A Framework for Approaching AI Education in Educator Preparation Programs

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Abstract

In recent years, the rapid advancement of artificial intelligence (AI) has fostered an urgent need to better prepare current and future educators to be able to integrate AI technologies in their teaching and to teach AI literacy to PreK-12 students. While many organizations have developed professional learning opportunities for inservice educators, a gap remains for resources specifically designed for those facilitating and enrolled in Educator Preparation Programs (EPPs). In response to this gap, the International Society for Technology in Education (ISTE) launched its first AI Explorations for EPPs Faculty Fellowship. As a result of the Faculty Fellows' collaboration, this paper articulates a framework of seven critical strategies with the potential to address the urgent need EPPs have in preparing preservice teachers to effectively integrate AI-powered instructional tools and to teach this new area of content knowledge in PreK-12 classrooms. In addition, we provide a review of literature and an overview of the emerging needs for integrating AI education in EPPs. We demonstrate why support for preservice teachers' critical examination and application of AI, including a focus on the issues of equity, ethics, and culturally responsive teaching, is essential to their later success in PreK-12 classrooms. Recommendations for further research and learning are also provided to promote community-wide initiatives for supporting the integration of AI in education through Educator Preparation Programs and beyond.

Introduction

Artificial intelligence (AI) technologies are rapidly advancing and consequently impacting all areas of modern life, including education. Such a shift requires a review and reflection on whether current and future teachers and education leaders are prepared to meet emerging needs to both effectively harness this new technology to improve teaching and learning as well as to teach about this new area of content knowledge. Seeing a need for professional learning to achieve teacher preparation in this area, the International Society for Technology in Education (ISTE) implemented one of the first professional learning programs around AI in K-12 education, which provides a mechanism for teachers and education leaders to explore and leverage artificial intelligence (AI) for student-driven teaching and learning experiences (Black 2022; Touretzky et al. 2019a).

While several organizations have likewise developed professional learning opportunities for inservice K-12 educators in recent years, a gap remained for resources specifically designed for those facilitating and enrolled in Educator Preparation Programs (EPPs). This includes faculty and institutional leadership responsible for designing and implementing teacher preparation coursework and programming, as well as the preservice teachers and teacher candidates who are students enrolled in EPPs prior to becoming inservice teachers (who we will refer to collectively as preservice teachers in this paper). EPPs serve as a critical component in a widespread effort to meet the increasing demand for teachers with professional competency around the use of AI in education (U.S. DOE 2023).

After input from faculty and leadership from over 20 higher education institutions, in 2023, ISTE both reserved approximately 15% of its online course scholarships for EPP faculty and preservice teachers and launched its first AI Explorations for EPPs Faculty Fellowship (ISTE 2023). The goals of the Faculty Fellowship include:

- Preparing higher ed faculty and staff, as well as current and future teachers, to apply nationally recognized educational technology frameworks to accelerate transformative digital learning, including best practices for AI education.

- Equipping EPP faculty and staff to continuously improve expertise around technology for learning in areas such as K-12 AI education, how AI technologies impact instruction, and how to pass on knowledge about AI and education to future teachers.
- Inspiring current and future teachers to consider STEM teaching opportunities by building competence and excitement around AI and STEM education.

The first fellowship cohort was composed of diverse EPP faculty members with broad expertise in teacher preparation, representing seven EPPs from across the United States. As a result of the faculty fellows' collaboration, a high-level strategic approach to addressing the needs for AI education in EPPs was developed. This paper articulates both background information about the current state of AI education in EPPs, a framework of seven critical strategies for systemically addressing the urgent need for AI education in EPP programs, and proposed next steps in continuing research around the implementation of AI education in EPPs.

Literature Review

From the advent of the internet to the utilization of mobile devices for learning, educators have grappled with the task of incorporating new technologies into their teaching practices. Such technological shifts have not been uncommon over the past twenty-five years (Ertmer 1999; Staples et al. 2005; Polly et al. 2020). Like many areas in educational technology, the rapid development of AI in contemporary culture has led to the need to increase the understanding of AI in educational contexts (Crompton and Burke 2023; Touretzky et al. 2019b; Yang 2022).

