p/182003

Galindo, L., Perset, K., & Sheeka, F. (2021). An overview of national AI strategies and policies. *OECD Going Digital Toolkit Notes*, No. 14, OECD Publishing,

Paris, https://doi.org/10.1787/c05140d9-en.

Gallup, Inc., & Walton Family Foundation. (2025). *Teaching for tomorrow: Unlocking six weeks a year with AI.* Gallup and Walton Family Foundation. https://www.gallup.com/analytics/659819/K–12-teacher-research.aspx

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2–3), 87–105. https://doi.org/10.1016/S1096-7516(00)00016-6

Gibson, D., Ostashewski, N., & Flintoff, K. (2015). Digital badges in education. *Education and Information Technologies, 20*(2), 403–410. https://doi.org/10.1007/s10639-013-9291-7

Gillett-Swan, J. (2017). The challenges of online learning: Supporting and engaging the isolated learner. *Journal of Learning Design*, *10*(1), 20–30.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching, 8*(3), 381–391. https://doi.org/10.1080/135406002100000512

Haristiani, N., Danuwijaya, A. A., Rifai, M. M., & Sarila, H. (2019). Gengobot: A chatbot-based grammar application on mobile instant messaging as language learning medium. *Journal of Engineering Science and Technology, 14* (6), 3158–3173.

Hendron, J. G. (2025). *The 57th annual PDK poll.* Phi Delta Kappan. https://pdkpoll.org/2025-poll-results/

Herman, K. C., Hickmon-Rosa, J., & Reinke, W. M. (2018). Empirically derived profiles of teacher stress, burnout, self-efficacy, and coping and associated student outcomes.

*Journal of Positive Behavior Interventions, 20*(2), 90–100. https://doi.org/10.1177/1098300717732066

Holstein, K., Hong, G., Tegene, M., McLaren, B. M., & Aleven, V. (2018). The classroom as a dashboard: Co-designing wearable cognitive augmentation for K–12 teachers. In *Proceedings of the 8th International Conference on Learning Analytics and Knowledge* (pp. 79–88). ACM. https://doi.org/10.1145/3170358.3170377

*Home.* AI4K12. (2025, November). https://ai4k12.org

Ingersoll, R., Merril, L., & May, H. (2014). *What are the effects of teacher education and preparation on beginning teacher attrition?* Consortium for Policy Research in Education. https://doi.org/10.12698/cpre.2014,rr82

Jääskelä, P., Häkkinen, P., & Rasku-Puttonen, H. (2017). Teacher beliefs regarding learning, pedagogy, and the use of technology in higher education. *Journal of Research on Technology in Education*, *49*(3–4), 198–211. https://doi.org/10.1080/15391523.2017.1343691

Jerrim, J., & Sims, S. (2021). When is high workload bad for teacher wellbeing? Accounting for the non-linear contribution of specific teaching tasks. *Teaching and Teacher Education, 105*, 103395. https://doi.org/10.1016/j.tate.2021.103395

Kaden, U. (2020). COVID-19 school closure-related changes to the professional life of a K–12 teacher. *Education Sciences, 10*(165). https://doi.org/10.3390/educsci10060165

Kandlhofer, M., Steinbauer, G., Hirschmugl-Gaisch, S., & Huber, P. (2016). Artificial intelligence and computer science in education: From kindergarten to university. In *2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1–9). IEEE. https://doi.org/10.1109/FIE.2016.7757570

Khlaif, Z. (2018). Teachers' perceptions of factors affecting their adoption and acceptance of mobile technology in K–12 settings. *Computers in the Schools*, *35*(1), 49–67. https://doi.org/10.1080/07380569.2018.1428001

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning design to support student–AI collaboration: Perspectives of leading teachers for AI in education. *Education and Information Technologies, 27*(5), 6069–6104. https://doi.org/10.1007/s10639-021-10831-6

Klusmann, U. Kunter, M., Trautwein, U., Lüdtke, O., & Baumert, J. (2008). Engagement and emotional exhaustion in teachers: Does the school context make a difference? *Applied Psychology, 57*, 127–151. https://doi.org/10.1111/j.1464-0597.2008.00358.x

Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). Exploring generative artificial intelligence preparedness among university language instructors: A case study. *Computers and Education: Artificial Intelligence, 5*, 100156. https://doi.org/10.1016/j.caeai.2023.100156

Kong, S.-C., & Yang, Y. (2024). A human-centred learning and teaching framework using generative artificial intelligence for self-regulated learning development through domain knowledge learning in K–12 settings. *IEEE Transactions on Learning Technologies*. https://doi.org/ 10.1109/TLT.2024.3392830

Lin, X., & Sun, Q. (2024). Discussion activities in asynchronous online learning: Motivating adult learners' interactions. *The Journal of Continuing Higher Education*, *72*(1), 84–103. https://doi.org/10.1080/07377363.2022.2119803

