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Generative AI, Teacher Knowledge and Educational Research: Bridging Short- and Long-Term Perspectives

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Abstract

This article reflects on the transformative nature of generative AI (GenAI) tools for teaching and teacher education, both reflecting on current innovation and consider future potentials and challenges. In that sense, we aim to position the field of education going forward with the implications of new technologies like GenAI for education and educational research. We argue the need for a dual-lens approach. First and foremost, practice and research should focus on the here-and-now, i.e. how to design powerful learning experiences for pre-service and in-service teachers for them to be productive, creative, critical, and ethical users. But there is also a need for a deeper, longer view—based on sociological and historical trends and patterns that will influence the socio-techno-cultural matrix within which education functions in the long term. We begin with a brief introduction to GenAI technologies. This is followed by an in-depth discussion of the fundamental nature of GenAI tools—their similarities and differences to prior technologies, and the implications for teacher education and research.

Keywords Creativity · Technology · Education · Artificial intelligence · ChatGPT · Generative AI · Responsible innovation · Futures thinking · Future · Equity

The pace of change has never been this fast, yet it will never be this slow again.

~ Justin Trudeau

We seem determined to give human qualities to objects and content to treat each other as things.
~ Sherry Turkle

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Introduction

In this article series, we explore a range of topics related to technology, learning and creativity. Most recently, our focus has been on Generative AI (GenAI), recognizing the transformative potentials and risks associated with this technological phenomenon. History shows the effects of even truly transformative technologies, like the printing press or the internet, often emerge over time. In contrast, ChatGPT, Bing Chat, DALL-E, Stable Diffusion and other such GenAI technologies have gained millions of users within months of their release into the world. November 2022 will remain a watershed moment, emphasizing the manner in which the introduction of ChatGPT, the first publicly available Large Language Model (LLM) based chatbot, changed the world.

These new tools seem poised to challenge prior conceptions of creativity and learning in ways we have yet to grasp. Moreover, it is often hard to judge the impact of nascent technologies and separate truth from hype. We believe that focusing thoughtful scholarly attention on these technologies, and their affordances and constraints, can reveal new insights into human potential. An underlying goal of this series is to foster dialogue among stakeholders: students, parents, educators, researchers, and policymakers to ensure these tools truly benefit learners. In the last year, we have

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covered key ideas through conversations with thought leaders such as Chris Dede (Warr et al., 2023a), Ethan Mollick (Henriksen et al., 2023), Kyle Jensen (Woo et al., 2023) and Andrew Maynard (Richardson et al., 2023).

In this first column we are writing in this new year, recognizing just what a transformative year 2023 has been, we take a moment to take stock—to reflect and position ourselves going forwards—on the implications of these new technologies to education and educational research. We argue the need for a dual-lens approach. First and foremost, practice and research should focus on the here-and-now, i.e. how to design powerful learning experiences for pre-service and in-service teachers for them to be productive, creative, critical, and ethical users. But there is also a need for a deeper, longer view—based on sociological and historical trends and patterns that will influence the socio-techno-cultural matrix within which education functions in the long term. We begin with a brief introduction to these GenAI technologies followed by discussion of the fundamental nature of GenAI tools—their similarities and differences to prior technologies, and the implications for teacher education and research.

Introducing Generative AI

Artificial intelligence (AI), as a field, has focused on creating intelligent systems that can perform tasks like decision-making and pattern recognition (Ruiz & Fusco, 2023). *Large language models (LLMs)*—a fairly recent AI innovation—rely on neural networks called transformers trained on massive datasets (UNESCO et al., 2023). Over the years, AI tools have entered almost every aspect of our lives, from YouTube recommendation algorithms to voice activated devices like Alexa or Siri; from navigation software such as Google Maps or Waze to facial recognition systems in many photography apps. More recently, the training of these neural networks on immense amounts of textual and image data, scraped from the Internet, has allowed the development of GenAI tools such as ChatGPT, Bard, DALL-E, Midjourney, and Stable Diffusion, which can create text and images from mere verbal prompts. Importantly, the *training data* shapes what AI systems learn, and these systems reflect biases in data and creators (Ruiz & Fusco, 2023).

The speed at which natural language processing tools have entered our world is striking. Commercial companies are marketing AI assistants to support teachers in planning and assessment, like MagicSchool and Eduaide based on OpenAI's technology (Extance, 2023). Direct student engagement is seen with Khan Academy's LLM-based tutor Khanmigo, piloted in 30 + US school districts (Extance, 2023). At East China Normal University, education-focused LLMs like EduChat are being created and open-sourced (Extance, 2023).