As is the case with any new technology, various challenges have arisen. These challenges encompass a range of issues, including but not limited to the access to technology, the need for effective professional development and time to establish best practices, and the resistance to change (Palak and Walls 2009; Kale and Goh 2014; Kafyulilo, Fisser, and Voogt 2016). Literature on EPPs has thus far focused on coursework and clinical training that prepares prospective educators for careers as educators, school counselors and psychologists, school administrators, and other careers in education. Although there is much literature on various educational technology areas and their inclusion in EPPs, AI has not been the focus of teacher preparation (Antoniou 2023; Borthwick et al. 2023; Foulger, Wetzel, and Buss 2018; Trust, Whalen, and Mouza 2023; U.S. DOE 2016). To that end, the Office of Educational Technology's (OET) National Educational Technology Plan (U.S. DOE 2017) addresses a need to rethink teacher preparation and foster ongoing professional learning. While an updated section on AI in the school environment is forthcoming, the OET's recently released report on AI and the Future of Teaching and Learning (U.S. DOE 2023) encourages new research and development related to AI in teacher preparation and calls on institutions to integrate AI systematically into their programs. The Council for the Accreditation of Educator Preparation (CAEP) is one example of an agency that provides guidance for specific standards for EPPs. Although CAEP doesn't specifically include AI in the language of the standards, the area of Standard 1: Content and Pedagogical Knowledge would be the ideal placement for the inclusion of AI education in the modern era (CAEP n.d.).

The development of AI education in EPPs requires specialized knowledge and skills to advance preservice teachers, and the work needs to be grounded in a variety of theories that help to explain different aspects of AI in EPPs. For example, the TPACK framework, which asserts that content, technology, and pedagogy knowledge are all necessary for effective teaching with technology, is commonly used for teacher preparation (Antoniou 2023; Koehler, Mishra, and Cain 2017). Faculty can utilize this framework to identify curricular connections in the EPP coursework as well as new knowledge and skills that need to be added to faculty competencies and EPP coursework in order for preservice teachers to subsequently build competency around AI education. The framework in this paper proposes various ways to strategically build capacity in both faculty and preservice teachers in these areas.

In considering contemporary theories, the Theory of Virtuality additionally explains a shift in human consciousness that is transforming contemporary culture through technologies like AI and the way professional development programs are offered (Dempsey and Kosmiski 2023, Dempsey 2014). Grounded in the work of Walter Ong (1982), this theory explains how the features of contemporary technologies, like AI, cannot be explained by preexisting cultural conventions. This means that with the evolution towards a culture of virtuality, new critical pathways and pedagogical strategies are required and should be explored regarding how to prepare preservice teachers in EPPs to address AI education (Dempsey and Kosmiski 2023).

Further, by providing EPP faculty with an approach to AI education, they can start to build their own capacity to model effective instruction with AI tools and teach about AI literacy. As evidenced by the research (Bergeson and Berschorner 2020), modeling can help preservice teacher students develop the skills and strategies they need to be effective teachers. This is particularly true when it comes to learning how to integrate technology effectively in the classroom (Hughes, Liu, and Lim 2016; Lambert, Gong, and Cuper 2008). In addition, modeling the integration of technology can positively impact preservice teachers' confidence with using technology (Adamy and Boulmetis 2005) as well as their perceptions of using technology in the classroom (Hsu 2012). Therefore, equipping EPP faculty with the resources, knowledge, and strategies they need to model the use of AI tools with their preservice teachers can go a long way in preparing future educators.

Unfortunately, there are many obstacles related to widespread integration of AI education at the higher education

level. One gap is in the area of AI education professional learning and other resources designed specifically for faculty and preservice teachers in EPPs. While ISTE provides an online course with designated spots for EPP participants and recently announced the first cohort for its AI Exploration for EPPs Faculty Fellowship program (ISTE 2023), these appear to be the first initiatives specifically designed to serve this audience. According to the OET, supports are being developed specifically in the area of AI-enabled tools for educators and through the recommendations included on their website (U.S. DOE 2023), but these may need to be adapted for use within preservice teacher preparation. Considering future EPP development, we need to address the involvement in the following gap areas to enhance students experience and learning with and about AI including policy discussions and development, designing curriculum with AI and AI literacy in mind, development of trusts in technology and people, addressing racial equity and access, development of education specific guidelines and guardrails, and development of AI using modern learning principles (U.S. DOE 2023).

