# Integrating AI Competencies Into Teacher Education Programs

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**Abstract**

The rapid advancement and integration of artificial intelligence (AI) into our everyday lives, work, and classrooms have added demands for PK-12 education to ensure that students are given opportunities to obtain AI competencies essential for responsible participation in the AI-driven future. AI literacy encompasses technical knowledge, ethical awareness, and critical evaluation of AI tools, as well as the ability to collaborate with AI systems in creative and productive ways. Research highlights the importance of age-appropriate approaches that address foundational AI knowledge, data literacy, ethics, problem-solving, and creativity, ensuring students can both use, analyze, critically evaluate, and design AI solutions for real-world challenges. This not only requires schools to prepare learners with AI competencies, but also colleges and universities to ensure that we prepare our preservice teachers to be AI-ready, who can integrate technological, pedagogical, and content knowledge in classroom practice. This paper highlights the importance of purposefully integrating AI competencies into teacher education programs and offers practical examples of how such integration can be achieved.

## Introduction

Artificial Intelligence (AI) has become an integral part of daily life, shaping industries such as healthcare, entertainment, education, and beyond (Maslej, Gil, and Perrault 2025). The rapid rise of generative AI has intensified the urgency to integrate AI and AI literacy in K–12 education (Black et al. 2024; Kasneci et al. 2023; Tlili et al. 2023). In response, many educational organizations now offer professional development opportunities to help teachers develop the skills and knowledge needed to integrate AI meaningfully into their instruction. Yet, despite these efforts, AI and AI literacy (TEPs) for preservice teachers.

Integrating AI literacy into teacher preparation is vital for equipping educators to use AI ethically and effectively while empowering students to thrive in an AI-mediated world. As industries increasingly adopt generative AI tools (Singla et al. 2025), students must learn both with and about AI to participate responsibly and critically in the evolving landscape.

This paper responds to these urgent needs by proposing an approach for integrating AI literacy into TEPs and outlining strategies for higher education institutions. It contributes by: (1) operationalizing the Framework for Approaching AI Education in Educator Preparation Programs (Black et al. 2024) through multi-level cases; (2) advancing AI-TPACK and AI literacy work by defining AI competencies as the interplay of content knowledge, fluency (technological knowledge), and responsibility (pedagogical knowledge); and (3) situating AI integration within a broader cultural and theoretical lens to guide institution-level strategy.

## Literature Review

Integrating new technologies into teaching has long enhanced learning quality, fostered pedagogical innovation, and equipped students with essential skills for a changing world. Over the past century, teachers' approaches to technology integration have continuously evolved, with the emergence of AI now marking another major paradigm shift in education.

Shulman (1987) identified pedagogical content knowledge (PCK) as vital for effective teaching in a changing educational landscape. Mishra and Koehler (2006) developed the Technological Pedagogical Content Knowledge (TPACK) framework, emphasizing that technology must be interwoven with pedagogy to foster equitable access and enhance instructional quality. Within this framework, technology-rich environments are essential for authentic, collaborative, and student-centered learning (Halder 2023). However, progress remains uneven, particularly in underrepresented and underserved communities, due to persistent gaps in teacher preparedness (Cowan 2015). As AI technologies increasingly shape everyday life and education, ensuring equitable, inclusive, and culturally responsive instruction has become imperative. Such approaches must cultivate AI literacy and responsible digital citizenship, equipping students to navigate and contribute meaningfully to a digitally mediated world (Lo 2023).

Responding to the urgent educational needs, organizations and researchers have developed various AI frameworks and teaching resources for K-12 teachers. The AI4K12 Initiative (AI4K12) developed the “5 Big Ideas in AI” to help teachers integrate AI literacy into classrooms (Touretzky et al. 2019). In the United States, by July 2025, at least 28 states and the District of Columbia had issued official guidance on using AI in K-12 education, including definitions, best practices, academic integrity, safety, and responsible use (Fitzgerald July 15, 2025). Globally, a range of AI literacy frameworks now supports K-12 integration efforts, including UNESCO’s AI Competencies for Students and Teachers (Miao and Cukurova 2024; Miao et al. 2024), the European Commission’s Digital Competence Framework for Citizens (DigComp) (Vuorikari et al. 2022), Digital Promise’s AI Literacy Framework (Mills et al. 2024), and the OECD’s AILit Framework, *Empowering Learners for the Age of AI* (OECD 2025). These frameworks collectively promote equitable, responsible, and informed engagement with AI. Supplementary resources such as lessons and digital tools further advance AI *learning about and with AI* approaches for K-12 inservice teachers (MIT RAISE Initiative 2025). However, most inservice teachers have not received formal training in AI concepts or pedagogy, underscoring the urgent need for AI-focused professional development. One of the first responses came from the International Society for Technology in Education (ISTE), through ISTE U (https://iste.org/iste-u), an online professional learning platform offering two 15-hour courses: *Artificial Intelligence Explorations for Educators and Next Level AI Skills for Educators.*