Even while writing this article (in mid-January 2024), we learned of OpenAI opening its GPT store, populated with thousands of chat-bots, many related to education. Contact North, a Canadian organization supporting online learning, provides two free educational chatbots (AI Tutor Pro and AI Teaching Assistant Pro) targeted at learners and educators. In research, there are commercial products such as AIlyze, Research Rabbit, LitMaps and more jostling for space as time-saving, high-impact tools designed to assist with the research process, from surveying literature to designing research questions and methodologies, from qualitative and quantitative data analysis and more.

It is important to ask—how will and should teachers' knowledge, skills, attitudes, and values (OECD, 2019) change in this new world? How do we conceptualize research in these new emerging environments? Answering these questions requires us to dig deeper into *what GenAI is*, how it compares to other digital technologies.

The True Nature of GenAI

GenAI technologies are similar to other digital technologies in that they are protean, opaque, and unstable (Koehler & Mishra, 2008; Mishra et al., 2023). They are *protean* in that they are a versatile meta-medium, capable of simulating various formats like images, sounds, texts, and numbers, including those not possible in the physical world, offering unprecedented potential for representation and expression. They are *opaque* in that their inner workings are often hidden from users, making interactions with these tools symbolic and abstract. Finally, these technologies are inherently *unstable*, with susceptibility to errors from both human and software sources. All digital technologies have these attributes, though they may be enhanced in specific ways in GenAI.

There are, however, two key factors that make GenAI different from all previous technologies—namely GenAI is generative and social (Mishra et al., 2023). They are *generative* in that they generate unique outputs even when given the same prompt or input. They also exhibit emergent capabilities (such as writing code, translating languages and more) that the designers did not intend or anticipate (Al-Sibai, 2023; Hutson, 2022). Moreover, they are constantly evolving as developers modify model parameters and guardrails. This generative aspect is most easily seen when these technologies confabulate and make up information (what has been, somewhat incorrectly, called hallucination).

Finally, GenAI is *social*—i.e. they display capacities that make them *appear* to be social actors, requiring a "a shift in perspective from a mere utilitarian technological approach to a relational one" (Mishra et al., 2023, p. 245). This is consistent with how philosophers of technology have argued: that technologies are not inert artifacts but actively shape our thinking and relationships (Ihde, 1998; Verbeek, 2015). As Mishra, Warr and Islam write, "GenAI technologies

are almost embarrassingly literal manifestations of these abstract philosophical ideas" (2023, p. 245).

This does not mean that these technologies are social or have psychological states. People often anthropomorphize technologies, using instinctive thinking for quick inferences, as opposed to slow, analytical thinking which requires more effort (Kahneman, 2011). This is evident when interacting with conversational AI, where people often anthropomorphize GenAI agents (Mishra & Heath, 2024). The ability of LLMs to use contextualized language to interact through dialogue with users through text, voice, and images makes these tools function as having a psychological reality (Mishra et al., 2001).

There are significant dangers in our human tendency to assign personality to GenAI. Specifically, GenAI's social quality will impact beyond individual user interactions, and could "bleed into various aspects of society, influencing human interaction, psychological well-being, institutional trust, and broad societal norms" (Mishra & Heath, 2024).

These attributes of GenAI, some shared with other digital technologies (being protean, opaque and unstable) and some unique to GenAI (generative and social) are important to understand in educational research and practice. Accordingly, it is imperative that teachers understand the nature of human-AI interactions, to encourage learners to critically evaluate its output. Furthermore, these technologies can fundamentally alter the dynamic between educators and learners. The social nature of GenAI underscores the need to reevaluate the interactions among students, educators, and AI platforms. Educational spaces, which till recently consisted of humans (educators and learners) and relatively passive technological artifacts (non-digital and digital technologies) will now also be inhabited by these agentic tools performing a range of tasks—AI-directed, AI-supported, or AI-empowered. The implications of this shift could be profound.

Teacher Knowledge in a World of Generative AI: the Short View

We frame the initial discussion of teacher knowledge in the age of GenAI around the TPACK framework (Mishra & Koehler, 2006; Mishra, 2019). The TPACK framework highlights the interplay between technological, pedagogical, and content knowledge teachers require (Mishra & Koehler, 2006). GenAI introduces new complexities to these domains. Concerning Technological Knowledge, teachers will need to develop a nuanced understanding of how GenAI systems operate. This includes grasping that they are trained on massive datasets and function based on pattern recognition (Bhatia, 2023), allowing AI to generate output that is realistic and contextual (Roose, 2022). Moreover, teachers need to understand how GenAI behaves as "black boxes"

with sometimes unpredictable and unexplainable outputs (Zewe, 2023).