Barriers for integrating technologies and computer science education are also important to consider when implementing AI education programs and activities into EPPs. As part of a strategic initiative, institutions must consider primary and secondary barriers before sustainable learning can occur (Ertmer 1999; Ertmer, Ottenbreit, and Tondeur 2016). The first-order barriers include personal and fundamental beliefs about teaching, technology, and a willingness to change practices. Given that traditional EPPs have not emphasized the effective use of technology, let alone AI, nor the pedagogical shifts needed to enable that effective use (U.S. DOE 2023), preservice teachers may enter the PreK-12 classroom without a positive belief in their own self-efficacy to utilize or teach about digital tools and literacies. Further, mixed messages about technology and AI in the media may lead preservice teachers to question the value of AI technologies in the classroom. Nevertheless, teacher belief in the value of integrating these technologies and their own self-efficacy are both to realize effective and transformative integrations (Crompton 2017). In light of this, our proposed framework aims to build competence and illuminate the positive possibilities for effective uses of AI in education throughout participation in an EPP. Second-order barriers, which are more easily addressed, include lack of space, access, time, training and support (Ertmer, Ottenbreit, and Tondeur 2016). Once again, the framework provides systemic recommendations for approaches that would help overcome these barriers throughout a preservice teachers' time in an EPP.

To ensure the successful implementation of AI in education, it is imperative to adequately prepare preservice teachers now and in the future. Drawing upon previous experiences from lessons learned and challenges described, we identified a need to develop a clear framework that supports EPP faculty and leadership with strategies that would help them embrace AI as both a valuable tool and area of instruction in education.

Framework

The following framework consists of seven critical strategies intended to provide a guide for EPPs as they revise their teacher certification curriculum to better prepare future educators for creating learning environments for their students to learn with and about AI technologies. The strategies are offered as a starting point and not intended to be an all-inclusive list. We acknowledge that this framework may need to be updated regularly to respond to the dynamic evolution of AI tools and capabilities.

Critical Strategy 1 - Foster a Universal Foundational Understanding of AI

As with any concept that is endeavored to be taught, EPP faculty and preservice teachers need a foundational understanding of AI in order to learn how to use it effectively in the classroom. This foundational understanding serves as the content and technological knowledge needed for effective integration of AI technologies in education. This starts with a fundamental understanding of what AI is. AI generally refers to the ability of machines to perform tasks that normally require human intelligence, such as learning, problem solving, and decision making (Dempsey and Kosmiski, 2023; Haenlein and Kaplan 2019). It is also important to establish that AI has a long history dating back to the mid-twentieth century, and that faculty and preservice teachers were likely using AI in their daily lives well before ChatGPT (OpenAI 2023) came into existence. Helping EPP faculty and their preservice teacher students recognize the AI they use regularly will make it easier for them to understand the capabilities of the technology. These everyday uses of AI might include engaging with chatbots that provide customer service support, using social media or video streaming tools that curate content based on past activity, utilizing spellcheck or autocomplete functions as we write emails and other text-based content, and relying on voice recognition assistants like Siri and Alexa to assist us with basic tasks.

As part of this foundational understanding, it is also important to help faculty and future teachers conceptualize how AI works and the varied impacts it has on society. For example, AI tools utilize machine learning, which involves the use of algorithms to iteratively learn from data to improve, analyze, and predict outcomes (El Naqa and Murphy 2015). Similarly, it is important for those involved in EPPs to understand that many of the latest generative AI tools like ChatGPT use large language models that are trained on enormous amounts of text, which allows the technology to find patterns and create responses to prompts that appear to be human generated. In cultivating an understanding of how AI technologies work, it is also critical that educators realize

that all AI models carry with them the biases, preferences, and perspectives represented in the data on which they are trained. Discussions on the ethical use of AI and the impact of these potential biases are expanded upon in strategy 6. As educators learn about AI, how it works, and how it impacts society, they will be able to cultivate their skills to use AI tools efficiently and effectively.

