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Editorial: Design Implications for Technology-Infused Teacher Preparation Programs

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In this concluding editorial, the editors 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: (a) technology integration curriculum, (b) modeled experiences, (c) practice with reflection, and (d) technology self-efficacy. They then offer additional, practical suggestions on how to initiate technology infusion in preparation programs and briefly discuss an adoption process to influence change toward an infused-technology approach that involves higher education, PK-12, and other stakeholders.

Our introductory editorial to this special issue defined the concept of infusion as a programmatic effort to address technology in teacher preparation programs and included four pillars that support the actualization of technology infusion, including the following: (a) technology integration curriculum, (b) modeled experiences, (c) practice with reflection, and (d) technology self-efficacy (Foulger, 2020; Graziano et al., 2023). The development of a technology-infused approach involves all systems within a preparation program. This means all stakeholders, such as teacher educators, mentor teachers and cooperating teachers, field experience supervisors, program coordinators, teacher educators, and university and PK-12 administrators, should actively support the design and implementation of educational technology within a preparation program.

From a micro level, all teacher educators and mentor teachers who directly engage with teacher candidates should support teacher candidates' growth in using technology for teaching and learning (Foulger et al., 2020). From a macro level, university administrators and PK-12 administrators should be involved in the creation of a shared technology-infused vision, establish support for professional development, expedite modifications to the curriculum, as needed, and ensure a commitment to the long-term adoption and refinement of technology infusion in teacher preparation.

While an argument can be made that representing technology throughout a preparation program is a good idea, to date, research that supports technology infusion in colleges and schools of education is limited. Consequently, program designers should draw upon theory-based literature and findings from individual studies about learning to teach with technology to support design decisions. The four pillar articles in this special issue were published to meet this need. But there is a further consideration: Because the four pillars are interrelated and should be addressed simultaneously, program coordinators will need to be strategic when designing their unique technology-infusion approach and systematic in adopting their technology-infused program.

Systems Design

In an effort to offer a systems perspective (Rogers, 2003) to the design of a teacher preparation program that infuses technology, we extracted highlights from each of the four articles published in this special issue (see Figure 1). Teacher educators and other stakeholders are encouraged to use the design considerations in Figure 1 to ensure their technology-infused preparation program effectively addresses the four pillars.

In addition to the program design considerations in Figure 1, teacher preparation stakeholders may consider the following additional suggestions in their quest to champion technology infusion. These suggestions stem from the four articles on technology infusion published in this special issue.

Figure 1
Design Implications for a Technology-Infused Preparation Program

Design Implications for a Technology-Infused Preparation Program
Pillar 1: Technology Integration Curriculum ● "fluid curriculum that is responsive to change" ● "ongoing engagement in curricular revisions" ● "curriculum must be constantly evaluated" (Warr, et al., 2023)
Pillar 2: Modeled Experiences ● "an explicit and consistent modeling design across disciplines" ● "frequent and quality modeling from faculty and cooperating teachers" helps develop TK, TCK, TPK, TPACK ● due to "candidates' diverse learning needs and profiles … modeling alone is insufficient" ● "modeling … accompanied by other strategies … had a compound effect" (Jin et al., 2023)
Pillar 3: Practice with Reflection ● "current methods … well-aligned to socio-cultural tenants of learning such as LPP, COPs, and ZPD" & Grossman et al.'s (2009) framework for practice ● "microteaching, simulations, and virtual reality can be used to support practice" ● "practice opportunities that are articulated across coursework and field-based experiences" (Sprague et al., 2023)
Pillar 4: Technology Self-Efficacy ● TSEinTI is a specific form of self-efficacy which is especially important in a "shifting educational landscape" ● program components that develop teacher candidate TSEinTI include elements identified as essential in Pillar 1, Pillar 2, and/or Pillar 3 ● "Grow a program culture that values TSEinTI" ● TSEinTI "is a predictor of actual technology integration" (Williams et al., 2023)

Pillar 1: Technology Integration Curriculum

As program designers plan their approach to technology infusion, they should incorporate an assessment plan to evaluate the curriculum continuously for its impact on teacher candidates' technology self-efficacy. The learning experiences that target the technology curriculum must be strategically situated as touchpoints (Warr et al., 2023). Where appropriate, touchpoints must align with core course content and field experiences. Technology in teaching should be scaffolded by teacher educators so teacher candidates' technology practice is developmental and continually progressing. As with any well-designed curriculum, the program design should include data collection and data analysis to help program coordinators and teacher educators support continual improvement. These measures should be tied to content knowledge, elevate instruction, and assist in establishing teacher candidates' professional responsibility and collaboration regarding technology. See Warr et al. (2023), specifically Figure 1, for an overview of key design elements.

