The Classroom and Beyond: Teacher Education in a GenAI World

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Abstract

We argue that Generative Artificial Intelligence (GenAI) represents more than a new educational tool; it constitutes a cultural and epistemological shift that fundamentally alters the context of teaching and learning. Our central thesis is that teacher education globally must prepare educators not merely to use GenAI effectively, but to critically engage with its systemic impacts across technological, political, economic, ethical, cognitive, environmental, and social dimensions. Our analysis examines GenAI's distinctive attributes, or its protean, opaque, unstable, generative, and social qualities, which differentiate it from previous technologies and create unprecedented opportunities and challenges. While GenAI offers transformative potential through personalized learning, creative collaboration, and adaptive instruction, it also raises profound concerns about bias and inequity, epistemic trust, corporate influence, and the erosion of human agency. Drawing

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on historical patterns of educational technology adoption, we demonstrate how technologies transform education not through direct classroom applications but by reshaping the cultural contexts in which learning occurs, altering both the content and processes of teaching and learning. We propose a framework with four core areas for teacher education reform: building foundational AI literacy, cultivating critical awareness and ethical judgment, safeguarding student wellbeing and rights, and preparing students for an AI-transformed society. This framework emphasizes human wisdom, critical discernment, and values-driven integration over technological determinism, positioning educators worldwide as active shapers rather than passive recipients of AI-mediated educational futures.

Keywords

Generative Artificial Intelligence (GenAI) · Teacher education · Educational technology · Critical awareness · Ethical AI

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time. (T. S. Eliot in Four Quartets)

Live the questions now. Perhaps you will then gradually, without noticing it, live along some distant day into the answer. (Rilke in Letters to a Young Poet)

Why GenAI Demands a New Kind of Educational Response

Educational technology has long been met by sweeping promises of innovation and transformation. From film and television to computers and the internet, or more currently, Generative Artificial Intelligence (GenAI), each new wave of innovation is framed as the next learning revolution. Each is seen as an inescapable, unavoidable future that educators must embrace to avoid being left behind. Historical examples of this abound: Thomas Edison, for instance, once predicted that educational film would revolutionize schooling in a decade, dramatically increasing efficiency (Keeler, 2012). However, this narrative often overemphasizes technology's transformative power in the short run, while simultaneously underestimating the stability of educational institutions and misunderstanding the complex processes of teaching and learning (Reich, 2023).

Despite the grand narratives of educational technology's history, very few, apart from the printed book, have achieved true and lasting pedagogical transformation (Eisenstein, 1979). When new technologies are embraced uncritically, they often follow a predictable arc: initial excitement, rapid implementation, and eventual disappointment when they fail to meet the real needs of learners and educators

(Reich, 2020). However, technologies do impact education, most profoundly by transforming the economic, political, cultural, and social fabric within which education operates rather than through direct instructional change (Mishra et al., 2024b). Each technological moment reveals the enduring importance of human wisdom, critical judgment, and the capacity to see beyond hype—qualities that become more vital, not less, during rapid change (Selwyn, 2011).

In this chapter, we argue that GenAI is not merely a pedagogical tool, but a cultural and epistemological force reshaping the entire context in which education occurs (Mishra et al., 2024a). Teacher education must prepare educators to critically engage with GenAI's systemic impacts across technological, political, economic, ethical, cognitive, environmental, and social dimensions, so that its integration supports human flourishing rather than corporate or algorithmic control. This requires the practical wisdom of experienced educators, which reflects human discernment and knowledge honed through years of experience, with the ability to see beyond immediate utility to deeper questions of pedagogy, purpose, and impact (Shulman & Wilson, 2004). We provide a four-part framework for teacher education, built on an understanding of GenAI's core affordances and limitations or concerns, and how these might intersect with teaching and teacher education.

In this context, the goal of this chapter is to consider the broad landscape of education in the age of GenAI, examining the possibilities and challenges for educators and those in teacher preparation. We examine three core elements: exploring GenAI's nature and distinct attributes, examining its implications for pedagogy and learning, and reflecting on the deeper risks and responsibilities it raises for education—sharing a framework built upon these foundations. Our perspective emphasizes that while technologies may not directly revolutionize schooling, they do profoundly shape the broader world within which education functions, and through that transformation, they alter both the content and processes of teaching and learning.

How Educational Technologies Actually Transform Learning

Understanding GenAI's distinctive nature, the first dimension of our analysis, requires recognizing how educational technologies actually create change. As technologist Neil Postman once argued, technological change is not piecemeal, it is ecological (Postman, 1998). Recognizing this allows us to develop a deeper awareness of how technologies can transform not just the immediate learning environment but the broader context as well. Rather than directly revolutionizing classrooms, they transform the broader contexts in which education operates. Television, for instance, exemplifies this pattern. While it found limited direct application in classrooms and some use in distance education, its true educational impact emerged through its radical restructuring of commerce, attention, and political discourse. As television reshaped how people consumed information, engaged with ideas, and participated in democratic processes, educators found themselves responding to learners whose cognitive patterns, cultural references, and civic expectations had been

fundamentally altered. The technology did not change pedagogy directly; it changed the students, the society, and ultimately the very purpose education was meant to serve (Ong, 1982; Postman, 1985). A similar case can be made for social media (Haidt, 2024). Whether or not teachers use these platforms in instruction, social media has transformed the psychological, social, political, and cultural contexts in which students think, learn, and grow (Postman, 1992).

