In this post-pandemic era, a P-12 education system void of technology-able educators is unimaginable. With a heightened awareness of how technology is critical for contemporary teaching and learning, some colleges of education are exploring technology infusion, a program-wide and program-deep approach for strengthening teacher candidates’ self-efficacy with implementing technology in the classroom. In infusion models, technology-supported learning strategies are taught, modeled, and practiced throughout the entire preparation program, with all teacher education faculty and P-12 mentors assuming shared responsibility for supporting candidates’ growth in teaching with technology. While goals of technology infusion are laudable, achieving infusion is a complex system-wide change process. To address this challenge, this paper outlines seven action steps for transitioning to a more systemic approach to teacher technology preparation and suggests future research to support transformation.

*Keywords:* technology infusion, self-efficacy, teacher preparation
INTRODUCTION

COVID-19 changed how we lived, interacted with family and friends, and taught and learned. P-12 teachers were forced to move classes online with little to no professional development. A survey consisting of students (38,739), parents (32,486), and teachers (2,890) revealed the extreme challenges faced by students and teachers during remote learning (Elgart, 2021). According to Elgart (2021), students reported their workload increased while the level of academic rigor decreased. Students and teachers both reported that the work was often too easy, leading to concerns about mastery of grade-level content. Although some teachers managed to learn new pedagogy for teaching online, the majority of the teachers (70%) reported that preparing lessons for teaching online and supporting students left them little time for professional development (Elgart, 2021). Phillips (2021) revealed her sense of helplessness by openly sharing that she found herself giving students activities that they already knew and could complete independently while she struggled to learn Microsoft Teams.

Self-efficacy refers to a person’s perceived ability to organize and execute a course of action to achieve a goal (Bandura, 1977). In the context of teaching with technology, self-efficacy is teachers’ beliefs and self-confidence that they can teach with technology in a way that supports student learning. Webb et al. (2021) examined how teachers’ knowledge and skills of technology related to their self-efficacy of teaching K-12 students online. They found that only 24% of the teachers in their study had completed a college course designed for teaching online in K-12 classrooms prior to the outbreak of COVID-19. However, the teachers engaged in professional development opportunities and additional college courses during the pandemic. These resulted in a higher self-efficacy toward being able to teach online.

Since the pandemic, the need for preparation programs to graduate technology-proficient teachers has intensified. As P-12 schools struggled to implement high-quality, virtual learning during COVID-19, technology emerged as essential, not optional. Even with the return to face-to-face instruction, school districts are sustaining their investments in student devices and robust beyond-school access, moving even closer to 24/7, 1:1 learning. No doubt, the post-COVID era has ushered in new pedagogical approaches such as online and blended learning that will likely have a lasting impact on P-12 education (Ferdig et al., 2020; UNESCO, 2021). During this time of unknown future scenarios, teacher preparation programs should consider how to prepare incoming teachers with strong self-efficacy in technology, so they can embrace the yet-to-be-developed teaching contexts of the future –
contexts that will surely be enabled, at least in part, by better access to technology in classrooms and homes.

TECHNOLOGY INFUSION:
A NEW VISION FOR TEACHER TECHNOLOGY PREPARATION

In order to enable teachers to develop strong self-efficacy in technology, how we prepare teachers for teaching with technology must be re-examined. Technology infusion is a concept being explored by teacher educators as a way to better prepare teacher candidates for teaching with technology (Borthwick et al., 2020). Technology infusion is defined as a program-deep and program-wide design approach to addressing teacher candidates’ technology integration practice that supports them across all their coursework and field experiences. It is a fairly new concept and vision that expands pre-service teachers’ knowledge of technology and pedagogy beyond what is possible to learn in a stand-alone technology course. A technology infusion approach does not necessarily advocate for the elimination of the stand-alone technology course. Instead, infusion promotes an expansion of how technology is represented – that technology is taught, modeled, and practiced throughout the teacher education program. While some programs may retain a technology course and others eliminate it, all remain committed to infusing technology-related content throughout candidates’ coursework, including clinical experiences (Clausen, 2020). In such a vision, technology is not the sole responsibility of the technology faculty but is a shared responsibility across all teacher education faculty, including clinical faculty and mentor teachers in P-12 schools.

Technology infusion is an ideal. Some colleges have made significant strides to move in this direction, but we know of no program that offers candidates a coordinated, developmentally-appropriate, trajectory of technology practice opportunities throughout their entire preparation program. Yet, with thoughtful planning for this change, we believe significant progress toward infusion is both possible and necessary by the year 2025.