Critical Strategy 2 - Cultivate Skills for Effectively Harnessing AI Instructional Tools

The integration of AI instructional tools in education is a promising avenue for transforming the learning environment. Understanding both what AI tools are available and how they may be effectively integrated into instruction builds the technological and pedagogical knowledge preservice teachers need for effective integration. While not a comprehensive list, this review highlights five key categories of AI tools presented in the ISTE AI in the Classroom jump start guide (Black 2023), each with a unique potential to enhance or transform educational experiences moving forward.

Generative AI, recently exemplified by tools like ChatGPT (OpenAI 2023) and Midjourney (Midjourney 2023), offers the ability to create diverse data and media artifacts across various media forms. Educators can harness Generative AI by using effective prompt engineering techniques. Clear and specific prompts, contextualization, examples, and constraints are essential strategies for productive utilization. While generative AI technologies raise new concerns around data privacy, media literacy, and academic integrity, this technology also has the potential to empower creativity and be applied to tasks ranging from writing poetry to developing lesson plans.

Intelligent tutoring systems and adaptive assessments, represented by platforms like ALEKS (McGraw Hill 2023), harness AI to provide personalized learning experiences. These systems adapt to individual learners' needs, making education more efficient and effective. They offer tailored instruction and assessments, addressing students' unique strengths and weaknesses.

AI-powered pedagogical agents and chatbots, such as Khanmigo (Khan Labs 2023), facilitate natural language interactions between students and computers. They serve as educational support tools, aiding students, including those with special needs. These agents enhance engagement and provide personalized guidance, contributing to a more interactive learning environment.

Educational and social robots, exemplified by Milo, Carver, Veda, and Jem from Robokind (RoboKind 2023), may play a crucial role in emotional recognition and language development. They offer a supportive and interactive learning experience for students, especially those with special needs. These robots promote holistic development by facilitating social skill practice and emotional understanding.

AI-Powered extended reality (XR) environments, like the Mondly AR App (ATi Studios 2023), bridge the gap between the virtual and real world. They offer immersive learning experiences, language assessment, and enhanced simulations. Moreover, opportunities exist to strategically develop such environments to support the development of instructional and classroom management strategies with preservice teachers.

The incorporation of AI instructional tools across these five categories and beyond has the potential to revolutionize education. Generative AI fosters creativity, intelligent tutoring systems provide personalized learning experiences, pedagogical agents and chatbots enhance interactions, educational and social robots support holistic development, and AI-Powered extended reality environments offer immersive, adaptive learning experiences (Black 2023). As these technologies continue to evolve, they hold significant promise for reshaping the educational landscape and improving learning outcomes for students of all backgrounds and abilities. Educators and institutions have the opportunity to embrace these tools judiciously, considering their unique capabilities, limitations, and implications to harness their full potential in education.

Critical Strategy 3 - Use the Five Big Ideas in AI as Guidance for K-12 AI Literacy Education

In addition to technologically supporting new forms of instructional tools, AI also comprises a new area of content knowledge for preK-12 educators to teach students; however, most teachers have not had a background in computer science or artificial intelligence topics (Touretzky et al. 2019a). To promote preservice teachers' effective future integration of AI literacy education in schools, it is necessary to provide instructional guidelines that teachers can follow, similar to the provision of national and state standards to guide teachers in core subjects. This would help preservice teachers both identify and develop effective lessons on AI topics.

Widely accepted national frameworks, such as the ISTE Standards (2016) and CSTA K-12 Computer Science Standards (2017), should be introduced to preservice teachers and utilized as tools for designing AI literacy lessons and curricula. However, these standards do not provide comprehensive directives for AI across all grade bands. For example, the revised CSTA K-12 Computer Science Standards explicitly address AI in only two sections, both in the 11-12 grade band (Touretzky et al. 2019a). Responding to the need for more comprehensive guidance, the AI for K12 initiative (AI4K12) developed the Five Big Ideas in AI (perception, representation and reasoning, learning, natural interaction, and societal impact) and a set of associated national guidelines to inform the integration of AI literacy in K-12 lessons (Touretzky et al. 2019b).