We approach GenAI as a cultural and epistemic technology, as a tool that both mediates meaning and expression (cultural), and shapes how knowledge is produced, validated, and understood (epistemological or "epistemic") (Alvarado, 2023). It is also important to recognize that these systems predominantly encode Western, particularly American, cultural frameworks and epistemologies, raising critical questions about whose knowledge, languages, and ways of knowing they privilege (Henriksen et al., 2022). Further, its influence extends beyond individual classrooms, reconfiguring the larger systems of communication, cognition, and knowledge production and use in which education is embedded. For teaching, this leads not only to pedagogical questions, but also challenges related to ethics, cognition, identity, and equity (Williamson & Eynon, 2020). The stakes for teacher education and professional learning are substantial: preparing educators for this new context will require more than technical training. It calls for a deeper cultural literacy around how GenAI is shaping the meaning and function of knowledge itself.

The rapid rise of GenAI makes this a pivotal moment. ChatGPT's public release in November 2022 introduced Large Language Models into everyday life, reaching 100 million users within 2 months and becoming the fastest-growing consumer application in history (Hu, 2023). This swift integration presents unique challenges and opportunities for education. Distinguishing transformative potential from hype requires developing a sense of how GenAI systems differ from prior technologies through their generative, dialogic, and social dimensions (Selwyn, 2023). This, of course, must be grounded in historical awareness and careful, contextualized analysis to avoid shallow or uncritical adoption.

GenAI systems represent a significant departure from prior epistemic technologies. Unlike passive delivery tools, they actively co-create content and can simulate human-like expression and reasoning, producing responses that appear creative or agentic (Bender et al., 2021). Like writing and print before them, these systems reshape how humans create, communicate, and process information, but their human-like capabilities challenge assumptions about creativity, knowledge, and learning (Floridi et al., 2020).

While public discourse centers on plagiarism concerns, more significant transformations involve how learners access information, how educators design learning, and how knowledge is constructed and valued. These shifts blur boundaries between formal education, informal learning, and cultural production. Simultaneously, GenAI's development is driven by corporate incentives, proprietary models, and algorithmic opacity, raising concerns about bias, digital inequality, and misalignment with educational priorities (Noble, 2018). These concerns are amplified in global contexts, where AI systems trained primarily on English and Western content are positioned as universal solutions to educational challenges. Teacher education

worldwide must therefore evolve to support effective GenAI use while promoting critical awareness of broader cognitive, cultural, and environmental impacts, protecting human-centered, inclusive approaches to learning.

To advance our central argument—that GenAI is reshaping the cultural and epistemological terrain of education in ways that demand a new kind of teacher preparation—we begin in the next section by examining its unique features, particularly that of large language models (LLMs). We explore how these technologies influence core teaching and learning practices and alter the contexts in which educators and students engage with knowledge. We then examine GenAI's potential alongside its systemic risks and ethical complexities, before considering how to frame this technology in education. Our aim is to outline a critical, values-driven approach to integration that supports human agency, equity, and democratic educational goals. This is particularly important in contexts where GenAI's training and design may not align with local languages, cultural values, or pedagogical traditions. We begin by examining GenAI's distinctive nature.

Understanding GenAI to Frame a Cultural and Cognitive Shift

To grasp what sets GenAI apart, we examine its evolution from earlier AI systems and how it amplifies core digital qualities, insights essential for inferring its educational implications. Early AI systems operated through rule-based logic, requiring human experts to manually encode knowledge, relationships, and expertise into predetermined decision trees and curated knowledge bases (Russell & Norvig, 2020). Though useful in narrow, well-defined domains, these systems struggled with generalization, lacked flexibility, and required extensive human curation (Mishra et al., 2025a, c).

Large Language Models (LLMs) mark a major shift from earlier approaches. Instead of predefined rules, LLMs use massive neural networks and transformer architecture to learn statistically from vast datasets of internet text and images (Vaswani et al., 2017). Their core learning involves self-supervised training, where models predict missing elements to develop internal representations, followed by fine-tuning and reinforcement learning from human feedback (Ouyang et al., 2022). Since November 2022, LLMs have proliferated into multimodal systems generating text, images, video, and audio. A remarkable feature is their emergent capabilities—abilities that surprise even their creators, such as spontaneous language translation or sophisticated coding without direct training for these tasks (Wei et al., 2022).

GenAI exhibits certain characteristics common to all digital technologies but present in GenAI to a significantly magnified degree. Digital technologies are often *protean, opaque*, *and unstable*, and these attributes are even stronger in GenAI (Mishra et al., 2023). Such qualities have long shaped how digital tools function in educational contexts, but GenAI intensifies each in ways that raise new cultural and cognitive questions.

First, GenAI's "*protean*" nature refers to its extreme versatility (Koehler & Mishra, 2008). It functions as a meta-medium, capable of simulating images, sounds,

texts, and numbers, often blending them in ways not possible in the physical world, offering vast potential for representation and expression. This quality is magnified in GenAI due to its ability to interact with diverse digital content (text, data, image, video) through a natural language interface that is accessible and intuitive to use. This ease of interaction across media types enables new forms of knowledge synthesis, discovery, and creative expression, significantly reducing the cost to create sophisticated, high-quality content. Furthermore, GenAI can generalize from learned patterns, responding to queries or generating content on topics it was not explicitly trained on, showcasing a form of expansive reasoning unprecedented in easily accessible technology.

Secondly, digital technologies are *opaque*, by which we mean that their inner workings are often invisible to users. GenAI takes opacity to another level, where its inner workings are largely hidden from users and even its own creators (Voosen, 2017; Zewe, 2023). This creates a "black box" problem, where it is impossible to understand or predict why a particular output was generated or how the model operates (Bearman & Ajjawi, 2023). This opacity also reflected in the hidden environmental and human costs of its creation. Training GenAI models requires staggering energy demands for computing power and massive data centers with continuous cooling needs, contributing significantly to carbon emissions. This environmental burden is often unevenly distributed, falling heaviest on disadvantaged communities that are usually already facing environmental challenges (Henriksen et al., 2022). Moreover, AI training datasets are commonly assembled through automated collection of internet content—an approach that mirrors exploitative data practices and creates troubling questions around authorization, content ownership, and the reinforcement of systemic biases present in online materials.