Lindner, A., & Berges, M. (2020). Can you explain AI to me? Teachers' pre-concepts about artificial intelligence. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1–9). IEEE. https://doi.org/ 10.1109/FIE44824.2020.9274136

Liu, Q., Zhang, S., & Wang, Q. (2015). Surveying Chinese in-service K–12 teachers' technology, pedagogy, and content knowledge. *Journal of Educational Computing Research*, *53*(1), 55–74. https://doi.org/10.1177/0735633115585929

Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1–16). ACM. https://doi.org/10.1145/3313831.3376727

Love, S. M., & Marshall, D. T. (2022). Video feedback and instructor social presence in an asynchronous online course. *Journal of Effective Teaching in Higher Education, 5*(2), 43-58. https://doi.org/10.36021/jethe.v5i2.324

Lu, Y., Lan, J., & Li, K. (2024). Enhancing AI education through educational games: Evidence from a meta-analysis study. In *2024 13th International Conference on Educational and Information Technology (ICEIT)* (pp. 72–77). IEEE. https://doi.org/ 10.1109/ICEIT61397.2024.10540611

Luckin, R. (2025). Nurturing human intelligence in the age of AI: Rethinking education for the future. *Development and Learning in Organizations: An International Journal*, *39*(1), 1–4. https://doi.org/10.1108/DLO-04-2024-0108

Luckin, R., & Holmes, W. (2016). Intelligence unleashed: An argument for AI in education. *UCL Knowledge Lab: London, UK.*

Magrill, J., & Magrill, B. (2024). Preparing educators and students at higher education institutions for an AI-driven world. *Teaching and Learning Inquiry, 12*, 1–9. https://doi.org/10.20343/teachlearninqu.12.16

Marshall, D. T. (2022). Actionable early warning indicators as predictors of high school graduation. *Preventing School Failure, 66*(3), 206-213. https://doi.org/10.1080/1045988X.2022.2028715

Marshall, D. T., & Pressley, T. (2024). *Lessons of the pandemic: Disruption, innovation, and what schools need to move forward.* Guilford Press.

Marshall, D. T., Smith, N. E., Love, S. M., Neugebauer, N. M., & Shannon, D. M. (2024). "At some point we're going to reach our limit": Understanding the pandemic's impact on teacher burnout and mental health. *Psychology in the Schools, 61*(3), 793-812. https://doi.org/10.1002/pits.23084

Marshall, D. T., & Love, S. M. (2025). Enhancing instructor social presence in asynchronous courses using weekly videos. *Journal for Research and Practice in College Teaching, 10*(1), 1-13. https://www.journals.uc.edu/index.php/jrpct/article/view/8332

Mhlanga, D. (2024). Digital transformation of education, the limitations and prospects of introducing the fourth industrial revolution asynchronous online learning in emerging markets. *Discover education*, *3*(1), 32. https://doi.org/10.1007/s44217-024-00115-9

Mogavi, R. H., Deng, C., Kim, J. J., Zhou, P., Kwon, Y. D., Metwally, A. H. S., Tlili, A., Bassanelli, S., Bucchiarone, A., Gujar, S., Nacke, L. E., & Hui, P. (2024). ChatGPT in education: A blessing or a curse? A qualitative study exploring early adopters' utilization and perceptions. *Computers in Human Behavior: Artificial Humans, 2*(1), 100027. https://doi.org/10.1016/j.chbah.2023.100027

Mouta, A., Torrecilla-Sánches, E. M., & Pinto-Llorente, A. M. (2025). Comprehensive professional learning for teacher agency in addressing ethical challenges of AIED: Insights from educational design research. *Education and Information Technologies*, *30*(3), 3343–3387. https://doi.org/10.1007/s10639-024-12946-y

National Center for Education Statistics. (2025). *School Pulse Panel: Surveying high priority, education-related topics.* U. S. Department of Education. https://nces.ed.gov/surveys/spp/?utm_medium=email&utm_source=newsflash

Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022). Teachers' trust in AI-powered educational technology and a professional development program to improve it. *British Journal of Educational Technology*, *53*(4), 914–931. https://doi.org/10.1111/bjet.13232

Nelson, K. R., Marshall, D. T., & Manning, K. Q. (2025). Teaching in the age of AI:

Exploring faculty perceptions and practices. *SocArXiv.* https://doi.org/10.31219/osf.io/nqb84_v1

Nistor, N., Derntl, M., & Klamma, R. (2015). Learning analytics: Trends and issues of the empirical research of the years 2011–2014. In *Lecture Notes in Computer Science* (pp. 453–459). Springer. https://doi.org/10.1007/978-3-319-24258-3_39

OpenAI. (2022). *Introducing ChatGPT [Large language model]*. https://openai.com/blog/chatgpt