Teachers can leverage the strengths of GenAI for personalized learning, feedback, and differentiated instruction (Arthur, 2023). GenAI can also increase accessibility, inspire creativity, and reduce educator workload (Baidoo-Anu & Owusu Ansah, 2023). Furthermore, it can serve as a collaborative writing partner, aiding with conducting research and summarizing literature (FAQ, 2023).

Perhaps more importantly, teachers need to help students cultivate a critical view of AI technologies so that they can make ethical, informed choices (Krutka et al., 2022). Because generative models learn from patterns in human-created data, they reflect embedded societal biases (Ray, 2023). This means teaching responsible AI use rather than relying on ineffective AI plagiarism detectors, which can result in false accusations of cheating (Mitchell, 2023). Furthermore, teachers can empower students to evaluate AI-generated content for accuracy given AI's propensity to confabulate false information (Alkaissi & McFarlane, 2023). Teachers can educate students about AI biases, such as discrimination against marginalized groups in areas like law enforcement, finance, surveillance, and healthcare (Bartlett et al., 2022; Benjamin, 2020; Kentayya, 2020; O'Neil, 2017).

Research also shows that GenAI often exhibit gender/racial prejudices (Snyder, 2023) and implicit racial bias in educational contexts as well. When given explicit race related cues, ChatGPT actually, contrary to an expectation of bias, scored Black students higher. But the bias appeared when the AI system was given implicit cues that correlated with race, such as socioeconomic status and school type (Warr et al., 2023b). These implicit biases make educators' tasks harder as they aim to develop their own and students' skills to identify and counteract these biases. Relatedly, generative models fail to properly attribute the human creators of their training data. Moreover, the appropriation of marginalized artists' work for profit perpetuates colonialism (Marx, 2023; Hendrix, 2023). Teachers can model responsible citation, empower student autonomy over their creations, and teach about ethical AI development and use.

Finally, this requires teachers developing new mindsets and contextual knowledge to shape the integration of GenAI in education. Teachers' ability to integrate GenAI tools in the classroom may be constrained by entrenched policies, systems, and cultures. As Mishra and Warr's (2020) five spaces for design in education framework highlights, broader systemic contexts influence what teachers can implement (Mishra & Warr, 2020, 2021; Warr et al., 2020).

From a short-term perspective, GenAI brings complexities and opportunities requiring new teacher knowledge and skills. Teachers can cultivate creative and critical perspectives, develop new forms of assessment even while modeling

ethical use to empower student agency over their learning. Meanwhile, researchers should adapt to quickly produce and share studies that are responsive and accessible, informing pedagogy in the face of rapid technological evolution.

Teacher Knowledge in a World of Generative AI: the Long View

GenAI has the potential to transform a wide range of human activities and professions (Li & Liu, 2020). Thus, it has the potential to significantly shift and transform the socio-political contexts education functions within and possibly redefine the purposes of education. As educators begin to respond to AI technologies, it is worth asking, "What would happen once a non-human intelligence becomes better than the average human at telling stories, composing melodies, drawing images, and writing laws and scriptures?" (Harari, 2023). This requires long-term thinking and a reexamination of curricula as AI reshapes knowledge, work, communication, and creativity.

As we respond to GenAI, we might learn from the way in which social media has transformed society and thus impacted the classroom. For instance, social media has exacerbated mental health issues (American Academy of Pediatrics, 2021) as well as polarization and misinformation (Stubenvoll et al., 2021), compelling schools to implement social-emotional learning and digital citizenship instruction (Mishra & Heath, 2024). Similarly, GenAI's risks around misinformation and social cohesion may demand educational responses.

In light of what we have learned about the impact of social media, we should be wary of the impact of GenAI in the longer term. Instead of solely focusing on classroom integration, educators must consider how AI is shaping individual lives and culture. Mishra and Heath (2024) encourage us to ask, "if oral cultures prioritize memory and print cultures emphasize systematic organization, what types of knowledge will AI systems foster?" This demands long-term thinking beyond incremental pedagogical innovations.

More specifically, we argue that we need to go beyond the immediate question of teacher knowledge to dig deeper into the broader social and cultural impacts of these technologies. These are difficult questions to answer—with complex cause-effect relationships that work at the level of broader social and economic systems. That said, technologies are not neutral—they can subtly or significantly influence our cognitive, interpersonal, and cultural practices, processes and structures. They set the basic rules for how we process and analyze information, like what data we deem important, how we assess it, and how we construct arguments. Furthermore, technologies often function below conscious awareness and critical examination, going unnoticed by users while significantly shaping their thinking, actions and more.