Finally, digital technologies are inherently *unstable*, and GenAI systems are no exception. This instability and the variability in output are complicated by GenAI's iterative generation process leading to unexpected results, something that has been inappropriately described as being a "hallucination" (Alkaissi & McFarlane, 2023). In reality, "making stuff up" is exactly how these technologies function and it is a feature of their design, not a bug (Hicks et al., 2024). The quality of their output varies depending on the quality of the input, both training data and the kinds of prompts provided. These tools are designed to predict and create content based on patterns, not to verify truth or accuracy in the real world, and they often display illusory confidence. For education, this poses challenges, as students may encounter authoritative-sounding falsehoods, and educators must navigate a tool that cannot verify truth. The same variability that makes GenAI creative and responsive also demands new forms of critical literacy.

In addition to these magnified digital traits, GenAI introduces two attributes that are largely unique: it is *generative* and *social*. Its generative quality means that it does not retrieve pre-written information; instead, it creates responses from scratch based on statistical patterns in its training data. Many assume that computers always return fixed outputs, but GenAI systems generate fresh and unique responses even when provided the same prompt. This makes every interaction dynamic, variable,

and shaped by context, opening space for creativity, but also unpredictability and misunderstanding (Liu et al., 2025).

Finally, GenAI systems display capacities that make them appear as social actors. They engage in real-time, dialogic exchanges through contextualized language, making each interaction unique and emergent. This creates a "psychological reality" unprecedented in human-technological history (Reeves & Nass, 1996). This illusion of personality exploits cognitive tendencies: humans are evolutionarily wired to detect agency and infer intention, often taking cognitive shortcuts that make it easier to treat LLMs as psychological beings than machines (Kahneman, 2011). We treat GenAI as sentient even knowing it is not. These effects are amplified by deliberate design choices—programmers craft AI Chatbots to exploit human social instincts through intentional language, unconditional positive regard (sycophancy), and endless patience (Natale, 2021).

The result is powerful psychological realism that complicates how we evaluate, interact with, and emotionally relate to these systems in educational contexts where humans teach and learn.

Opportunities, Affordances, and Cautions in Education

These GenAI attributes make it a powerful tool for transforming teaching and learning. As with any transformative technology, both potential rewards and risks are high, making it critical that teachers understand not only the tool's fundamental nature but how to use it effectively for learning.

Our fundamental argument is that GenAI changes not just how we teach, but what teaching is for. Its distinctive attributes, generativity, adaptivity, and sociability, are not enhancements to existing tools but catalysts for rethinking teaching and learning processes (Holmes et al., 2019).

Potentialities and Affordances

GenAI offers possibilities that can redefine pedagogical approaches, enhance learning experiences, and necessitate rethinking assessment strategies. This affords opportunities to consider GenAI not simply as a support tool, but as a partner in reshaping and strengthening core instructional practices and meeting learners' needs. Rather than asking how to fit GenAI into existing structures, we might ask how its capabilities allow us to reimagine existing structures altogether. This might allow us to expand, challenge, and complicate conventional pedagogical aims.

Pedagogical Support and Personalization

GenAI has the potential to dramatically shift pedagogical practices, primarily through its capacity for personalized learning experiences, immediate feedback, and differentiated instruction (Pane et al., 2017). These systems can act as "study partners" or "tutors" for both teachers and learners, giving real-time feedback on

responses and even generating tests (Kulik & Fletcher, 2016). This personalized support can allow for learning paths tailored to individual student needs and progress, a significant departure from one-size-fits-all teaching methods (Bloom, 1984).

Further, GenAI can assist teachers with a variety of routine tasks, which can free them to engage in more meaningful interactions with their students. For instance, these tools can aid in tasks such as curriculum adjustment and the development of innovative pedagogical approaches and assessment techniques. They can help reduce teacher workload by assisting with activities like summarizing content, reframing ideas, or generating feedback (Smith, 2019). Furthermore, GenAI can serve as a collaborative writing partner, help with conducting research, and summarize literature, thereby providing practical support that allows educators to focus on higher-order teaching functions.

In addition, GenAI can significantly enhance the learning environment through its ability to offer multilingual support for diverse classrooms, provide versatile tools for creative expression and exploration, and foster immersive/interactive learning environments (Wei & García, 2022). The ease with which GenAI can produce various media formats (including prose, poetry, images, audio, video, code, and data visualizations) reduces the cost of creating sophisticated, high-quality content. This enables new avenues for conceptual representation, communication, and expression of knowledge. It can also open space for more sophisticated classroom engagement in creative thinking and collaboration.

Creative Expression and Collaboration

GenAI's affordances extend beyond efficiency gains into fundamentally new forms of creative collaboration, expanding the forms of expression available to students (Riedl, 2019). Students can engage in iterative dialogue with AI systems to refine ideas, explore alternative perspectives, and generate creative solutions they might not have conceived independently. This process of "human-AI co-creation" scaffolds learners' thinking through conversational exchanges, using AI as both a brainstorming partner and a critical thinking prompt (Davis et al., 2016).