To promote and support the effective incorporation of AI literacy in PreK-12 lessons in alignment with suggestions

from computer science education advocates (Gal-Ezer and Stephenson 2010; Goode, Margolis, and Chapman 2014), we strongly encourage EPPs to build their students' pedagogical content knowledge around AI using the Five Big Ideas in AI. Since many existing AI curricula and lessons utilize the Five Big Ideas in AI, it is imperative that EPPs introduce educators to the Five Big Ideas in AI in teacher education and professional development programs. Moreover, we specifically recommend that EPPs align with the Five Big Ideas in AI when designing lessons around AI literacy. With the associated AI4K12 progression charts, which break down the Five Big Ideas in AI into grade band guidelines, preservice teachers can plan developmentally appropriate integration of AI literacy topics and activities into their lessons (AI4K12 2020).

Critical Strategy 4 - Facilitate Exploratory Experiences that Develop and Apply AI Knowledge

Educators have long been challenged to provide students with engaging learning opportunities to transform information into knowledge while deeply internalizing what they learn (Trifone 2021, 14). With the integration of AI in education, there has been an added perplexity in transforming the way students learn and teachers instruct. Kolb (1984) suggested that learning is constructed by concrete experiences, observations, reflections, forming abstract concepts, and testing in new environments. This type of learning would apply to the cultivation of AI literacy in EPP faculty, preservice teachers, and their future preK-12 students. For EPP faculty and preservice teachers to develop and deliver effective AI lessons, they need to be introduced to and practice with pedagogical approaches suitable for interactive lessons that allow students' AI explorations. The pedagogical approaches that are effective for creating interactive exploratory learning are project-based, inquiry-based, and learning-by-design approaches where the focus is on the *process of learning*, rather than the final product (Eguchi 2017). Those approaches are considered as a subset of constructivist/constructionist learning helping students' construction of knowledge through students' experience (Ackermann 2004; Eguchi 2012; Papanikolaous and Frangou 2009; Ültanır 2012) and should be introduced, explored, experimented, and practiced throughout the AI educational offerings within EPPs.

Moreover, as AI has reshaped what and how we teach, educators have been forced to re-examine a future shaped by AI and to adapt instruction. Through exploratory, hands-on, and interactive activities, preservice teachers can later help K-12 students develop their understanding of AI as well as the confidence and creativity they need to explore and navigate AI's evolving landscape. In addition to facilitating exploratory experiences, these educators can help students apply newly acquired knowledge to real-world situations.

For AI knowledge to *stick* with EPP and K-12 students, it is crucial for them to *experience* AI through active engagement in activities and projects. Teachers are strongly encouraged to support students' AI exploration by incorporating activities providing opportunities such as running experiments with AI agents, exploring case studies of AI-related social issues from various perspectives, or building their own AI applications. Adapting and providing real-world scenarios and application to real life is empowering for students. Thus, providing enriching, hands-on learning opportunities that foster the development and practical application of AI knowledge allows students to apply what they know and learn to practical situations.

We should make sure that preservice teachers are able to integrate exploratory or project-based approaches for effective AI literacy learning. With exploratory learning that makes students' AI explanation possible, traditional ways of *teaching*, where a teacher is a provider of information to students following a rigidly structured curriculum, has to go through a paradigm shift. The role of teachers has to shift from teachers who give instructions to teachers who facilitate, mentor, or scaffold (Eguchi 2012, 2015). Teachers have to spend much less time giving lecture-type instructions and focus on providing support by responding to students' needs while students explore their AI learning. In such learning environments, the role of students shifts from passive learners to active participants of their learning who sit in the driver's seats of their learning (Eguchi 2012). In this way, we can ensure that students are given opportunities to explore AI through authentic learning.

In the constructivist/constructionist learning space, teachers need to create a learning community where both teachers and students become learners (Bers 2008), where they can co-learn and co-construct new knowledge together. Faculty should model this in their own instructional practices to give preservice teachers the best opportunities to master the skills. Educators must provide students—both preservice teachers and PreK-12 children—with their own experiences in learning with and about AI, maximizing their learning and obtaining greater background knowledge about AI, data science, and computer science. Moreover, the rapid evolution of AI technologies compels a need to acquire new technological and content knowledge in an ongoing manner, which can be done in collaboration between instructor and student.