Teachers are now required to act as facilitators and designers of learning environments, guiding students to engage with AI critically and ethically rather than simply delivering content (Davin et al. 2024). However, limited progress in integrating AI and AI literacy in TEPs underscores this paper’s aim to support higher education institutions to accelerate AI education infusion.

## Integration of AI Competencies in Teacher Education Programs – Intentionality

The Framework for Approaching AI Education in Educator Preparation Programs (Black et al. 2024) presents seven critical strategies to guide TEPs in revising their teacher certification programs for the AI age. The Framework intends to support TEPs with an integrated TPACK approach to “[identifying] curricular connections in the TEP coursework as well as new knowledge and skills that need to be added to faculty competencies and TEP coursework in order for preservice teachers to subsequently build competency around AI education” (p. 23070). Chiu (2025) explains the differences between AI literacy and AI competencies as follows:

> AI literacy is about knowledge and understanding; AI competency is about skillful application and optimization. While literacy asks, “What does this AI do?” competency asks, “How can I make this AI work better?” AI competency fundamentally depends on AI literacy; you cannot effectively optimize or troubleshoot an AI system (“How?”) without first understanding its core functions and constraints (“What?”). Literacy is the compass; competency is the engine. Thus, while literacy provides the necessary knowledge, competency represents the higher-level skill of applying that knowledge to achieve superior outcomes and make the AI work ethically, effectively, and healthily for you. (p.3226)

AI literacy and AI competency are distinct but closely interconnected.

Intentional integration of AI literacy and competencies within TEPs requires more than simply introducing AI into the classroom or utilizing AI tools; it involves cultivating in preservice teachers’ ways of thinking that emphasize inquiry, reflection, and ethical judgment (Tammets and Ley 2023). Within this approach, candidates are encouraged to critically analyze and question AI-generated outputs, considering their accuracy, potential biases, and relevance for diverse learners. By strengthening preservice teachers’ technological competencies, we can enhance their ethical use of AI (Bautista et al. 2024), highlighting the importance of teacher training that develops not only technical proficiency but also ethical awareness. While fostering these habits, TEPs can prepare future educators to harness AI thoughtfully and intentionally, in ways that preserve essential human capacities for decision-making, problem-solving, and critical analysis within their practice.

This also means preparing preservice teachers to engage with AI in ways that acknowledge both its potential to enhance teaching and learning and the need to remain mindful of its limitations and ethical considerations. Competency, in this context, involves using AI effectively while ensuring its application aligns with professional standards, equity, and responsible practice. Teacher preparation programs can support this by creating opportunities for candidates to examine their own use of AI, evaluate AI outputs, and reflect on the broader implications for their educational practice. Embedding structured moments to pause, observe, and question AI's capabilities helps to leverage AI's strengths while avoiding over-reliance on the tool (Filiz, Kaya, and Adiguzel 2025).

## AI in TEPs: An Infused TPACK Approach

While the Framework for Approaching AI Education in Educator Preparation Programs (Black et al. 2024) looks at program-wide considerations for addressing leadership, faculty, and preservice teacher needs, here we focus directly on curricular shifts that foster AI competencies in preservice teachers.

Researchers worldwide are reassessing how the AI era reframes TPACK. Building on Celik's (2022) proposal of Intelligent-TPACK or AI-TPACK and subsequent analyses by other scholars (Ning, 2024; Yue, Jong, & Ng, 2024), this line of work foregrounds shifts in developing and applying AI technological knowledge and its intersections with TCK, TPK, and TPACK as educators design instructions, often in disciplines such as English language arts and mathematics. In much of this literature, AI-TPACK treats AI primarily as a teaching tool or collaborator; descriptions of the construct frequently overlap with AI literacy, emphasizing how teachers develop and deploy AI capabilities within pedagogy rather than teaching AI as disciplinary content (Ning et al., 2024).