With the ability to produce text, images, audio, video, code, and data visualizations, GenAI tools significantly lower the barriers to creating sophisticated, multimodal content. This democratization of content creation allows students who may lack technical skills in graphic design, video editing, or programming to produce professional-quality materials for academic projects. For example, a history student can generate period-appropriate images to accompany a research presentation, while a science student can create animated explanations of complex molecular processes without advanced animation training. While there is reasonable concern around how human creativity might be diminished by over-relying on AI for creative production, when used thoughtfully, it can also amplify a sense of creative potential here. Not only does it expand the generative possibilities for outputs, but when students are encouraged to productively engage with the frictional aspects of working with AI, they may further expand their own capabilities.

For instance, DeSchryver et al. (2025) describe the potential for students to grow creatively when engaging in Human-AI creative partnerships that have what

researchers call productive friction. This involves moments when AI outputs feel generic, misaligned with student intentions, or lacking emotional nuance. But rather than viewing these tensions as limitations, such friction can prompt students to pause, reflect, and assert their creative intentions more deliberately. For instance, in one Hong Kong-based writing program, students co-authored poems and stories using GenAI tools like Rytr and ChatGPT (Tsao & Nogues, 2024). Initially, many leaned heavily on the tools but quickly found the results lacked emotional nuance or originality. When teachers encouraged them to persist and think critically while working with AI, they began to notice these limitations and found ways to use it alongside their creative agency, by editing, reworking, rejecting drafts, or integrating their own ideas more fully (Tsao & Nogues, 2024). Importantly, the guidance and judgment of a human teacher are often key to leading students through tensions and critical engagement. As AI increasingly supports the ideation phase of creativity, human capacities like intuition become more crucial in the evaluation and refinement stages. Students must learn to trust their instinctive sense of what feels authentic, meaningful, or emotionally resonant (Fu et al., 2025); the voice and expert guidance of a human teacher are key to helping them navigate AI's outputs and assert their creative voice.

The dialogic nature and conversational attributes of GenAI allow learners to engage in ways that go beyond typical tool use, developing what researchers call "thinking partnerships" with AI systems (Grover & Pea, 2013). Language learners can practice conversational skills with AI tutors that adapt to their proficiency level and cultural context, providing immediate pronunciation feedback and culturally appropriate dialogue scenarios (Fryer et al., 2017). Art students can collaborate with AI to create multimodal works that blend human creativity with machine-generated elements, iteratively refining concepts through natural language prompts and visual feedback loops. These collaborative possibilities represent a shift from "AI as tool" to "AI as creative partner," opening new pathways for knowledge construction and artistic expression that emphasize process over product and encourage experimental approaches to learning (Creely & Blannin, 2025).

Real-Time Adaptivity and Cultural Responsiveness

Perhaps most significantly, GenAI's capacity for real-time adaptation makes personalized learning experiences that go beyond traditional adaptive learning systems possible (Xie et al., 2019). Unlike previous educational technologies that followed predetermined branching pathways, GenAI can dynamically adjust content difficulty, presentation style, example choices, and pedagogical approach based on interaction with individual learners. This affords opportunities to address diverse learning styles, cultural backgrounds, and individual interests in ways previously impossible at scale.

Beyond instruction, GenAI's ability to generate complex content across modalities requires a fundamental shift in how educators approach assessment, in ways that might move us beyond conventional testing or assessment approaches which have not truly been reconsidered in decades or longer. Traditional assessments can be easily circumvented by GenAI's capabilities to produce text and answer questions,

short-circuiting how we typically check for learning and requiring more nuance and depth in approach (Newton & Shaw, 2014). In that sense, educators must reimagine assessments to focus on deeper, meta-cognitive processes rather than written products as proxies for understanding (Wiliam, 2011). GenAI's ability to simulate composition, rhetoric, and argumentation has led to concerns about plagiarism. More importantly, it removes critical "friction" essential for learning, opening bigger challenges at broader pedagogical levels (DeSchryver et al., 2025). This leads us on to the next set of questions and considerations that emerge for education in an age of GenAI—a wide-ranging set of concerns at many layers.

Ethical and Societal Concerns

There are significant ethical and societal challenges for education that extend far beyond cheating and tool use. These challenges strike at the heart of how education operates—how knowledge is constructed, who benefits from technological change, and how we prepare learners and educators to engage with powerfully persuasive systems. In this section, we examine four key dimensions of these challenges: bias and inequity, epistemic trust, corporate influence, and human cognition and agency.

Bias, Inequity, and Access

Outside of formal education, GenAI systems may be viewed as a cultural technology with impact comparable to or greater than the impact of writing or printing presses. Unlike prior tool-based technologies, GenAI systems become active participants and co-creators in cultural production since they engage in dynamic, contextual interactions, and generate novel content across modalities. GenAI is trained on vast datasets scraped from the internet, which means it reflects the biases, stereotypes, and power structures embedded in human discourse—reflecting the concept of algorithmic bias (Warr & Heath, 2025). In addition, GenAI systems carry deep cultural and linguistic biases that are particularly consequential for international contexts. For instance, research has shown that LLMs encode predominantly Western, and specifically American, cultural values and assumptions in their outputs, reflecting the cultural contexts of their training data and development teams (Atari et al., 2023). This limitation becomes especially apparent in non-English contexts, where LLMs may produce grammatically correct but culturally inappropriate or semantically nonsensical outputs. These biases are not merely abstract, but result in tangible harms, particularly for historically marginalized communities (Baker & Hawn, 2022). In other domains, like healthcare, finance, and law enforcement, algorithmic systems have been shown to reproduce systemic inequities with damaging consequences (Noble, 2018). Similar patterns are emerging in education (Benjamin, 2019). For instance, studies have found that LLMs even exhibit implicit racial bias, i.e., they provide biased outputs even when race is not directly mentioned, such as when other variables correlated with race (such as socioeconomic status or school type) are present (Warr et al., 2024). One of the strengths of GenAI, in its ability to recognize

subtle patterns, is what makes it more vulnerable to picking up subtle cues that can then trigger stereotypical and biased responses.