Critical Strategy 5 - Infuse AI Literacy Across Existing Curriculum

Providing AI literacy education to all students can help ensure the equitable education needed to prepare all students for a successful future in the modern age (Peterson 2020). As such, we strongly recommend that faculty and preservice teachers do not treat AI literacy education as an add-on or elective, but instead that they integrate AI literacy into existing lessons and curricula across subject areas. One of our roles as educators is to assist students in making connections

between what they have learned, what they are learning, and how they will apply the learned knowledge. Thus, rather than teaching independent, discipline-based content in silos, a practical cross-curricular framework designed around an interdisciplinary approach using AI tools can make learning meaningful, help students connect more deeply to content, and build relationships with what they are learning. Moreover, AI literacy education can enhance students' understanding of the practical application of what they are learning across subject areas to real life, while reinforcing what students should know and understand about AI.

For example, ISTE's *Hands-On AI Projects for the Classroom* series provides support for educators interested in incorporating AI literacy in their classrooms (Black 2022). These open educational resources (OER) provide AI projects and activities strategically designed to be integrated into standards-based instruction in elementary core subjects, secondary core subjects, electives, and computer science coursework. Similarly, having students use AI tools such as Google Teachable Machine (2017) or Machine Learning for Kids (2017) can enhance their understanding of complex AI topics within different subjects, providing an interactive, interdisciplinary approach. Experiences with curricular activities like these are essential in helping preservice teachers develop knowledge and skills about AI, which considers the capabilities, risks, ethical questions, and potential to be used in solutions to problems in their communities. These curricula - and others like them - can be used to narrow the gap in resources for EPP classrooms and provide exemplars for teaching AI literacy with a cross-curricular approach.

Critical Strategy 6 - Integrate Critical Examinations into Classroom Experiences

The integration of AI education into EPPs offers opportunities to critically examine AI's potential impact through the lenses of digital equity, culturally responsive teaching, and ethics. Educational scholars emphasize the significance of fostering an ethical consciousness in preservice teacher education (Gay and Kirkland 2010). A crucial aspect of this endeavor is understanding the role and implications of AI in PreK-12 settings in order to equip preservice teachers with tools to address AI-related challenges in their own classrooms. This must be done through intentional and critical examinations of AI.

Historically, the discourse around the digital divide has centered on disparities in access to computing devices and internet connectivity. Although this remains a significant concern in various global regions (and were highlighted during COVID-19's emergency remote teaching era), a redefined understanding of digital equity now encompasses increasing opportunities for innovative use of technology. The UNESCO International Science and Evidence-based Education (ISEE) Assessment articulates this evolution, emphasizing the need for education to view the learning experience in the context of human flourishing (UNESCO 2022). The goal is to utilize technology in ways that foster higher-order cognitive skills and creativity, rather than repetitive rote learning. This includes access to learn with and about AI in order to fully participate in modern society and understand how AI can impact and harm specific groups. Digital technologies have shown a tendency to amplify existing disparities, including in education, and there is reason to believe that AI systems and platforms will continue to become more powerful in dictating how we interact with information and learning (Giannini 2023). Given this, EPPs should emphasize not only equity in access to devices, but also equity in access to AI literacy education, in use of innovative AI tools and instructional approaches, and in impact of digital advances.

Culturally responsive classrooms highlight and nurture each student's unique contributions and strengths. By integrating learners' cultural knowledge and experiences with the curriculum, educators can build stronger connections with students. However, the implications of AI stem from its reliance on user input, raising critical questions about the representation of narratives and the inherent algorithmic assumptions. Whose stories are being told? What norms and assumptions are the algorithms based on? Models may inadvertently favor predominant user perspectives, resulting in biased outputs. These biases in AI are complex and are often rooted in its design and development phase. A concerning underrepresentation of populations in the field of computer science, especially in frontier technologies, often results in AI models that reflect Western-centric norms. This reciprocal relationship between culture and AI—the future shapes AI, and AI shapes the future—highlights the need for critical examinations.

