Teaching With, About, and Through Technology: Visions for the Future of Teacher Education in 2025

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The shift to emergency remote teaching in the face of the COVID-19 pandemic suggests that we need new pre-service interventions in supporting teachers’ dynamic and flexible uses and knowledge of technology. In this paper, we argue for the need to do this in teacher preparation programs and the importance of developing pre-service teachers’ knowledge of educating children with, about, and through technology. We set a vision for teacher education programs that prepares pre-service teachers to use technology to support teaching and learning in their classrooms (with), identify how technologies lead to productivity and harm (about), and strategize how technologies can support creativity and personal expression (through).

INTRODUCTION

The shift to emergency remote teaching in the face of the COVID-19 pandemic suggests that we need new pre-service interventions to support teachers’ dynamic and flexible uses and knowledge of technology. The sudden shift to remote learning required teachers to learn and use educational
technologies as a way to deliver content to their students. This involves not only using technology to support teaching and learning, but also educating teachers about how technologies “engage in data practices that put children’s rights at risk, contributed to undermining them, or actively infringed on these rights” (Human Rights Watch, 2022, para. 9). It is not unreasonable to assume that this needs to be done as early as their pre-service education. In this paper, we discuss the importance of teaching pre-service teachers with, about, and through technology. We set a vision for teacher education programs that prepares pre-service teachers to use technology to support teaching and learning in their classrooms (with), identify how technologies lead to productivity and harm (about), and strategize how technologies can support creativity and personal expression (through).

VISIONS

Teaching with Technology

Teaching with technology has been the primary focus of preparing educators to use devices and systems to support learning in the classroom. Several frameworks, including Technological Pedagogical Content Knowledge (TPaCK) and the Substitution Augmentation Modification Redefinition (SAMR) model have been developed to think about how technology should be integrated into teaching and learning. Mishra and Koehler (2006) explain how TPaCK is a theoretical framework that, among other things, forms the “basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content” (p. 1029). From a TPaCK perspective, when teachers use technologies, such as NetLogo simulation software for students to explore complex phenomena and representations, they provide students with opportunities to engage with the content that would not be possible without the technology; hence, teachers are teaching with technology. Similarly, Puentedura’s (2006) SAMR model proposes a hierarchical trajectory for integrating technology into PK-12 classrooms, with teachers moving from one level to the next. At the lowest level technology acts as a direct tool substitute with no functional change (Substitution). The next level is Augmentation, where technology acts as a direct replacement with functional improvement. The next two levels are Modification that involves technology being used for significant task redesign and Redefinition where technology allows for the creation of new tasks, previously inconceivable.
Many teacher education programs require pre-service teachers to take an “Introduction to Educational Technology” course to learn how to use those technologies to support pedagogy and content (Mouza et al., 2014). A recent meta-analysis found that educational technology courses have a largely positive impact on pre-service teachers’ knowledge (e.g., TPaCK) to teach with technology (Wilson et al., 2020). However, research has also suggested that pre-service teachers’ knowledge about technology in education does not easily transfer into the classroom since they often do not get opportunities to continue their professional development with technologies and iteratively practice with them (Wilfried et al., 2017). Wilfried and colleagues (2017) have argued that learning to teach with technology allows pre-service teachers to put it into instruction and serves as an opportunity for them to get feedback from students in the class. Another factor that influences future teachers’ use of technology is how teacher educators themselves model use of technology in their own courses (Brush et al., 2003).

As part of teaching with technology, pre-service teachers need to also be reflective about how their own assumptions and identities will shape their classroom. There is emerging evidence that suggests that pre-service teachers’ use of technology for instruction is often grounded in performative whiteness and they fail to acknowledge the race of their students in making pedagogical and technological choices (Heath & Segal, 2021). Heath and Segal (2021) found that pre-service teachers’ ideas about technology integration lacked conceptions of race or used a color-adverse approach that prioritized white social and cultural capital. Given the interrelated inequities in digital skills and competencies for the use of technology (van Deursen & van Dijk, 2019) and that the level of digital skills is positively associated with motivation to pursue STEM for K-12 students (Hampton et al., 2020), the future of teacher education needs to develop pre-service teachers’ expertise in recognizing and acknowledging minoritized students’ lived experiences when designing technology learning environments.

Teaching about Technology

While teaching with technology is the primary focus within teacher education, there needs to be a shift to also include teaching about technology. Uses of technologies in education have always been driven by educational technology companies since the 1920s when typewriters were sold as a technology that could enhance mastery of school subjects and improve student attitudes towards schoolwork (Waters, 2021). Educational technol-
ogy companies have a long tradition of offering products that promise to improve student outcomes, even as those technologies are “oversold and underused” (Cuban, 2002), without any empirical evidence to support their claims (Nobel, 2001; Selwyn, 2012). In addition, privacy issues are raised when technology companies harvest behavioral data that are aggregated and sold to third parties for micro-targeted advertising (Zuboff, 2019). A recent report by Human Rights Watch (2022) found that 164 educational technology products endorsed by 49 governments for children’s education during the pandemic tracked children’s activities outside of virtual classrooms and across the internet. In addition, the number of data breaches within commercial and private sectors raise additional concerns about who can get access to students’ data and its long-term impact. Existing laws to protect student privacy, such as FERPA, have not kept up with the changing nature and scale of student data. Further, companies are often opposed to any new regulation in the name of stifling innovation and limiting the educational benefits of technology (Peterson, 2016).