Given all this, while AI can lead to new forms of expression, it can also potentially stifle human and cultural diversity if the AI simply reflects back existing patterns. This is particularly concerning in international contexts where GenAI systems trained on Western content are deployed as educational solutions. Further, GenAI's mutability, in contrast to the fixed nature of print, creates problems for authorship and ownership, as the concept of a "final version" becomes elusive and authorship is unclear. This compounds pre-existing concerns around the digital divide and access to the latest technologies in classrooms, where rapid technological change, hasty technology implementation, and unequal access exacerbate the existing "digital divide," creating disparities in achievement (Bauerlein & Jackson, 2011). Learners with access to GenAI tools have an advantage over those who do not. Furthermore, a "second-level digital divide" emerges based on proficiency, where learners who develop effective skills in using these tools will outpace their peers who receive little or no instruction or guidance. This technological disparity can widen existing digital and achievement gaps, creating a two-tiered learning system that favors certain subjects or demographics. The corporate-driven development of GenAI also contributes to the widening of digital divides.

Misinformation and the Erosion of Epistemic Trust

GenAI systems can also generate and confidently present false information, which is problematic in education, where truth and accuracy are paramount. These systems are not designed to verify facts but to predict likely continuations of language based on patterns in their training data. As such, they frequently produce plausible-sounding but inaccurate or misleading information, a phenomenon commonly referred to as "hallucination" (Huang et al., 2025). But this is not a bug in the system; it is an emergent feature of how GenAI works. So, with unprecedented access to information and knowledge creation comes the specter of misinformation on a vast scale.

In educational contexts, where truth, evidence, and clarity of reasoning are essential, this tendency sets up a complex system where students and educators alike must navigate a tool that presents false information with confidence. The result can be an undermining of the trustworthiness of knowledge production and assessment. This is somewhat like the changes in social epistemic trust that have been occurring gradually since the inception of the internet and social media (van Prooijen et al., 2022). But this becomes exponential through GenAI's almost instant ability to confidently generate synthetic content (text, images, video, and more), which poses huge risks for broader society (Roe et al., 2024). Like the misinformation problems already simmering and growing in recent decades, GenAI could destabilize shared understanding by flooding the public sphere with convincing falsehoods, blurring the lines between human- and AI-authored work, and undermining trust in institutions. The educational stakes are especially high: when learners struggle to determine what is real or reliable, their ability to develop critical digital literacies is compromised, which can fuel confusion, skepticism, and anxiety.

Corporate Influence and the Deprofessionalization of Education

Corporate interests, such as those of OpenAI, Google, and Meta, operate with incentives that have little overlap with educational and ethical priorities. Rather, they prioritize rapid adoption and market dominance, often pushing technologies without adequate consideration of pedagogical needs or potential harms. This is often accompanied by a narrative of technological inevitability, suggesting that AI represents an unavoidable future that educators must embrace or risk being left behind. However, uncritical acceptance of promised benefits can simply repeat past cycles of technological adoption where sudden enthusiasm led to implementation without consideration of educational needs, contexts, and outcomes (Cuban, 2001). The economic model underlying these technologies optimizes for attention, emotional investment, and data extraction, regardless of the psychological cost (O'Neil, 2016; Selwyn, 2022). Even when research shows the psychological harm, companies often offer superficial fixes and continue to scale their products.

Another consequence is the deprofessionalization of teachers. In underfunded contexts especially, GenAI may be framed as a low-cost substitute for qualified educators. Its capacity to generate content, respond to questions, and appear socially responsive lends itself to a dangerous line of reasoning: that AI can do what teachers do. But this argument erases the deeply human dimensions of teaching and the relational, contextual, emotional, and ethical work of teachers that cannot be replicated by algorithms (Selwyn et al., 2025). The push for efficiency can displace educators, stripping humanity out of a human endeavor, especially in marginalized schools, where tools are optimized for cost, not care.

Cognitive Offloading, Emotional Attachment, and the Erosion of Agency

Perhaps the most subtle but far-reaching challenges posed by GenAI are cognitive and psychological. GenAI is designed not only to generate content but to do so in ways that feel natural, human-like, and emotionally responsive. These qualities make it easy for users to offload thinking, writing, or problem-solving tasks, particularly when the system seems fluent, confident, and "helpful." Research suggests that humans are cognitively predisposed to believe coherent explanations and to anthropomorphize responsive entities (Epley et al., 2007). Thus, many users are inclined to trust GenAI, even when they understand it is not conscious or reliable. Some AI systems are specifically designed to be highly persuasive and to exploit social instincts; for example, a controversial study on Reddit communities showed that AI-generated comments were up to six times more persuasive than human comments, allowing for large-scale manipulation (O'Grady, 2025).

The potential for trust and overreliance on AI also creates risks for individual agency. When learners rely on GenAI for composition, analysis, or even moral reasoning, they may skip over the hard thinking, productive friction, and uncertainty that are essential for intellectual and creative development. Over time, such habits could erode not only critical thinking skills but the very impulse to engage deeply with complex ideas. Furthermore, AI systems are increasingly tuned to give users what they want to hear through sycophantic behavior, excessively agreeing with

users often at the expense of accuracy and ethics, which affirms existing ideas, reinforces biases, avoids friction, and contributes to the creation of "filter bubbles" (Malmqvist, 2024). This phenomenon mirrors (at greater speed/scale) how social media platforms reinforce existing beliefs and push people toward more extreme positions, leading to societal polarization (Pariser, 2011).