Pillar 2: Modeled Experiences

Program designers should consider faculty use of technology in their teaching as a technology infusion design feature that will support teacher candidates learning to teach with technology (Jin et al., 2023). This means that *all* teacher educators must integrate technology in their teaching, be proficient with course-specific technology, and recognize they are role models for efficient and effective use of technology in their content area (see Teacher Educator Technology Competencies; Foulger et al., 2017).

Preparation experiences should identify and showcase various PK-12 models of teaching with technology. Modeled learning experiences are complex, and technology is continually advancing. Program designers and teacher educators should critically review teaching models, update them, and ensure they effectively represent various facets of effective teaching. See Jin et al. (this issue), specifically Appendix D, for guiding questions to inform program design.

Pillar 3: Practice with Reflection

An infused technology approach should encompass practice and reflection in numerous settings, and teacher candidates' practice experiences should be iterative to support growth in all aspects of teaching. This includes practice opportunities that involve candidates teaching in PK-12 classrooms with the technology that is available in their classroom, the use of accessibility features, and teaching online. Practice experiences should also support candidates' professional development such as their participation in professional learning networks and their use of technology to measure the effectiveness of their teaching practice (i.e., learning by PK-12 students).

Preparation programs should consider how to strengthen mentorship and field experiences, induction programs, and university-PK12 partnerships to support this pillar. Further, teacher educators should align their technology-infused preparation program to national technology competencies and standards. Programs should be supported by foundational technology integration models and frameworks, research and guidelines for online instruction, strong university-PK12 partnerships, and ongoing professional development of teacher educators. See Sprague et al. (2023), specifically Appendix A, for links to selected resources.

Pillar 4: Technology Self-Efficacy

Those who support the design of technology-infusion preparation programs should prioritize the goal of candidates graduating with teacher self-efficacy in technology integration (TSEinTI), a belief in their abilities to meet the everyday challenges associated with teaching with technology. TSEinTI is highly relatable to the other pillars and, thus, is a good predictor of a candidate's future use of technology (Foulger et al., 2021).

Teacher educators should be involved in designing technology components of coursework *so that they* positively influence growth in

teacher candidates' TSEinTI. Program coordinators need to establish an organizational culture that prioritizes expectations for teacher educator technology competencies and provides infrastructure for equitable access to technology tools that enhance a candidate's learning experiences and core beliefs about the value of technology for teaching and learning. Further, programs should consider adopting a standard practice of measuring changes in teacher candidates' technology self-efficacy and TSEinTI at specific milestones and use this data to adjust program design and delivery. See Williams et al. (2023), specifically the appendix, for more detailed design implications.