However, the proposed Framework (Black et al. 2024) adapts a broader perspective on how AI advancements drive fundamental shifts in teaching practice (Black et al. 2024). It considers the diversity of AI tools and classroom use cases across PK-12 education, and underscores the need for teachers to cultivate students' AI literacy. Moreover, it asserts that there is not merely new technological knowledge (TK) in the AI age, but also new AI content knowledge (CK), in addition to the subject-specific CK, and pedagogical knowledge (PK), which must all be addressed to develop comprehensive TPACK, and therefore, competency around AI in education. This broader view resonates with ongoing research on teacher readiness in both preservice and in-service contexts, highlighting that the expertise required for AI integration extends beyond technological proficiency (Ng, 2021, 2024; Yue, Jong, & Ng, 2024).

While prior AI-TPACK research emphasizes AI as a teaching tool or collaborator, our framing positions AI as both content and context for teaching, showing how preservice teachers learn with and about AI across TCK, TPK, and TPACK. This triadic view helps TEPs identify gaps in AI readiness and design targeted learning experiences across all domains.

We assert that AI-competent teachers have all three core knowledge elements around AI: content, technological, and pedagogical. The core knowledge elements can then be built upon to achieve shifts to both teaching with AI tools and teaching about AI through AI literacy for PK-12 students.

### AI Content Knowledge: AI Literacy

In contrast to prior work that treats AI literacy primarily as a student learning outcome, we emphasize that AI literacy, especially their understanding of AI's functions and implications, is one of the critical knowledge for teachers that enables them to help students become informed, responsible digital citizens (Touretzky et al. 2019a, 2019b; Ravi et al. 2023). Moreover, AI knowledge enables teachers to address concerns around AI, such as bias, privacy, and misuse, deepening students' understanding of AI's societal impacts and fostering safe and ethical classroom applications (Reiss 2021; Du et al. 2024). To guide teachers to define what AI concepts to teach in accessible and engaging ways, the AI for K-12 initiative (AI4K12 2020) developed the Five Big Ideas in AI to support them in designing effective AI lessons/activities for K-12 students (Figure 1). Five Big Ideas are guidelines that identify what K-12 students should know and be able to do with AI.

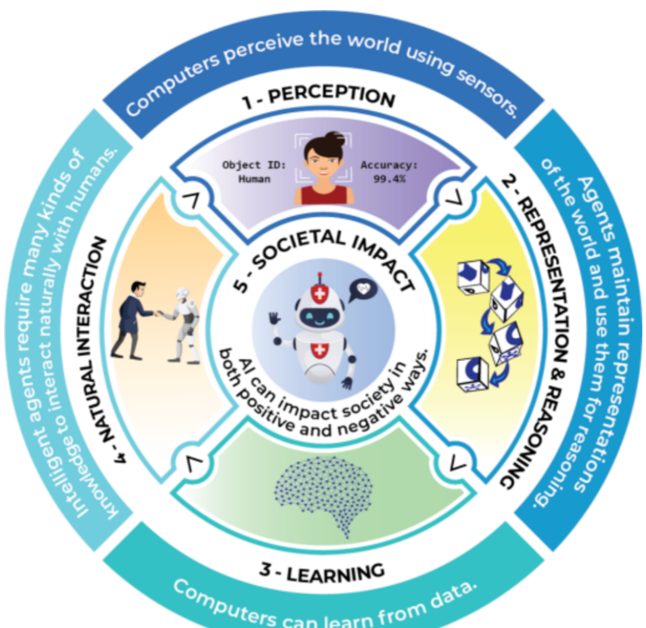


Figure 1: Five Big Ideas in AI (AI4K12 2020).

**Big Idea 1 Perception (How do AI systems perceive the world?).** It examines how AI systems perceive the world through sensor or data inputs, such as images, text, and sound, similarly to how humans interpret the world through their senses (speech recognition and computer vision - object recognition, face recognition, are some of the examples).

**Big Idea 2 Representation & Reasoning (How do AI systems reason the world?).** It focuses on how AI systems use datasets to construct representations of the world and apply those representations to reason about the world (navigation apps, recommendation systems, medical diagnostics, and path planning for self-driving cars are some of the examples).