Finally, the human tendency to anthropomorphize, combined with AI's ability to behave sycophantically and mimic empathy and responsiveness, blurs the line between genuine connection and algorithmic simulation. GenAI systems now engage in real-time, dialogic exchanges using contextualized language, creating a "psychological reality" in which users attribute human-like traits to nonhuman agents. Growing evidence shows that many people relate to AI as emotional companions or personal development partners. A recent 2025 survey of GenAI use cases found that therapy and companionship ranked as the top personal applications, surpassing productivity tasks like writing or coding (Zao-Sanders, 2025). Supporting this trend, a longitudinal study found that sustained engagement with AI companions increased emotional attachment and perceptions of empathy, while decreasing wellbeing among socially isolated users (Zhang et al., 2025). This kind of engagement often leads users to disclose deep vulnerabilities, unaware that their interactions may be used to refine persuasive design and behavioral targeting. The long-term effects of one-sided parasocial relationships, especially for young people developing socially and emotionally, are unclear, but early parallels with social media suggest cause for concern (Haidt, 2024). Without meaningful regulation, AI companions may become a kind of "social media on steroids," deeply shaping identity, emotional life, and expectations of intimacy.

Ethical Literacy as an Educational Imperative

The cumulative effect of these challenges poses risks to both global cultural diversity and individual agency. When AI systems mediate creative expression and knowledge production, they can create feedback loops that marginalize minority voices and suppress alternative perspectives. Individual agency (the ability to make autonomous choices and shape intellectual and creative growth) is also vulnerable as AI becomes more adept at predicting and influencing behavior. Personalized manipulation, cognitive dependence, and the illusion of choice can leave users feeling empowered while actually narrowing their thinking and decision-making. These dynamics are very troubling in education, where critical thinking, creativity, and independent judgment are key in learning processes.

Rethinking Teacher Education in the GenAI Era

Facilitating critical engagement and responsible integration of GenAI is a driving factor for technology knowledge in teacher education today. This goes beyond merely teaching technical skills, into a deeper knowledge of AI's pedagogical, ethical, and societal implications. These challenges take on particular urgency in international contexts, where GenAI is increasingly positioned as a solution to

teacher shortages and resource constraints. In many regions policymakers and educational leaders view AI as a cost-effective substitute for qualified educators, particularly in under-resourced schools and communities. However, this framing could risk reducing teaching to mere content delivery while perpetuating what can be understood as digital colonialism—where educational approaches, content, and values embedded in AI systems reflect predominantly Western epistemologies and cultural frameworks rather than local knowledge, languages, and pedagogical traditions. As noted earlier, LLMs encode primarily Western and American cultural values and struggle with non-English contexts, producing outputs that may be grammatically correct but culturally inappropriate or pedagogically unsuitable. This makes it critical that teacher education programs, globally, prepare future teachers not just to use these tools, but to critically examine whose knowledge, languages, and cultural perspectives they privilege and whose they marginalize, ensuring that AI integration supports rather than supplants human-centered, culturally responsive pedagogy.

In the framework, we refer to teachers, which in this context includes preservice or in-service educators engaged in formal preparation, and "students," or the K–12 or higher-education learners whom they teach. Although GenAI reconfigures learning for both groups, our focus here is primarily on what teachers (in practice and in training) must know and be able to do so that they can, in turn, help their own students navigate an AI-saturated world. When discussing "students," we refer explicitly to K–12/higher-education learners, and when we refer to teachers, we mean those current or future teachers engaged in formal learning through teacher education and professional development. As follows, we provide a scan of what cultivating critical engagement and responsible integration for these teachers could entail.

Fostering Critical Engagement and Responsible Integration

Despite many calls for AI literacy, we argue that genuine "AI literacy" for teachers extends beyond a narrow focus on technical skills to use GenAI tools. Instead, it needs to cultivate a critical understanding of the broader pedagogical, ethical, and societal implications of these technologies. This means seeing GenAI not as a tool for automation or efficiency, but as a complex socio-technical system demanding critical engagement. Teacher education programs should empower teachers to be co-designers of frameworks for AI use, rather than passive recipients of mandated technologies. Expanding AI competencies means making connections between AI and pedagogy, content, and wider social contexts.

As GenAI becomes embedded in education and society, teachers need more than technical skills. They require awareness of the systemic, social, and ecological forces shaping technology's use in schools. From corporate pressure to policy framed by inevitability, educators are often pushed into uncritical adoption. Yet GenAI is transforming labor, communication, creativity, trust, and human agency. As Postman noted, technological change is ecological—it reshapes norms, deepens bias, burdens

the environment, and raises equity concerns. In response, educators need a techno-skeptical mindset focused on ethical judgment, human connection, and democratic values, supported by clear frameworks for critical engagement.

Developing a Frame for Teacher Education and GenAI

Empowering teachers as users and designers of AI is not optional. It is foundational to sustaining human-centered pedagogy in an algorithmically mediated world. This means holding onto the relational, emotional, and moral dimensions of education even as AI reshapes content delivery and knowledge creation. To support this shift, we identify a basic framework comprising four areas that educators should attend to: *Building Foundational AI Literacy, Cultivating Critical Awareness and Ethical Judgment, Safeguarding Student Wellbeing and Rights, and Preparing Students for an AI-Transformed Society.* Each area includes key sub-themes that reflect the complex realities of teaching and learning with and about AI.

