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Editorial: Design Pillars for Technology-Infused Teacher Preparation Programs

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This introductory editorial is a brief explanation of the history that led to the special issue of *Contemporary Issues in Technology and Teacher Education* – General Section. It discusses the difference between technology infusion and technology integration. It then expands on Foulger's (2000) four pillars to a technology-infused teacher preparation program, and the special issue includes four articles that individually examine each pillar. These pillars include the following: (a) technology integrated curriculum, (b) modeled experiences, (c) practice with reflection, and (d) technology self-efficacy. Written by 19 authors who are considered experts in the field of educational technology, this special issue offers practical guidance and recommendations to assist teacher educators with program development that supports technology infusion and prepares preservice teachers and in-service teachers to use technology effectively.

In 2016, the U.S. Department of Education's (DoE) Office of Educational Technology (OET) published a policy brief, *Advancing Educational Technology in Teacher Preparation*, that called upon leaders of teacher preparation programs to engage in concerted programmatic shifts in their preparation of teachers and use of educational technology. The policy brief offered four guiding principles for the use of technology in teacher preparation programs. Two of the four guiding principles (Principle 2 and Principle 3) recommended that higher education faculty members and preservice teachers experience technology at program-deep and program-wide levels.

The guiding principles recommended that higher education faculty, including teacher educators, build and engage in sustainable, program-wide systems of professional learning to strengthen and continually refresh their capacity to use technological tools that enable them to transform learning and teaching (Principle 2). Preparation programs that intend to bridge the gap between what teachers need to know about technology and what they are learning in their coursework must have a process for supporting teacher educators' professional development with technology and pedagogy (U.S. DoE, OET, 2016).

The OET also recommended that preservice teachers' experiences with educational technology be program deep and program wide, rather than one-off courses separate from their methods courses (Principle 3). To better prepare preservice teachers to use technology effectively so they can support PK-12 student learning, teacher educators need to embed educational technology throughout preparation programs.

The remaining principles offered by the OET (U.S. DoE, OET, 2016) discussed the importance of technology creation, production, and problem-solving (Principle 1) and technology standards, frameworks, and credentials (Principle 4). All four principles can be viewed in the policy brief.

To build on the recommendations offered by the OET in its 2016 policy brief, we gathered 20 education experts and practitioners in the field of educational technology to write a book for stakeholders responsible for technology infusion in teacher preparation (Borthwick et al., 2020a). In the book, *Championing Technology Infusion in Teacher Preparation: A Framework for Supporting Future Educators*, we referred to program-deep and program-wide efforts to address technology in teacher preparation programs as an "infused" technology approach.

Technology infusion involves supporting preservice teachers throughout all aspects of their preparation and assuring that they are proficient in teaching with technology by the time they become in-service teachers. The infusion of technology into courses offers frequent opportunities for modeling and the application of technology aligned with content that meets multiple learning objectives and not simply adds courses on top of courses in degree requirements (Miller et al., 2000).

Technology infusion involves "all the systems and personnel surrounding teaching and learning in preparation programs including teacher educators, administrators, professional developers, instructional designers, field supervisors, district and school administrators, mentors, etc." (Borthwick et al. 2020a, p. xxvi). In this approach, one or two technology instructors are not responsible for the bulk of the technology instruction for preservice teachers, but rather, the responsibility is shared among all teacher educators (Borthwick et al., 2020b; Egeland, 2009; Graziano et al., 2020). Research on technology infusion in teacher preparation has been shown to be effective in fostering development of technology, pedagogy, and content knowledge (TPACK) and technology integration skills among preservice teachers (Buss et al., 2018). Importantly, Egeland argued that when technology is integrated across the curriculum and infused in a preparation program, its success is dependent on the actual implementation by the entire faculty.