To support this transformation, this article presents seven action steps for the design and implementation of fully-infused programs. These action steps were culled from a review of published literature using the term “technology infusion” and related to the technology infusion movement launched by Foulger et al. (2012). Using this criterion, the authors identified eight published, peer review articles (Buss et al., 2015, 2017, 2018; Clausen et al., 2021; Foulger et al., 2012, 2015, 2019; Wetzel et al., 2014), and a foreword,
a preface, and eleven chapters in a co-edited book dedicated to technology infusion (Borthwick et al., 2020). In addition to these published works on infusion, the authors reviewed six policy documents relevant to preparing digital-age educators (Council for the Accreditation of Educator Preparation, 2022; Council of Chief State School Officers, 2022; International Society for Technology in Education, 2017, 2018; Office of Educational Technology, 2016, 2017). Pursuing technology infusion is a challenging, systemic change initiative that will require long-term commitment. Breaking down the current siloed approach to technology preparation will require buy-in from leadership, faculty, clinical supervisors, and P-12 partners. We hope the content synthesized from this review will provide a literature-based approach and practical wisdom for teacher educators striving to provide the types of extended, practice-based learning experiences candidates need to become digitally-capable, post-COVID teachers.

**STEPS TOWARD IMPLEMENTING TECHNOLOGY INFUSION**

Nurturing the transformation toward technology infusion is likely to span a significant amount of time and involve small, incremental changes. As preparation programs navigate this process, we offer the following seven action steps to consider:

**Create a Unified Vision**

Research indicates that candidates can be exposed to conflicting messages about the roles of technology in teaching and learning during their preparation program and as early-career teachers (Sprague et al., 2020; Williamson & Moore, 2020). The rift between higher education and P-12 partners on this matter are especially problematic. For example, researchers have described higher education efforts that emphasized constructivist uses of technology and P-12 schools with more traditional technology applications (Polly et al., 2020). Other sources have portrayed P-12 schools as more innovative, with higher education lagging in their ability to promote effective technology use (Office of Educational Technology, 2016, 2017; Nussbaum-Beach, 2020). In either case, the process of creating a unified vision will align university and P-12 perspectives and create mutual understanding among partners. Results from this collaboration will support a cohesive infusion effort and reduce angst for teacher candidates.
Garner Leadership Support for Systemic Change

Transitioning to a fully-infused program is complex and likely to challenge long-standing beliefs about technology integration practices and teacher preparation (Mishra & Warr, 2020). Because technology infusion is truly a systemic change initiative, the transformation will take time and resources (Mueller, 2020), yet leadership is often lacking (Clausen et al., 2021). Clausen (2020) warns that “…a technology infusion effort will require sustained support from leadership that creates instructional contexts that empower faculty to spearhead and actively participate in the change process” (p. 185). Without sustained support from program leaders, it is very likely that technology infusion efforts will fail or be underdeveloped.

Establish Specific Outcomes for Candidate Performance

A vision for technology use must be operationalized with clear descriptions of what candidates must know and be able to do by the time they graduate from the program. The Educator Standards published by the International Society for Technology in Education (ISTE-E, 2017) may provide a starting point, but teacher educators will need to develop a more specific, measurable set of outcomes to guide their efforts. Engaging both higher education and P-12 partners in collaboratively constructing this foundation provides another opportunity to build understanding among stakeholders and continuity across program components.

Construct a Curriculum and Assessment Plan

Technology infusion should not be viewed as wishful thinking or a voluntary activity. It is a coordinated, program-deep, program-wide initiative to help candidates become self-efficacious technology users by the time they graduate. Unfortunately, program wide planning for addressing technology is often absent or weak (Clausen et al., 2021). Therefore, program designers will need to formally assign specific technology-related outcomes to various courses and field experiences and create high-quality learning experiences to help candidates achieve those outcomes (Council for the Accreditation of Educator Preparation, 2022; Council of Chief State School Officers, 2022; International Society for Technology in Education, 2017). They will also need to design varied, multi-stage assessments to measure candidates’
progress and decide how to administer these assessments at strategic points in the program (Buss, 2020). While this level of curriculum and assessment planning is likely to be extremely time consuming, it ensures that all candidates will have access to the iterative, developmentally-appropriate, practice-based opportunities necessary to become digitally-capable teachers.