The kinds of questions we need to consider shifts when we take on this longer-term framing. We identify five questions, inspired by Postman (1998), that we need to ask about technological change. Taking each in turn:

Who pays the price for a technology? Postman argued that technology involves trade-offs (it giveth and it taketh away). With AI, these trade-offs include balancing personalization with human interaction, data reliance vs., teacher expertise, and the value of learning struggle vs. easy knowledge acquisition. We must consider if AI use makes our intelligence artificial and diminishes authentic human learning and connections. Educators need to carefully balance AI's efficiencies with human-centered, socio-emotional teaching methods.

Who are the winners and losers? Technology often exacerbates inequities in access and quality education, with AI potentially widening digital and achievement gaps. This creates a risk of exacerbating existing two-tiered learning systems and favoring certain subjects. AI's current capabilities, including in traditionally human domains like the arts, underscore the need for educators to teach critical assessment of AI biases to promote equitable futures.

What are the powerful ideas (and biases) embedded in the technology? AI systems, influenced by societal biases in training data, can introduce or amplify biases. GenAI, with its vast knowledge and social capabilities, may deepen mistrust in institutions, increase confusion about truth, and impact identity development. As corporations focus on profit with generative models, educators must address these consequences by staying vigilant of AI biases and fostering critical thinking.

How does the technology change the very ecosystem in which it exists? Postman argues that technological change is not additive, it is ecological. Technologies like print, television, and social media have fundamentally reshaped society, and AI's impact is similarly vast and unpredictable. AI's persuasive potential could exploit cognitive biases, spreading misinformation and eroding trust. Educators must prepare students for an AI-transformed world, emphasizing critical thinking and navigation skills in a future filled with synthetic media.

How can we reclaim agency with technology? Postman suggests that technologies are fictions, i.e. they are often accepted uncritically. They are designed by humans and can be redesigned by scrutinizing their contexts, questioning impacts, and asserting control over their development and deployment. The responsible use of GenAI hinges on human moral awareness, to humanize its use and impact. Educators must guide students to thoughtfully navigate this shift, promoting both individual and collective control over their technological futures.

Bridging the Short and Long Views

We suggest there is value in taking both these views: short-term and long-term. In the short-term, our research and practice should focus on the immediate, the context and situation now. That means engaging with and responding to the advent of GenAI and its immediate use in educational contexts. A short-term view requires new forms of scholarship and dissemination avenues for research findings, as well as the development of rapid-response models of research, that capture the here and now of this shape-shifting technology.

Yet, we cannot lose sight of the bigger, more long-term picture—encompassing the five bigger questions listed above. As these technologies become part of our lives, they will influence broader political, social, and cultural discourse, disrupting existing ways of being and living in the world and the manner in which we connect with each other. We must create or adapt research methods (or borrow from fields like cultural theory and sociology) to probe deeper, complex ideas. Our typical methods often fail to address deeper questions, especially regarding the nuances of ethical integration.

Conclusion

The advent of GenAI in education is a double-edged sword, presenting both unprecedented opportunities and formidable challenges. Its potential to revolutionize learning through personalized systems, intelligent analytics, and conversational agents is undeniable. These innovations promise to reshape the educational landscape, offering adaptive learning paths and freeing educators from mundane tasks to focus on higher-order thinking. Yet, this technological leap also casts a shadow of risks—from eroding the role of educators to introducing biases and widening inequality gaps. The moral quandaries of fairness, accountability, and data privacy loom large, urging us to tread cautiously in this new era.

As GenAI rapidly evolves, its impact will go beyond schools and classrooms, influencing societal norms and youth development. This calls for a reexamination of traditional educational frameworks recognizing that AI not just as a tool but as a social entity that shapes relationships and perceptions. Navigating this complex terrain requires a future-oriented vision. We must anticipate and address issues like polarization, epistemic trust erosion, and identity confusion. A critical vision and perspective is essential to responsibly integrate GenAI into education. It is not just about adapting to the immediate changes in classrooms; it is about steering the broader societal transformations AI will inevitably bring.

In sum, GenAI in education is a catalyst for change – one that demands a delicate balance between embracing innovation and safeguarding ethical principles. As educators and researchers, our role is pivotal in shaping a future where technology enhances human potential without compromising our core values. A critical and future-oriented perspective is key to ensuring responsible integration and guiding research in this area, even as we navigate the challenges of the here-now.

Declarations

Competing Interests There are no competing interests.

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