Others have discussed technology infusion in higher education and the changes needed for infusion to be successful. Miller et al. (2000) wrote, "Although administrators and faculty boast technological infusion is contributing to instructional effectiveness and transforming learning, in reality, the surface is still being scratched" (p. 9). They elaborated further, noting,

> In order to infuse technology, faculty have to re-examine the curriculum in terms of what they teach and how they teach it. Faculty understand curricular re-examination leads to labor-intensive change. Some faculty are opposed to such change. They have argued that technological infusion is not necessary or even beneficial. Other opponents have insisted that curricular revision in the name of technological infusion may well be counter-productive. Faculty proponents of technology infusion note the real problem is faculty are generally not prepared to accept the challenges forced upon them by technology. (p. 228)

In the end, change requires visionary leadership and real partnerships between administrators and faculty.

In contrast to technology infusion is technology integration. Technology integration or technology immersion (Egeland, 2009) is defined as "any learning experience where technology is seamlessly used by educators (PK–20) and/or learners within the context of a learning process and in a manner that enhances the experience and/or outcome in some way(s)" (Foulger, 2000, p. 6). The integration of technology occurs during a discrete point in time, where technology is used to enhance learning but may not be extended or continued beyond that point in time. For example, teacher candidates may use probes during their science methods class to import data to a spreadsheet. Students then analyze the data and generate a bar graph to report their findings but may not use spreadsheets in other content methods courses (Borthwick et al., 2020b; Foulger, 2020).

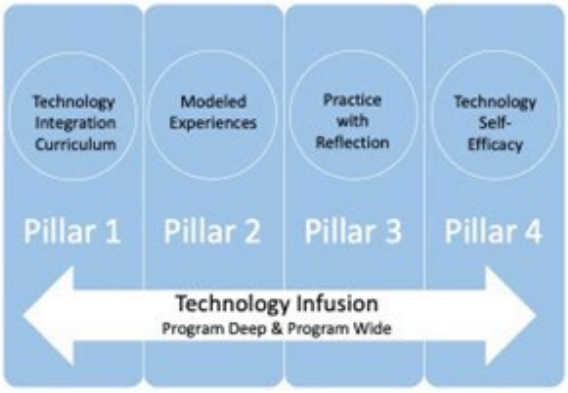
We still have a way to go to help colleges and schools of education, across the United States and internationally, to be more effective in their efforts to prepare teacher candidates to teach with technology. Miller et al. (2000) reminded us of organizational barriers and individual resistance to

technology infusion that may interfere with our work. Organizational barriers include a lack of leadership, lack of funding and resources, an intractable institutional culture that impedes infusion at the institutional level, and a lack of adequate incentive for change. Individual resistance involves faculty fear of change and inertia and faculty complacency, which may impact their technological literacy and competency. These barriers have been discussed by other researchers as challenges to technology infusion in preparation programs (see Buss et al., 2018; Ross, 2020).

In a post-COVID pandemic era with technology integration on the rise, there is no better time for educational leaders to combat the aforementioned barriers and become champions for technology infusion. At the time of writing this editorial, the OET has partnered with a consortium of professional organizations to update its 2017 *National Education Technology Plan* (NETP), the flagship educational technology policy document in the United States (U.S. DoE, OET, 2017).

In addition to the NETP, leaders from colleges and schools of education interested in getting started with technology infusion should consider four pillars to a technology-infused teacher preparation program (see Figure 1). These pillars include the following: (a) technology integrated curriculum, (b) modeled experiences, (c) practice with reflection, and (d) technology self-efficacy (Foulger, 2020). To assist in our efforts to enlist more champions to inform policy and program design criteria on technology infusion, we decided to expand on our work in the book and publish four articles in this invited special issue. Each article critically discusses one of the four pillars supporting program-deep and program-wide technology infusion in teacher preparation programs.

Figure 1
Four Pillars to a Technology-Infused Teacher Preparation Program



This invited special issue was written by 19 educational technology researchers and practitioners from across the United States. In the first article, "Curriculum Design for Technology Infusion Requires a Continuous Collaborative Process," Warr et al. (2023) discuss Pillar 1. The authors remind us of the essential elements and underlying foundations

of curriculum development: the competencies to be developed, content (both technology and discipline-related), and the evaluation of outcomes, along with attention to core values and context. As they discuss implementation and sequencing, they introduce the term "touch-points" and examine the value of a standalone technology course as part of a program-deep and program-wide approach.