**Big Idea 3 Learning (How do AI systems learn and improve?).** It focuses on how AI systems learn by identifying patterns in training data. The concept should be presented in age-appropriate manners. Upper-grade students can explore different machine-learning concepts, including supervised learning, unsupervised learning, and reinforcement learning, etc. (recommender systems used in Netflix or YouTube that learn from human inputs and generative AI tools that can learn to improve their responses using human inputs). On the other hand, lower-grade students can compare how humans learn with how machines learn.

**Big Idea 4 Natural Interaction (How do AI systems interact naturally with humans?).** AI systems interact with humans using input data with the ultimate goal of making it as natural as human interactions. Recent development of Generative AI tools has made AI capable of responding to humans much faster and in similar ways as humans interact with each other. AI-integrated chatbots and text-to-speech / text-to-text / speech-to-speech translation tools are some of the examples.

**Big Idea 5 Societal Impact (How do AI technologies affect our world?).** Big Idea 5 is an overarching concept that addresses AI's impacts on students, their families, society, and the world. It challenges students to look beyond AI technologies and, through an ethical lens, consider their societal impacts, in both positive and negative ways. Students explore what ethical AI entails by examining principles such as human-centeredness, fairness, accountability, trustworthiness, sustainability, and transparency.

The Five Big Ideas in AI are not intended to be taught as standalone lessons. Instead, it is strongly recommended to integrate them into existing subjects in creative ways that engage students through interactive, project-based, inquiry-driven, and student-centered learning experiences (Black et al. 2024; Touretzky et al. 2019b; Eguchi 2025a, 2025b). Therefore, new knowledge around AI is not simply TK. Now, preservice teachers are expected to incorporate new AI CK into their lessons, both about AI itself and about how advances in AI are transforming society through integrated approaches.

## Technological Knowledge: AI Fluency

Beyond developing AI-specific content knowledge (CK) for teaching about AI, preservice teachers also need robust technological knowledge (TK). Within the TPACK framework, TK refers to teachers' ongoing ability to use and adapt to emerging educational technologies (Mishra & Koehler, 2006). Applied to AI, this means preservice teachers require TK that enables them both to understand the inner workings of AI tools and to use them effectively to meet instructional goals. This expanded form of TK encompasses not only AI literacy, a foundational understanding of what AI is, its basic concepts, and its ethical implications, but also *AI fluency*, which reflects the flexible, transferable application of AI skills in practice. We use the term *AI fluency* to emphasize preservice teachers' capacity to adapt and transfer their AI-related technological skills as tools, systems, and policies evolve. Whereas AI literacy equips preservice teachers with essential conceptual and ethical grounding, *AI fluency* enables them to apply that knowledge effectively in teaching, integrate AI tools into educational practice, and adjust their use of AI as technologies advance.

As AI technologies become more ubiquitous in daily life, so too has the availability and number of AI educational technologies increased as well. AI models, features, and agents are now integrated into edtech visibly and invisibly, for uses across teaching, learning, assessment, and administration. It would be impossible for teachers to be fluent in all available tools. To develop AI competencies, TEP faculty must support preservice teachers in identifying AI edtech appropriate for their intended teaching setting, such as early childhood, science education, or high school Career and Technical Education (CTE). Across contexts, the AI tools educators use and the corresponding TK and fluency skillsets required will vary. Early childhood educators might introduce AI through unplugged pattern-recognition activities, while high school CTE teachers may need advanced skills with AI industry tools and platforms. Ultimately, preparing preservice teachers with AI fluency, through both AI literacy and AI competencies, ensures they understand the foundations of AI but also are able to critically and effectively integrate AI technologies in ways that are developmentally appropriate, context-specific, and responsive to the evolving needs of their students.

## Pedagogical Knowledge: AI Responsibility

In the context of AI competency, PK addresses how AI reshapes the design of learning experiences, the allocation of cognitive tasks, and the evolving role of educators (Black et al. 2024; Celik 2023), including preservice teachers. Central to developing preservice teachers' competencies is using AI to extend and enrich student thinking (onloading) rather than simply delegating tasks to AI (offloading). AI integration should move beyond passive consumption and instead foster a classroom culture of thinkers, where preservice teachers can embrace and model the use of AI as *cautious advocates with a moral compass*. Framing pedagogical knowledge as 'AI responsibility' emphasizes both effective design and the cultivation of ethical cautious advocates in preservice teachers.