Given this landscape, we need to better prepare pre-service teachers to think critically about technologies and their implications for student privacy. Prior work has found that while pre-service teachers believe it is important to teach students about data privacy issues, the majority of them are not familiar with data privacy policies (Marín, et al., 2021). Marín and colleagues (2021) also found that few pre-service teachers are comfortable with their students’ data being used by private sector actors or trust the government to regulate companies’ use of data. Despite calls for teacher education programs to embed privacy issues into the curricula since the 1990s (e.g., Oravec, 1999), there is little evidence that we are preparing future educators to think about them.

The recent calls and push for increasing the role of artificial intelligence (AI) to support teaching and learning also makes it important to prepare teachers to understand how AI works (transparency) and how it uses existing data to make decisions (explainability). We need to educate pre-service teachers to go beyond seeing AI as a black box and understand how data and models are used by AI that could have potential biases and do not capture the complexities of students’ lives. Educating teachers about AI learning systems is important so they see students as full humans that are more than what AI models might suggest. Thus, the importance of transparency and explainability is not just about how AI makes decisions, it is also about teachers’ ability to explain their decisions to students, parents, and administrators.

Teaching about technology should also include critical perspectives
about the multi-directional shapings of technology and society, as well as the diverse roles that computational literacies can play in engaging with socio-technical devices and systems (Kafai & Proctor, 2021; Yadav & Heath, 2022). We need to prepare pre-service teachers to think critically about how technologies reproduce structural inequities that disproportionately harm low-income and racially marginalized communities (Yadav & Heath, 2021). Additionally, pre-service teachers should start to develop a pluralistic conception of computational literacies—without falling into relativist notions of “anything goes”—to critically engage with technological problem-solving and communication at multiple scales and with a diversity of media (Kafai & Proctor, 2021). This requires teacher education programs to help their students understand the diverse relationships between technical and social worlds as politically dynamic by acknowledging that “neither technologies nor societies are neutral” in their co-constitution of each other (Yadav et al., 2022, p. 42). The result should not be disengagement with technology—though that should always be an option and in many cases might be morally warranted—but ongoing negotiations with devices and systems for supporting children’s wellbeing and trying to make the world a better place. Thus, we turn to our next vision: teaching through technology.

Teaching through Technology

We need to educate pre-service teachers to go beyond only using technologies for delivering and consuming information. We must also find ways for critique and moral considerations to not limit our material engagement with technology but creatively inform techno-pedagogical practices. We think this can be done by teaching through technology: using technology in the classroom to support students’ personalized and creative expressions. This has been foundational for much of the “construction genre” of learning technologies (Ito, 2009); from Papert’s (1980) early LOGO programming environment to MIT’s visual programming environment Scratch (Resnick, 2017). Much of this work is focused on the agentic affordances and limitations of technology that children use while creating, designing, and tinkering.

Pre-service teachers can teach through technology by creating computational artifacts for their future students to tinker with, as well as thinking about how students might be given opportunities to create their own digital artifacts (Kafai & Burke, 2014). Today’s computational tools (Scratch or modeling tools like SageModeler) can support teachers to engage their
students in disciplinary ideas while students use technology for creativity and the pursuit of their own personal interests. While these tools are readily accessible and have a wide user-base, many forms of personalization remain at a surface level (e.g., simply coding slideshows) and the reproduction of commercial and corporate content as personalization is all too common (Lachney et al., 2016). In order for learning through technology to happen in more critical and transformative ways that go beyond merely reproducing commercial content, technology education can connect with family, community, and/or heritage cultures (Eglash et al. 2013; Moreno Sandoval 2019), as well as political issues and social movements (Lachney, 2017; Scott et al., 2015). This often means creating material and epistemic “trading zones” between professional or educational computing cultures, local community contexts, and Indigenous knowledge systems or vernacular cultural practices (Eglash et al., 2021).