**Develop Technology Competent Teacher Educators and P-12 Mentors**

The *Teacher Educator Technology Competencies* (TETCs) provide a professional development framework for what faculty must know and be able to do to support candidates’ technology skills (Foulger et al., 2017). Clinical supervisors, and cooperating P-12 teachers will need professional development to address their technology-related responsibilities, too. For example, Clausen et al. (2021) reported teacher educators had “various levels of confidence in their ability to model technology use with candidates” and “to evaluate content specific technology to support student learning” (p. 23). To address this need for adequate support for teacher candidates, Slykhuis et al. (2020) recommend (1) assessing and increasing expertise, (2) providing resources for course development and 1:1 coaching support, and (3) establishing hiring and evaluation policies related to technology competencies. To ensure technology-rich clinical experiences, similar professional development and selection principles would apply for P-12 mentor teachers (Mueller, 2020).

**Provide Ubiquitous Access to Learning Technologies**

While infusion efforts extend far beyond the issue of availability of technologies, access remains an issue to consider (Nussbaum-Beach, 2020). To maximize infusion efforts, candidates need technology-rich environments in both their universities and P-12 schools. Candidates also need after-hours access so they can complete technology-related assignments and plan technology-supported instruction for their field experiences. To support online and blended learning, as well as face-to-face instruction, infusion efforts should include access to technologies applicable to all possible P-12 learning modalities (McVey, 2020). Optimally, there will be a strong alignment between the technologies available in the university and P-12 schools (Williamson & Moore, 2020).
Establish Structures for Informed Design and Continual Renewal

High-quality technology infusion programs will be aligned to theory, research, and policy related to technology, teaching, and learning (Council for the Accreditation of Educator Preparation, 2022; Council of Chief State School Officers, 2022; International Society for Technology in Education, 2017, 2018; Kolb, 2020; Nussbaum-Beach, 2020; Office of Educational Technology, 2016, 2017; South & Song, 2020). Expertise in teaching with technology, which is very dynamic and contextualized, must inform the design and constant renewal of infusion programs. While all stakeholders involved in infusion programs will contribute to this goal, the expertise of instructional technology faculty may position them as central to the effort. They hold advanced knowledge and experience with instructional technology and keep pace with rapid advancements in the field in ways that non-instructional technology faculty and P-12 mentor teachers cannot. Because of this expertise, they may need accommodations for their expanded roles.

SUMMARY AND RESEARCH NEEDS

Technology infusion has received a “yes” head nod from many teacher educators, simply because it makes sense that technology opportunities be addressed throughout a teacher candidate’s preparation experience. But, a recent national study by Clausen and colleagues (2021) of thirty-one non-technology education faculty from six teacher education programs described “little iterative practice for candidate technology use, poorly coordinated field experiences, and no systematic assessment of candidate outcomes” (p. 30). The disparity between the shared vision and the reality in preparation programs widens when considering articulating teacher candidates’ preparation experiences and accountability measures across the field experiences in P-12 and university coursework. Graduates of teacher education programs should be able to command high levels of performance in any teaching context, including complete changes in contexts like what happened at the onset of the pandemic. Because of the dynamic factors involved in leveraging technology in teaching and learning, the work of adopting technology infusion will never be complete.

Research is needed to support the field in the initial design of programs that address technology in a program-wide and program-deep fashion. As well, a continually growing and constant read on far and distant factors of context, and how these factors play out in how teacher candidates design
classrooms, plan for teaching with technology, and operationalize learning experiences for P-12 students will be necessary. Becoming technologically adept means teachers who are self-efficacious with technology can adjust to bigger contextual challenges, like the rapid move to online learning.

Research studies provide support for preparation programs to move forward with technology infusion efforts through in-roads that are ripe for their programs to make changes. But no program has addressed all systems involved and research is not available for a rapid change effort toward technology infusion. Additionally, we assume a variety of models for infusion will emerge. Since an infused program has not been developed to the point of full adoption, no research about the effectiveness of models for infusion exists for preparation programs to draw on or to glean best practices (Foulger et al., 2019) as they design their adoption models (Fullan, 2007). Certainly, a comparison of fully-infused programs will be helpful to the field. As a starting point, preparation programs that have established one or more small efforts toward a fully infused program (for example, the articles cited in the action steps) serve as proving grounds for researchers to document the affordances of infusion, how systems can be established and nurtured, and ways the P-12 and university organizations can articulate their individual work and combined efforts.

The field needs to work together. Program administrators, teacher education faculty, and P-12 mentor teachers need to establish their own approach to technology infusion and share their successes, challenges, and even setbacks with the field. Researchers should work toward establishing larger research agendas that cross institutional boundaries and move infusion from a vision to a reality. As local, innovative solutions emerge, researchers should broadly disseminate findings and implications for other preparation programs to consider. The result will be designs for technology infusion that are unique to the affordances and barriers of each preparation program.

References