Achieving this vision requires intentional modeling within TEPs, as preservice teachers often draw heavily on the instructional approaches they themselves experience

(Oleson and Hora 2014; Cox 2014). For instance, a preservice teacher might default to flashcards for multiplication simply because that method was modeled for them. AI presents a distinct challenge because preservice teachers lack firsthand experience learning with AI; they cannot draw on personal exemplars to inform AI-related pedagogy. This absence offers opportunities to adopt research-aligned practices but may also mean they struggle to envision effective applications for AI, feel uncertain about implementation, or lack the structural guidance to teach with and about AI.

Thus, modeling within a TEP serves as a blueprint for preservice teachers' future practice. Michalak and Ellixson (2025) suggest, "instructors should adopt structured frameworks that prioritize human control, agency, and interpretation when integrating AI into our coursework" (p. 374). By intentionally modeling empowering uses of AI, such as designing generative AI activities that require student analysis, synthesis, and creativity, teacher educators can help preservice teachers learn to design lessons in which AI prompts thinking rather than replacing it.

To clarify the scope of implementation, the following four cases reflect a combination of (a) interventions directly designed and implemented by authors, and (b) examples from colleagues across institutions using the same frameworks. We specify the authors' involvement in each case, and for others, discuss how the frameworks informed implementation, noting key strengths, limitations, and opportunities for improvement. This distinction clarifies attribution of experience and supports the contribution to practice.

## AI Infusion Cases – at Various Levels

The Framework for Approaching AI Education in Educator Preparation Programs (Black et al. 2024) calls for intentionally infusing the seven critical strategies into TEPs and coursework. In fact, successful AI literacy and competency development for preservice teachers must be strategically cultivated, program-wide, and program-deep in TEPs. Many higher education institutions are making efforts toward this goal. This paper explores the authors' implementation across four cases of AI infusion at four universities, highlighting approaches to developing AI competencies at the course, program, and institutional levels. Case 1 addresses Critical Strategy 4: Cultivate Skills for Effectively Harnessing AI Instructional Tools and Critical Strategy 6: Integrate Critical Examinations into Classroom Experiences. Case 2 focuses on Critical Strategy 5: Infuse AI Literacy Across Existing Curriculum and Critical Strategy 6: Integrate Critical Examinations into Classroom Experiences. Case 3 reports how Critical Strategy 5: Infuse AI Literacy Across Existing Curriculum was implemented across a departmental program. Finally, Case 4 addresses how Critical Strategy 5: Infuse AI Literacy Across Existing Curriculum is implemented through an institution-wide initiative.

### Case 1: Mixed Level Coursework

This case details a multi-week instructional activity in which thirty undergraduate preservice teachers at a Central Texas university used ChatGPT and Google Bard to create lesson plans on assignment topics. Groups were intentionally heterogeneous, mixing novices (lower-level) with more experienced (upper-level) preservice teachers. No prior AI tool training was given, simulating a cold-use scenario common in current teacher preparation classrooms. This approach enabled researchers to examine how preservice teachers engage with AI for lesson planning, and their ability to critically evaluate AI-generated content across varied experience levels (Zhang et al. 2023).

Small groups of students were scaffolded through evaluating, modifying, and finalizing their AI-generated lesson plans. The instructional design intentionally emphasized reflection and discernment: students worked with peers to assess the pedagogical merit of the AI suggestions, revised their plans accordingly, and individually reflected on their own process. Evaluative methods included peer discussion, instructor feedback, and final assessment via a rubric (Merriam 2009).

The project revealed meaningful differences in how novice and experienced preservice teachers interacted with AI tools. Novice participants often prioritized student engagement and creativity, selecting AI-suggested activities that were perceived as fun, but sometimes misaligned with instructional goals. In contrast, experienced preservice teachers demonstrated greater awareness of learning objectives, filtering AI recommendations through a pedagogical lens to ensure alignment. This highlighted differing stages in the development of *practical wisdom* - a concept introduced by Shulman (2004) that involves the application of theoretical, practical, and ethical judgement in teaching.

Reflections indicated that students in both groups valued AI as a brainstorming tool but differed in their levels of critical engagement. This underscores the importance of structured opportunities in TEPs to fluid AI literacy and self-efficacy (Bandura 1986), particularly through experiences supporting the development of evaluative judgement.

This instructional activity demonstrated that integrating AI directly into lesson planning provides a practical model for cultivating instructional discernment. It also illustrates that, when thoughtfully included in coursework, AI tools stimulate meaningful conversations among preservice teachers and encourage them to think more deeply, reflect more critically, and collaborate more intentionally about their teaching decisions.