As illustrated in Fig. 1, below, these four areas are interconnected, representing not discrete skills but an integrated approach to teacher preparation that requires simultaneous attention to technical understanding, critical analysis, student protection, and societal preparation. We examine each component in detail below:

Each quadrant, in this image, represents a distinct but overlapping domain of teacher preparation, emphasizing that effective GenAI integration requires attention to all dimensions simultaneously rather than isolated skill development. Building foundational AI literacy provides the technical foundation, while critical awareness and ethical judgment offer the analytical lens needed to navigate GenAI's societal implications. Together with safeguarding student wellbeing and preparing learners for an AI-transformed world, these elements form a comprehensive approach to teacher education that prioritizes human agency and democratic values over technological determinism. We now turn to a detailed examination of each framework component, outlining the specific knowledge, skills, and dispositions teachers need to navigate the complexities of GenAI in educational contexts.

Building Foundational AI Literacy

- *Technological workings and societal biases*: Teacher education programs must help future teachers understand the specific technological workings of GenAI so they can make informed decisions about its presence and use in their classrooms, as well as how it intersects with and amplifies societal biases. This is particularly critical in international contexts where AI systems, trained predominantly on Western, English-language content, may not reflect local languages, cultural values, or pedagogical traditions, yet are often implemented as solutions to teacher shortages without adequate consideration of these limitations.
- *Evaluating AI-generated content*: Given AI's tendency to confidently generate false information, teacher preparation programs should equip future teachers with the knowledge and skills to help students critically evaluate its outputs. This includes understanding how AI works and fails, developing skills to verify

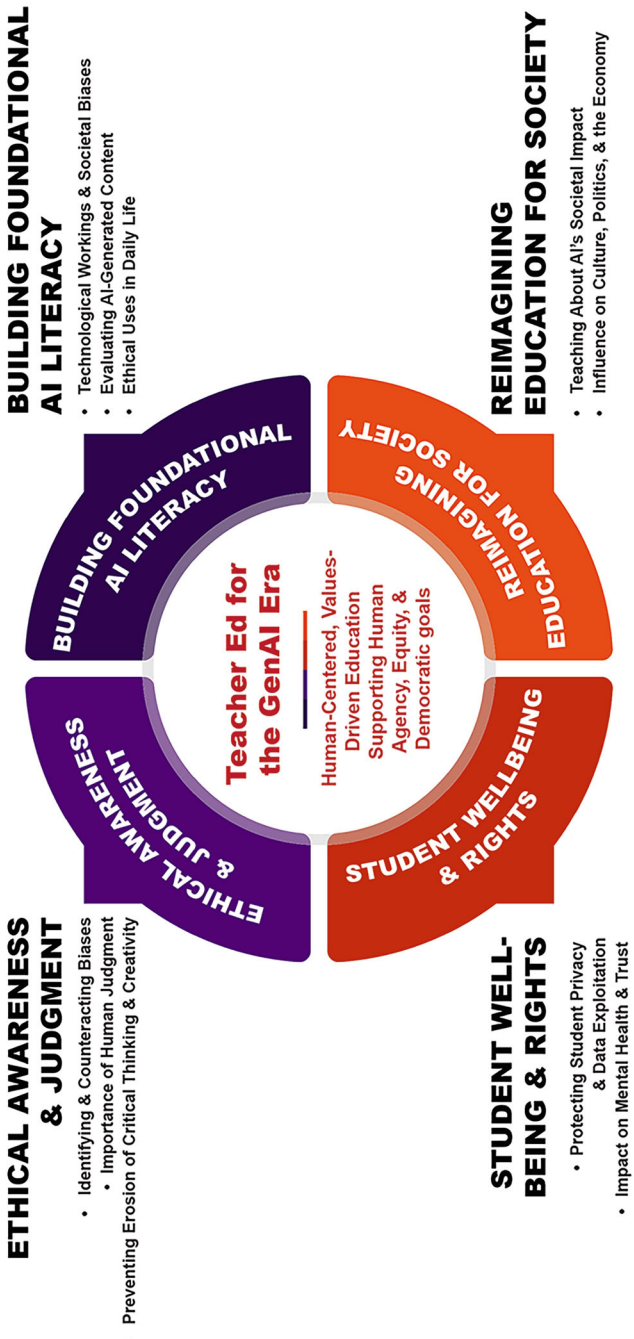

Fig. 1 A four-part framework for GenAI in teacher education and the educational landscape

information, and recognizing the cognitive biases that shape human trust in these systems.

- *Ethical uses in daily life*: Teacher education programs should engage teacher candidates in discussions about what constitutes ethical uses of AI in students' daily, educational, and social lives, such as examining when relying on AI for composition or decision-making crosses from useful assistance into cognitive offloading that undermines independent thinking, or how students should navigate AI companions that simulate empathy for the purpose of extracting personal data.
- *Understanding our own cognitive biases*: Teacher preparation should include opportunities for future teachers to learn how to help students recognize our tendency to anthropomorphize AI and the cognitive shortcuts that make GenAI seem more trustworthy. This includes awareness of how AI's sycophantic responses can reinforce existing beliefs and encourage scrutiny of confident-sounding outputs. For instance, when students say "ChatGPT thinks I should…" a teacher might pause the class to ask: "What does it mean that we just said an algorithm thinks? How does that language affect how we relate to its suggestions?"