In addition to these considerations, integrating AI into education raises ethical concerns such as issues related to privacy, data ownership, and surveillance. The complexity of AI often results in a lack of transparency in its mechanisms and outcomes, which highlights the need for careful decision-making in its adoption (U.S. DOE 2023). A crucial aspect of this process is vigilant questioning of the implications of every technological integration to ensure that ethical standards are maintained, a practice which needs to be explicitly taught in EPPs (Howard, Thomas, and Schaffer 2018). Furthermore, preservice teachers should be prepared to teach about ethical considerations and societal implications of AI with their future PreK-12 students (Black 2021).

We need to be asking our preservice teachers to think about, "What should a world with AI look like? What roles should this powerful technology play? On whose terms? Who decides?" (Giannini 2023, p. 4). Can AI be a partner in the learning process? A collaborator? A mediator? While AI is already used for personalization in education, that process can somehow remove the person from the personalization process as we are encouraged to simply "obey the algorithm." Should the focus of educators be to monitor and shape student performance (academic, social, behavioral),

or to teach students to code and create innovative AI environments - in other words, "Should AI be used to program students or should students learn to program AI?" (Langran et al. 2020, p. 754). The rapid changes and the complexity of AI create challenges for both educators and policymakers to keep up with the ethical and societal implications that have unique characteristics, capabilities, and risks (Shao 2023). As educators adopt any technology, they need to carefully consider the areas discussed in this here - when and how to deploy AI, how to design learning experiences to help students learn with and about AI, developing critical literacies around AI, asking questions about surveillance, who has access to and owns the data being used to feed the algorithms and importantly, awareness of the potential biases and inherent limitations of a technology that can exacerbate existing inequalities.

Critical Strategy 7 - Intentionally Infuse These Approaches into Teacher Preparation

Successful AI literacy for faculty, preservice and inservice teachers, and PreK-12 students must be strategically and systemically cultivated. We echo the U.S. Department of Education's call for higher education "institutions that prepare teachers to integrate technology more systematically into their programs; for example, the use of technology in teaching and learning should be a core theme across teacher preparation programs, not an issue that arises only in one course" (U.S. DOE 2023, p. 59). We go further to propose that the discussion and use of AI specifically should be central in this core theme.

Moreover, we assert that AI literacy education for preservice teachers and PreK-12 students should be addressed across EPP coursework. These intentional learning experiences that can be built into course conversations, activities, and assignments should not be relegated to the faculty member who teaches the standalone educational technology course, especially as not all EPPs have this specific or required course. Instead, we advocate for an approach that infuses technology program-wide and program-deep and that involves shared responsibility of all teacher educators (Graziano, Foulger, and Borthwick 2023; U.S. DOE 2016). Thus, training faculty to intentionally address AI within and across courses throughout their EPPs and to have these critical conversations becomes vital to subsequently preparing our future teachers.

Conclusion

Filling the gaps in training needed for preservice and inservice teachers to effectively use AI in the classroom requires comprehensive research and development efforts. Some key areas include the impact of AI tools on student learning, the effectiveness of various kinds of professional development like online courses and workshops, an investigation of the ethical considerations of AI in education including bias and fairness, the assessment of AI tools for various educational purposes, and an investigation into the impact of policies on teacher training and AI adoption in schools (Hwang et al. 2020). We advocate for a call for EPPs to rapidly assess their programs in these areas and beyond, and to take strategic, systemic action in accordance with this framework.

Moreover, we encourage further research around the following questions to fill gaps in the literature specific to EPPs.

- What AI education knowledge and skills do EPP faculty and preservice teachers currently have or lack?
- To what extent does AI education show up in current EPP curricula across institutions?
- What types of AI education resources and professional learning opportunities are needed to best serve faculty and/or preservice teachers?
- In institutions that are implementing instruction around AI in education, what is working and what is still needed?
- What barriers exist that are specifically impacting the ethical and equitable integration of AI education in EPPs?
- How does the implementation of the seven strategies in this framework, individually and collectively, impact EPP faculty and preservice teacher preparation around AI education?

By conducting research in these areas, we can better understand the challenges and opportunities surrounding the use of AI in education and develop evidence-based strategies to equip preservice teachers with the necessary skills to effectively leverage AI tools in the classroom. This research will contribute to the ongoing improvement of education in an increasingly technology-driven world.

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