This case extends AI in teacher education by documenting a *cold-use* scenario where preservice teachers use GenAI without prior training and comparing how novices and experienced peers show instructional discernment. It highlights developmental differences in practical judgment and offers implications for scaffolding AI-related decision-making at different stages through structured, critical lesson-planning tasks.

## Case 2: Course Level Syllabus Integration

The GAI$^2$N: GenAI Integration Navigator is a reflective guide to address the need for intentional and ethical generative AI integration at a course level, guiding faculty in systematically enhancing their syllabi (Kasun et al. 2025). This reflective process, used by TEP faculty at multiple institutions, is structured around three fundamental stages of inquiry: *whether, when, and how*.

The initial *Whether* stage centers on clarifying purpose. Educators must look past novelty and determine whether GenAI meaningfully supports course learning outcomes. This stage also involves assessing one's readiness to teach with and about GenAI, including modeling ethical use and addressing misconceptions. Faculty should plan for equity by considering student access, potential linguistic and cultural biases in AI models, and accessibility needs. A key product of this stage is a clear syllabus policy that establishes transparent expectations for AI use.

The next stage, *When*, focuses on pedagogical timing and strategic sequencing. The introduction of GenAI is not a neutral act. Used for pre-learning, it can support brainstorming, background building, and early drafts of lesson plans. Used after learning, it can deepen synthesis through activities such as critiquing AI-generated lessons or using chatbots to rehearse challenging classroom conversations. Introducing AI early in a course enables scaffolding across assignments, whereas introducing it later ensures preservice teachers first develop foundational concepts before applying AI for more complex synthesis.

The final stage of *How* addresses implementation. Effective implementation begins with intentional curation of GenAI tools, guiding preservice teachers toward specific platforms and explaining the rationale based on factors like data privacy and pedagogical alignment. Assignments should promote critical engagement, moving beyond simple generation tasks, for example, comparing outputs across models, adapting AI-generated materials for culturally and linguistically diverse learners, or using AI as a thought partner to refine pedagogical ideas. Implementation should also include structured reflection, through journals or discussions, to help preservice teachers examine the benefits, challenges, and ethical dilemmas of using AI, fostering reflective and responsible practitioners.

TEP faculty reported high levels of enthusiasm and a sense of meaningful support when engaging the GAI$^2$N. Others expressed that it provided a sense of relief in having basic structures to guide their thinking. Some reported that it helped them feel supported, related to the notion that they are also *on the right track* while they adapt brand-new forms of technology into their regular pedagogy. It was effective in terms of initial impacts. Overall, the early feedback suggests it reduces anxiety and promotes program-level messaging, offering a practical bridge between high-level frameworks and course-level design.

## Case 3: Program Progression

The initiative at a rural university in Virginia showcases the progression of AI literacy across three course levels in TEP. Course outcomes and field expectations guided decisions about how to integrate generative AI (GenAI). Key questions included: *Would GenAI advance learning outcomes? Were faculty prepared to teach responsible use? Was a clear usage policy in place*? By positioning students as critical, independent users, opportunities for reflection on the benefits and challenges of GenAI were created. Based on this reflection, AI literacy was embedded at multiple levels, tailored to students' preparation stages.

In a lower-level Human Development course, students were introduced to AI literacy and ethics by co-creating an AI usage policy and discussing why AI was not used in assignments. The faculty demonstrated AI-supported productivity by modeling AI use in presentations, reinforcing transparency, and responsible practice.

At the junior level in the Content Area Literacy course, the focus shifted toward disciplinary literacy and AI pedagogy. Students examined ethics, privacy, and bias; evaluated tools; and presented digital engagement strategies. Some wrestled with tensions between innovation and ethics, leading to what Mezirow (1991) terms a *disorienting dilemma*, a critical learning moment that challenges assumptions and can spark perspective transformation. Reflective practice also drew on the *Five Big Ideas in AI,* supported by mentor texts and the *Hands-On AI Projects Guides*.

By the senior year of the Literacy Methods course, preservice teachers confidently and fluently engaged with AI. Students created lesson plans, refined them using a custom AI Chatbot Coach, and documented their decision-making in reflection memos. Coursework emphasized prompt engineering, critical evaluation of AI-generated lessons, and the application of innovation, making decisions that honor social, cultural, moral, emotional, and educational needs while creating positive change for humanity (Mary Lou Fulton Teachers College, Arizona State University 2025).