The authors note that essential to the development of a cohesive curriculum that is adaptive to emerging technologies is a continuous, collaborative process for monitoring the need to update and revise the curriculum. Intended or not, the alliteration in this article helps the reader summarize key points: core values, context, competencies, content, continuous collaboration, and most importantly, coherence.

In the second article, "Modeling Technology Use for Teacher Candidates: Design Principles for Learning Experiences in Technology-Infused Preparation Programs," Jin et al. (2023) describe an investigation of how teacher educators model technology use in various contexts (Pillar 2). Through their integrative review of literature between 2012 and 2022, the authors identify 25 types of learning experiences for modeling technology integration but conclude that "modeling alone is insufficient." Thus, in addition to providing a comprehensive list of modeling strategies, the authors describe examples of instructional designs for modeling found in the literature. Following a summary of four types of modeling design that illustrate a progression of more pedagogically complex components, the authors envision a fifth type encompassing elements from the other types, adding candidate hands-on experiences to cement their learning. The authors also provide tables and an appendix to document the literature related to each implementation strategy. The article ends with recommendations for future research to enhance the effective use of modeling practices.

Sprague et al. (2023) draw from sociocultural theories of learning and change in their paper, "Technology Infusion and the Development of Practice: The Quest to Create Digitally-able Teachers." The article broadens the concept and understanding of "practice" as the authors describe instructional strategies to enhance candidate growth from novice to veteran practitioner. Clinical practice, including opportunities to teach with technology in PK-12 schools, remains the most complex experience for both candidates and for teacher preparation programs. The authors provide nine program design recommendations, emphasizing the importance of building partnerships with PK-12 leaders and strengthening PK-12 teacher mentorship and induction programs. The article begins with an introduction to several theoretical bases for practice-based technology preparation and concludes with a reference to theory-to practice connections via well-structured school-university partnerships. An appendix provides program design resources with URLs for easy access.

The final article in this special issue, "Teacher Self-Efficacy in Technology Integration as a Critical Component in Designing Technology-Infused Teacher Preparation Programs,"addresses Pillar 4. Williams et al. (2023) coin a new acronym, TSEinTI – for Teacher Self-Efficacy in Technology Integration – as they trace the roots of TSEinTI back to the theoretical

foundations of self-efficacy and teacher self-efficacy (TSE). The authors synthesize the literature around technology self-efficacy and then, more specifically, the development of teacher self-efficacy through building competence and confidence in integrating technology into teaching and learning (TSEinTI).

Eight design implications for teacher preparation programs are provided, falling into two categories: program design components to develop teacher candidates' TSEinTI and recommendations for growing a program culture that values TSEinTI. Not surprisingly, several of the examples for design implementation echo elements identified as essential elements in Pillars 1, 2, and 3, reinforcing the authors' positioning of TSEinTI as a "critical component" of teacher preparation.

In the concluding editorial, we summarize design considerations, as presented by the coauthors of the articles in this special issue, for the four pillars of a technology-infused teacher preparation program. We then offer additional, practical suggestions for initiating technology infusion in preparation programs and briefly discuss an adoption process to influence change toward an infused-technology approach.

Whether considering one or more of the four pillars to improve or build a teacher preparation program, teacher educators and administrators should continuously be reminded that technology cannot be viewed as an add-on to the curriculum; rather, technology must be viewed as a *necessity* across the curriculum. Developing a rich technology-infused program and preparing preservice teachers to become self-efficacious practitioners with technology are not easy tasks. The four pillars for program-deep and program-wide technology infusion in teacher preparation programs have been expanded on in this special issue by invited authors, as a starting point to guide program development and to provide a research-based foundation for updating state and national recommendations, guidelines, and policies.

After reading this special issue, we hope that you walk away encouraged and motivated with a clear sense of how to get started with technology infusion, and we invite you to become part of the research and leadership community that advocates and implements infusion.

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