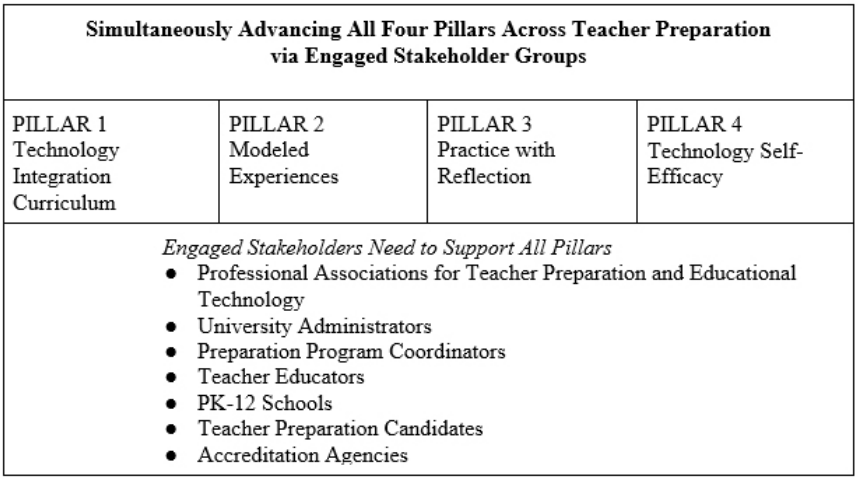
Incremental Change

As with any large-scale change effort, taking the time to plan for implementation will be paramount to the change process. In their adoption efforts, program leaders should consider how the following principles might support their adoption efforts: (a) honor current technology-related experiences and involve current champions, (b) apply an incremental change orientation to adopting an infused technology approach, (c) maximize the reciprocal influence of each of the four Pillars to technology infusion, and (d) align with the *National Educational Technology Plan* (U.S. Department of Education Office of Educational Technology, 2017).

Those who champion technology infusion must have a commitment to change and a strategic plan with deliverable action steps. They should understand that a large-scale, systems change operation like adopting the four, interrelated pillars of technology infusion all at once will involve nearly all units surrounding teacher preparation. A successful adoption can only be accomplished through genuine involvement and collaboration across stakeholder groups (see Figure 2). Champions of technology infusion should also operate from an *incremental change* perspective where stakeholders in PK-12 schools and universities work together to address appropriate, next-step changes at a pace that establishes and maintains commitment from all stakeholder groups to a shared vision (Borthwick et al., 2020b). Incremental change, metaphorically speaking, is like navigating a giant ocean liner that is moving toward the vision with a constant and continual need to monitor and adjust all systems so that all passengers stay on board, enjoy the voyage and, hypothetically, arrive at full program infusion.

Enlisting champions, mavericks, and other change agents of technology infusion (Borthwick et al., 2020b; Clausen et al., 2022) can be supportive. Proponents of technology infusion must work together to keep the vision of the goal (the destination) alive: Given the availability (potential ubiquity) of technology, the teacher candidate creates new and innovative approaches to effectively integrating technology in targeted, value-added ways that are responsive to the context and culture (Foulger et al., 2020).

Figure 2
Simultaneously Advancing All Four Pillars Across Teacher Preparation via Engaged Stakeholder Groups



Conjoint Efforts

The detailed literature and rich information shared in this special issue hold merit in helping preparation programs meet the grand challenge of adopting an infused technology approach. Soon, the next *National Educational Technology Plan* (NETP) will be published by the U.S. Department of Education, Office of Educational Technology (see https://tech.ed.gov/netp/ for updates). The plan will be authored in partnership with a consortium of expert organizations, including the State Educational Technology Directors Association, InnovateEDU, Learning Forward, and Project Tomorrow.

In this post-COVID era, we anticipate the NETP will include new expectations for PK-12 educators with regard to technology usage and will highlight online learning. In addition, preparation programs should expect the next NETP to prompt teacher preparation programs to establish program-deep and program-wide models that thoroughly address teaching with technology, more equitably support graduates of preparation programs, and ensure graduates are self-efficacious in teaching with technology.

The four pillar articles in this special issue provide a knowledge base on which to build state policy expectations (licensure and certification) for teacher preparation curricula, including PK-12 field experiences. As South and Song (2020) have shared, the innovation and change surrounding adopting an infused approach will require research, support, and funding – needs that are best addressed by multiple stakeholders who work together. New national policy, funding opportunities, and more sophisticated PK-12 and university partnerships will be needed. Notably, collaborative engagement from organizations like the International Society for Technology in Education, the Society for Technology in Teacher Education, and the American Association for Colleges of Teacher

Education, along with the U.S. Department of Education/Office of Educational Technology, can help meet these needs.

In closing, all preparation program stakeholders need to commit to creating a coherent learning experience for teacher candidates regarding their use of technology in their future classrooms (Borthwick, 2020a). In the complex environment of teacher preparation, those involved in the design and adoption process need to be aware that multiple social, organizational, interpersonal, and structural constraints will make the work difficult (Mishra & Warr, 2020). However, having the expectation that long-term benefits can outweigh any setbacks will make a difference to the teacher candidates who enter the field as technology-savvy educators.

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