This iterative process revealed that starting from a place of trust fosters openness and shared growth (Bayraktar, Ragupathi, and Troyer 2025). Lower-level students engaged with curiosity, juniors developed analytical skills, and seniors demonstrated professional readiness for responsible integration. These experiences indicate that AI literacy must be introduced early, gradually increasing in complexity, and supported by faculty AI fluency.

This case contributes a longitudinal, program-level view of AI literacy and competency development, showing how AI-related outcomes can be intentionally sequenced from foundational awareness and ethics in lower-division courses to critical analysis and principled innovation in upper-division methods courses. Whereas much of the existing literature focuses on isolated, course-specific AI activities or single professional development experiences, this example shows how teacher education programs can *spiral* AI concepts and practices across multiple semesters. It offers a concrete model for meeting emerging policy expectations, while aligning instruction with preservice teachers' developmental readiness, translating existing frameworks into actionable curricular design.

### Case 4: Institutional Movement

Higher education institutions started to embed AI literacy into TEPs in response to the rapid expansion of AI in education (Katsamakas, Pavlov, and Saklad 2024). TEPs are increasingly expected to prepare graduates who can use AI tools and model the critical, ethical, and pedagogical competencies needed to guide students in AI-rich environments (Council for the Accreditation of Educator Preparation, 2025; Kohnke et al., 2025; UNESCO, 2021). However, recent surveys show that many TEPs remain in the early stages of AI integration, with efforts often centered on immediate concerns such as plagiarism detection rather than on cultivating proactive, future-ready AI competencies for teaching and learning (Weiner & Lake, 2025). These trends highlight the need for systemic, multi-level approaches that include faculty capacity-building, curriculum redesign, supportive institutional policies, and broader cultural shifts toward AI-informed educational practice. The Theory of Virtuality Culture (TVC) offers a conceptual foundation for this institutional movement by explaining how AI-mediated technologies reshape human consciousness, communication, and meaning-making (Dempsey 2014, 2017). In TEP, integrating TVC ensures AI education is not merely about tools, but about navigating transformations in how knowledge is created, shared, and experienced.

A compelling example of institutional action is the establishment of an AI center at a university in Pennsylvania (Bennett, 2025). Designed to serve the entire campus, the center also acts as a hub for educator preparation programs, demonstrating how higher education can operationalize AI integration through coordinated faculty learning communities, workshops, and ongoing professional development (Halder, 2023). Faculty have benefited from one-on-one support and small-group work with the director, encouraging dialogue and collaboration. The center further promotes student leadership through an AI and Technology Ambassador Program, where digitally fluent students—including preservice teachers—engage in service learning, professional development, and co-design of AI-enhanced projects (Vuorikari et al., 2022). The center demonstrates how TEPs can create sustainable, culturally responsive ecosystems for AI integration, aligning with the university's needs, preservice teachers, the workforce, and the communities they serve.

## Conclusion

Integrating AI competencies into TEPs requires more than adopting new tools; it calls for preparing preservice teachers to become competent, cautious advocates who engage with AI through curiosity, critique, and care. Although progress has been made in integrating AI into TEPs, significant gaps remain, especially in research on how to model balanced approaches for preservice teachers. Our four implementation cases illustrate that institutions can provide support at various levels, including at the syllabus level, across entire programs, and even university-wide to empower faculty with agency to select relevant AI competencies and determine how best to address them. Persistent questions remain about how to effectively support faculty in developing their own AI literacy and competencies, so they may strengthen their students' readiness and embed reflective, purposeful uses of AI throughout their courses. Some advancement has taken place, particularly in addressing foundational strategies such as fostering a universal understanding of AI and cultivating instructional skills for harnessing AI tools as recommended in the Framework for Approaching AI Education in Educator Preparation Programs (Black et al. 2024). However, further studies should document best practices and help institutions better equip faculty to design and deliver AI literacy and competency-infused curricula.

Ongoing research must examine ways to cultivate AI literacy and competencies while exploring methods for framing their use through an explicit compass rooted in fairness, equity, and care. It is essential to maintain a human-centric approach that safeguards dignity, connection, and the irreplaceable value of human judgment. The effects of AI integration extend beyond preservice teachers to those who mentor them, emphasizing the need for spaces for reflection, robust learning communities, and targeted support for faculty.

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