Ottenbreit-Leftwich, A., Glazewski, K., Jeon, M., Jantaraweragul, K., Hmelo-Silver, C. E., Scribner, A., Lee, S., Mott, B., & Lester, J. (2023). Lessons learned for AI education with elementary students and teachers. *International Journal of Artificial Intelligence in Education, 33* (2), 267–289. https://doi.org/10.1007/s40593-022-00304-3

Pappula, K. K., & Rusum, G. P. (2024). AI-assisted address validation using hybrid rule-based and ML models. *International Journal of Artificial Intelligence, Data Science, and Machine Learning*, *5*(4), 91–104. https://doi.org/10.63282/3050-9262.IJAIDSML-V5I4P110

Pardo, A., Bartimote, K., Buckingham Shum, S. B., Dawson, S., Gao, J., Gašević, D., Leichtweis, S., Liu, D., Martinez-Maldonado, R., Mirriahi, N., Moskal, A. C. M., Schulte, J., Siemens, G., & Vigentini, L. (2018). OnTask: Delivering data-informed, personalized learning support actions. *Journal of Learning Analytics, 5*(3), 235–249. https://10.18608/jla.2018.53.15

Patrick, S. K., Grissom, J. A., Woods, S. C., & Newsome, U. W. (2021). Broadband access, district policy, and student opportunities for remote learning during COVID-19 school closures. *AERA Open*, 7. https://doi.org/10.1177/23328584211064298

Pears, A., Tedre, M., Valtonen, T., & Vartiainen, H. (2021). What makes computational thinking so troublesome? In *2021 IEEE Frontiers in Education Conference (FIE)*. IEEE. https://doi.org/10.1109/fie49875.2021.9637416

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial intelligence in education: Challenges and opportunities for sustainable development*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000366994

Picault, J. (2021). Structure, flexibility, and consistency: A dynamic learning approach for an online asynchronous course. *Applied Economics Teaching Resources*, *3*(4), 30–43.

Pope, N., Vartiainen, H., Kahila, J., Laru, J., & Tedre, M. (2024). A no-code AI education tool for learning AI in K–12 by making machine learning-driven apps. In *2024 IEEE International Conference on Advanced Learning Technologies (ICALT)* (pp. 105–109). IEEE. https://doi.org/ 10.1109/ICALT61570.2024.00037

Pörn, R., Braskén, M., Wingren, M., & Andersson, S. (2024). Attitudes towards and expectations on the role of artificial intelligence in the classroom among digitally skilled Finnish K–12 mathematics teachers. *LUMAT: International Journal on Math, Science and Technology Education, 12*(3), 53–77. https://doi.org/10.31129/LUMAT.12.3.2102

Pressley, T. (2021). Factors contributing to teacher burnout during COVID-19 *Educational Researcher, 50*(5), 325–327. https://doi.org/10.3102/0013189X211004138

Ragput, R., & Sharma, P. (2025). Teacher professional development in the digital age. In A. Sorayyaei Azar, S. Gupta, K. Al Bataineh, N. Maurya, & P. Somani (Eds.), *Smart education and sustainable learning environments in smart cities* (pp. 533–556). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-7723-9.ch030

Randall, D. L., Harrison, J. B., & West, R. E. (2013). Giving credit where credit is due: Designing open badges for a technology integration course. *TechTrends*, *57*(6), 88–95. https://doi.org/10.1007/s11528-013-0706-5

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education.

*International Journal of Artificial Intelligence in Education, 26*, 582–599. https://doi.org/10.1007/s40593-016-0110-3

Roshan, S., Iqbal, S. Z., & Qing, Z. (2024). Teacher training and professional development for implementing AI-based educational tools. *Journal of Asian Development Studies, 13*(2), 1972–1987. https://doi.org/10.62345/jads.2024.13.2.154

Rukadikar, A. V., & Khandelwal, K. (2023). Adoption of artificial intelligence in personalising e-learning: A helping hand for K–12 teachers. In *2023 7th International Conference on New Media Studies (CONMEDIA)* (pp. 94–98). IEEE. https://doi.org/ 10.1109/CONMEDIA60526.2023.10428508

Salloum, S. A. (2024). AI perils in education: Exploring ethical concerns. *Artificial intelligence in education: The power and dangers of ChatGPT in the classroom*, 669–675. https://doi.org/10.1007/978-3-031-52280-2_43

Shapiro, R. B., & Fiebrink, R. (2019). Introduction to the special section. *ACM Transactions on Computing Education, 19*(4), 1–6. https://doi.org/10.1145/3354136

Shen, B., McCaughtry, N., Martin, J., Garn, A., Kulik, N., & Fahlman, M. (2015). The relationship between teacher burnout and student motivation. *British Journal of Educational Psychology, 85*, 519–532. https://doi.org/10.1016/j.ijedro.2020.100023