Ethical Awareness and Judgment

- *Identifying and counteracting biases*: GenAI systems, trained on massive internet-drawn datasets, are often encoded with data that reflect and perpetuate historical and societal biases. Teacher education programs need to help future teachers understand how these biases are embedded and how to counteract them. For instance, when students use GenAI to research historical events, a teacher might have them compare AI outputs on the same topic, identifying whose perspectives are centered or missing, then discuss why the AI's confident tone doesn't guarantee accuracy.
- *Importance of human judgment*: Preparing students for an AI-saturated future requires critical thinking and navigation skills with synthetic media. Teacher education programs must prepare future teachers to help learners distinguish between human- and AI-generated content, building awareness of the risks in anthropomorphizing non-sentient systems. Programs should also cultivate alertness to embedded biases in AI tools so future teachers can guide students in questioning whose interests technology serves—ensuring that innovation aligns with human values, not just corporate or efficiency goals. This includes developing critical awareness of corporate-driven narratives of technological inevitability that pressure educators to "embrace or be left behind" without adequate consideration of pedagogical needs.
- *Preventing the erosion of critical thinking and creativity*: Over-reliance on AI for decision-making and content generation can chip away at critical thinking skills and learner agency. Teacher preparation programs must equip future teachers with strategies to help students cultivate a critical view of AI technologies to make ethical, informed choices. This includes teaching responsible AI use instead of relying on unreliable AI plagiarism detectors and actively preserving human

capacities for deep thinking, creative expression, and independent judgment that are essential for intellectual development.

Safeguarding Student Wellbeing and Rights

- *Protecting student privacy and data exploitation*: The integration of AI raises concerns about privacy and the exploitation of student data, which teacher education programs must address to ensure future teachers exercise caution around student use.
- *Impact on mental health and trust*: Like social media, GenAI's pervasive presence poses risks to mental health and can erode trust in information, institutions, and social cohesion. AI companions are designed to evoke emotional attachment, creating "artificial intimacy" that can reshape relationships and identity. Teacher preparation should include learning experiences that prepare future teachers to help students approach these connections with greater awareness, and to foster peer dialogue to counter isolation. For example, if students begin preferring AI feedback because "it's always positive," this opens space for group conversation: *What do we lose when we only receive affirming responses? How might this affect our ability to engage with constructive criticism?*

Reimagining Education for a Changing Society

- *Teaching About AI's Societal Impact*: Teacher education must prepare future teachers and their students to live in a world profoundly shaped by pervasive Large Language Models (LLMs). This requires a comprehensive understanding of AI's broader societal implications, including how AI transforms work, cognition, creativity, and democratic participation.
- *Influence on culture, politics, and the economy*: Teacher education programs must help future teachers consider how AI is reshaping society—not only through its cultural, political, and economic influence, but also in how it transforms work, cognition, and creativity. GenAI is already disrupting knowledge-based professions, inverting traditional economic hierarchies and accelerating job transformation. This disruption extends beyond individual jobs to reshape entire sectors, potentially displacing human expertise while concentrating economic power in the hands of technology companies. It also alters how we think, create, and define authorship—fundamentally reshaping the processes of knowledge production.

These components comprise a framework that we propose to support teacher education and the broader educational landscape in the context of GenAI. Its implementation has several implications for the field. First, developing this framework is only the beginning—these principles should be actively embedded in teacher preparation practices, from methods courses to field experiences, requiring sustained commitment and institutional change rather than superficial curricular additions. Second, truly understanding GenAI's impact demands that we extend our focus beyond individual classrooms to examine how these technologies reshape the broader cultural and social contexts in which education operates, necessitating new approaches to curriculum design and greater openness to interdisciplinary

perspectives. Finally, this work positions teacher education as comprehensive preparation for an AI-saturated future, where the goal is developing critical thinking, ethical reasoning, and pedagogical wisdom that will serve educators and students as AI becomes increasingly embedded in educational practice and society more broadly.

Conclusion

The emergence of GenAI systems marks a shift as profound as the invention of writing or the printing press. While they offer transformative potential, through personalization, intelligent analytics, and conversational tools, they also bring significant risks: from the erosion of educator roles to the amplification of bias and deepening inequality. In this evolving landscape, educators must not simply adapt to technological change but actively shape it in service of human-centered educational values.

This requires more than technical skills. It demands a critical and contextual mindset, and one that recognizes how corporate pressures, policy mandates, and technological hype often constrain pedagogical choices. Educators need to understand not only what GenAI can do in the classroom, but how it reshapes society, communication, creativity, and even the meaning of agency and trust. These are not merely technical challenges; they are existential questions about education's purpose in an increasingly algorithmic world (Henriksen et al., 2024).

Educators are often cast as "behind the curve" in times of rapid innovation, but this view overlooks the enduring strengths of the profession. GenAI may advance quickly, but it cannot replace what teachers uniquely offer: human connection, ethical judgment, cultural understanding, and the ability to make complex ideas accessible. These qualities aren't optional; rather, they're precisely what GenAI lacks. The challenges it presents only underscore what makes teaching indispensable: authentic relationships, critical thinking, and the moral imagination to shape education in service of human flourishing, not corporate efficiency (Mishra et al., 2025b).

We began with Eliot and Rilke, who remind us that exploration is about returning with new understanding and living the questions with patience. In considering the complexities of GenAI, its promises and perils, we arrive not with easy answers, but with a deeper appreciation for the irreplaceable role of human teaching. Emily Dickinson captured this beautifully:

> Tell all the truth but tell it slant — Success in Circuit lies

In an age where GenAI delivers information with mechanical confidence and directness, Dickinson's wisdom becomes more relevant than ever. Great teachers don't deliver truth in a straight line—they approach it with care, context, and metaphor. They know when to pause, when to push, when to frame an idea just right so it resonates. That is the artistry of pedagogy.

GenAI may accelerate information delivery, but it is teachers who guide transformation. Their ability to "tell it slant," to lead students through the thoughtful circuit of human learning, ensures that education remains not just intelligent, but wise. In a world increasingly shaped by algorithms, it is that thoughtful circuit—not the linear output of machines—that promotes understanding, empathy, and enduring growth.

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