In the context of Indigenous knowledge, practices, and designs, Eglash et al. (2020) report on a collaboration between the Culturally Situated Design Tool research and development team and Northern Michigan University’s Center for Native American Studies to design a culturally responsive computing program for a summer camp. The collaboration created space for children to study about the uses of arcs in Anishinaabeg architecture and design through creating arc structures of their own in a 3D visual programming environment (Eglash et al., 2020). Or consider how in the context of research on language and power in computing education, Vogel’s (2021) work on critical translingual computing education helps to reveal how computational learning environments can support multilingual students’ sense of agency in ways that are personalized but also ways that problematize hegemonic language ideologies. In another case, Lachney and Yadav (2020) showcase how a white middle school technology teacher collaborated with a local African American braider to help students learn block-based programming through computational explorations of the dynamic geometries of cornrow braiding. Lachney (2017) hypothesizes that these types of relationships might not only support in-class learning and teaching but may be advantageous for helping teachers find support when organizing for more school resources and better working conditions. All these cases link personalization and creative expression up with larger contexts, so that children and adults can learn about them in experiential and active ways through computing.
IMPLEMENTATION

We cannot expect pre-service teachers to carry out these visions if faculty in colleges of education who teach educational technology courses are not willing to also engage in their constructions. This may require some reflexivity on the part of pre-service teacher faculty; e.g., turning the TPaCK framework back onto the teaching of TPaCK itself, analyzing the politics of the technologies we use in our classrooms, and/or providing opportunities for culturally situated and popular expertise to shape creativity and personalization in assignments. In addition, this will require universities to invest in faculties’ own technology literacies and competencies in ways that go beyond simple box checking to critical exploration and creative expression. As faculty become more familiar in teaching with, about, and through technology they will be able to blend these technology-human relationships into their syllabi and courses. We outline actionable steps below that faculty can begin to take within their courses.

Teaching with Technology

We recommend two strategies for faculty to support pre-service teachers in teaching with technology: 1) being transparent about their own successes and failures in transferring technology into university classrooms; 2) creating assignments where pre-service teachers explore socio-technical infrastructures in their own lives and the lives of people who live in different geographical locations. The former is meant to model behavior that prepares pre-service teachers to confront the inevitable gaps between what designers of technologies intend and what will actually happen in the local context of their future classrooms. This means acknowledging that teachers have expertise that is grounded in both pedagogy and localized experiences, that differs from the expertise of technologists. This brings us to the latter suggestion. To better understand local contexts and how uneven infrastructure between contexts shapes uses and experiences (e.g., Howe et al., 2016), faculty should create assignments where students both identify what the local infrastructures are in their own lives and then experiment with various technologies across contexts that are familiar and unfamiliar (e.g., internet in a suburban school versus a rural school) to see how use varies.
Teaching about Technology

For faculty to prepare pre-service teachers to teach about technology requires expanding the disciplinary scope of the educational technology classrooms in colleges of education to include research in fields that range from computer science and sociology to history and philosophy and beyond. Including these fields in course syllabi will help students ask cultural, social, and political questions about educational technology alongside more traditional questions about use and implementation. In addition, these fields will help pre-service teachers contextualize educational technology within the larger socio-technical landscape that they are situated in beyond the school walls. One interdisciplinary field that will be particularly helpful is science and technology studies (STS) since it brings together science, technology, engineering, and mathematics with the social sciences and humanities (Felt et al., 2017). Indeed, to push the field in more critical directions some educational technology scholars already draw on STS in their own research (Lachney et al., 2018; Selwyn, 2014; Turkle & Papert, 1991; Williamson, 2017). One of the institutional benefits of expanding the disciplinary scope of educational technology classroom is that doing so provides opportunities for colleges of education to network with other faculty in other colleges across campuses.

Teaching through Technology

To integrate teaching through technology into pre-service teacher education, faculty should engage with and learn from how PK-12 educators are already integrating research and practice from the maker movement into their schools and classrooms (Lee 2015). Indeed, this seems to be where Papert’s constructionism is being advanced today in and out of traditional primary and secondary educational settings (e.g., Martinez & Stager 2013). In many places the groundwork for bringing making into educational technology classrooms is already laid since an increasing number of universities and colleges are designing and implementing their own makerspaces. At Michigan State University, for example, we have collaborated with the campus makerspace to integrate coding and engineering skills for media and technology personalization into class participation and assignments during our “Teaching and Learning with Technology” course. If there is not a makerspace on campus, then this becomes an excellent opportunity for building university-community partnerships. But faculty should also be aware of the limitations of the maker movement, especially around issues of class, race,
gender, and dis/ability. Indeed, the maker movement tends to be rather white and male (Eckhardt et al., 2021; Lachney & Foster, 2020). Therefore, faculty should look beyond traditional demarcations of the maker movement to what Afro-futurist artist and education scholar Gaskins (2021) calls instances of “techno-vernacular creativity”: a concept that points to inventions and innovations from racially and ethnically marginalized communities that often go overlooked in mainstream technology research and development (e.g., Eglash et al., 2006; Fouché, 2006). Highlighting techno-vernacular creativity can help resist reproducing some of the more problematic aspects of the maker movement when bringing it into colleges of education.

CONCLUSION

The COVID-19 pandemic revealed that teachers must have flexibility in their technology literacies and competencies. We have suggested three visions for how these can be developed at the pre-service stage. Of course, we do not mean to suggest that these different visions should be thought of as separate or discrete domains. The separation is merely analytic; in practice they overlap and co-constitute each other. In order to achieve these co-constituting visions, teacher education programs need to rethink their own relationships to technological knowledge, systems, and devices.

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