Shi, Y. R., Sin, K. F. K., & Wang, Y. Q. (2025). Teacher professional development of digital pedagogy for inclusive education in post-pandemic era: Effects on teacher competence, self-efficacy, and work well-being. *Teaching and Teacher Education, 168*, 105230. https://doi.org/10.1016/j.tate.2025.105230

Sun, J., Ma, H., Zeng, Y., Han, D., & Jin, Y. (2023). Promoting the AI teaching competency of K–12 computer science teachers: A TPACK-based professional development approach. *Education and Information Technologies*, *28*(2), 1509–1533. https://doi.org/10.1007/s10639-022-11256-5

Taguma, M., Feron, E., & Lim, M. H. (2018). *Future of education and skills 2030: Conceptual learning framework*. Organization of Economic Co-operation and Development. https://www.oecd.org/en/about/projects/future-of-education-and-skills-2030.html

Tan, X., Cheng, G., & Ling, M.H., (2025). Artificial intelligence in teaching teacher professional development: A systematic review. *Computers and Education: Artificial Intelligence*, *8*, 100355. https://doi.org/10.1016/j.caeai.2024.100355

Tompkins, A. (2023). Breaking the cycle of teacher attrition. *Journal of School Administration Research and Development, 8*(1), 24–35. https://doi.org/10.32674/jsard.v8i1.3960

Touretzky, D., Gardner-McCune, C., Martin, F., & Seehorn, D. (2019). Envisioning AI for K–12: What should every child know about AI? In *Proceedings of the AAAI Conference on Artificial Intelligence* (Vol. 33, No. 1, pp. 9795–9799). https://doi.org/10.1609/aaai.v33i01.33019795

Unal, Z., & Unal, A. (2025, March). The impact of professional development on K–12 educators' AI integration: A mixed-methods study of attitudes, self-efficacy, and implementation. In *Society for Information Technology & Teacher Education International Conference* (pp. 356–371). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/225539/

U.S. Department of Education, Office of Educational Technology. (2023). *Artificial intelligence and future of teaching and learning: Insights and recommendations.*

U.S. Department of Education, Office of Educational Technology. (2024). *A call to action for closing the digital access, design, and use divides.*

Vartiainen, H., Tedre, M., & Valtonen, T. (2020). Learning machine learning with very young children: Who is teaching whom? *International Journal of Child-Computer Interaction, 25*, 100182. https://doi.org/10.1016/j.ijcci.2020.100182

Vazhayil, A., Shetty, R., Bhavani, R. R., & Akshay, N. (2019). Focusing on teacher education to introduce AI in schools: Perspectives and illustrative findings. In *2019 IEEE Tenth International Conference on Technology for Education (T4E)* (pp. 71–77). IEEE. https://doi.org/ 10.1109/T4E.2019.00021

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F.D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Vilcarino, J., and Langreo, L. (2025) *Rising use of AI in schools comes with big downsides for students. Education Week*. https://www.edweek.org/technology/rising-use-of-ai-in-schools-comes-with-big-downsides-for-students/2025/10.

Wan, X., Zhou, X., Ye, Z., Mortensen, C. K., & Bai, Z. (2020). SmileyCluster: Supporting accessible machine learning in K–12 scientific discovery. In *Proceedings of the Interaction Design and Children Conference* (pp. 23–35). ACM. https://doi.org/10.1145/3392063.3394440

Weiner, S., Lake, R., & Rosner, J. (2024, October). *AI is evolving, but teacher prep is lagging: A first look at teacher preparation program responses to AI.* Center for Reinventing Public Education. https://crpe.org/ai-is-evolving-but-teacher-prep-is-lagging/

Wolff, A., Zdrahal, Z., Nikolov, A., & Pantucek, M. (2013). Improving retention: Predicting at-risk students by analysing clicking behaviour in a virtual learning environment. In *Proceedings of the Third International Conference on Learning Analytics and Knowledge* (pp. 145–149). ACM. https://doi.org/10.1145/2460296.2460324

Wong, G. K. W., Ma, X., Dillenbourg, P., & Huan, J. (2020). Broadening artificial intelligence education in K–12: Where to start? *ACM Inroads, 11*(1), 20–29. http://doi.org/10.1145/3381884

Yadegari, M., Mohammadi, S., & Masoumi, A. H. (2024). Technology adoption: An analysis of the major models and theories. *Technology Analysis & Strategic Management*, *36*(6), 1096–1110. https://doi.org/10.1080/09537325.2022.2071255

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J.-B., Yuan, J., & Li, Y. (2021). A review of artificial intelligence (AI) in education from 2010 to 2020. *Complexity, 2021*(1), 8812542. https://doi.org/10.1155/2021/8812542

Zimmerman, M. (2018). *Teaching AI: Exploring new frontiers for learning*. International Society for Technology in Education.