Title: The Practice Based Teacher Education Engagement Ladder: A Developmental Model of Adoption, Adaptation, and Redesign

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Submitted to: Journal of Teacher Education 11/2019 (awaiting review 4/2/20)

Abstract (150 words)

In a design-based implementation study, we supported 11 teacher educators from diverse institutions across the country in implementing new approaches to practice-based teacher education. We observed that teacher educators proceeded through a developmental process in implementing new approaches, and we propose the Practice Based Teacher Education (PBTE) Engagement Ladder as a model of this process. Teacher educators proceed through stages of Adoption, Adaptation, and Redesign, as they shift from “off-the-shelf” implementations of PBTE approaches in individual lessons and units, towards more ambitious modifications of courses and eventually, program and curricula. This developmental process of teacher educator learning and change builds on prior research about teacher adoption of technology-enhanced pedagogies. We illustrate this developmental process through a series of case studies, and we conclude with a set of design hypotheses for promoting the adoption of PBTE approaches across the diverse landscape of teacher education.

Keywords

Teacher preparation, practice-based teacher education, preservice teachers,
collaborative research

Introduction

Practice-based teacher education (PBTE) research has focused largely on three kinds of questions: *what should teachers practice?* (e.g. TeachingWorks, 2019, Core Practice Consortium, 2019), *how should teachers practice?* (Grossman, Compton, Igra, Ronfeldt, Shahan, & Williamson, 2009; Grossman, Hammerness, & McDonald, 2009), and *does practice-based teacher education work—does it lead to meaningful changes in classroom teaching?* (Boyd, Grossman, Lankford, Loeb & Wyckoff, 2009; Brouwer, & Korthagen, 2005; Darling-Hammond, Chung, & Frelow, 2002). In this research, we pose a fourth question, *how could practice-based approaches spread across the field of teacher education?* The responsibility for teacher preparation and professional learning in the United States is spread across more than 1,200 colleges of education, 13,000-school districts, and 130,000 schools. For practice-based approaches to teacher education to have a meaningful impact, they need to be widely adopted by diverse teacher education professionals and adapted to diverse local contexts. As evidence grows that practice-based teacher education is a promising approach to improving teacher education, questions of dissemination of practice-based teacher education will become increasingly salient.

We address the dissemination of practice-based teacher education through a program of design-based implementation research with two key components: “practice spaces” and a fellowship program. First, we developed a set of learning activities and platforms,

“practice spaces,” that embody a particular approach to practice-based teacher education. Practice spaces are learning environments, [Program name]d by games and simulations, that let teachers rehearse for and reflect upon important decisions in teaching. They range from card games about school design, to mobile apps that facilitate digital clinical simulations, to design activities about performance assessment. They provide opportunities for approximation of discrete elements of teaching, like looking at student work or eliciting learner knowledge. If most approaches to PBTE such as rehearsals and digital simulations attempt to replicate the full complexity of teaching, practice spaces complement these approaches by supporting targeted practice of discrete skills. Our practice spaces are freely-available and open-licensed, so they can be easily used “as-is” or “off-the-shelf” by teacher educators, and they can also be modified and adapted to better fit into local programs and curricula.

Second, we experimented with disseminating these practice spaces through a fellowship program called [PROGRAM NAME]—[Full program name]. We recruited 11 fellows from different higher education contexts across the country; our fellows worked in “Research 1” (R1) and teaching focused programs, in private and public schools, in rural and urban contexts, and they included assistant professors to deans and department heads. Fellows were provided a \$2,000 stipend for a six month fellowship that included attending a two-day summer workshop about practice spaces, implementing practice spaces in their teacher education courses, participating in interviews and discussions, and communicating their experiences. The expectations for fellows were deliberately open-ended—they could use any one of several practice

spaces or all of them, once per semester or multiple times, with minimal guidance or extensive support, and then write about their experience as part of a program of publishable research or a blog post. The goal of the program was to naturalistically observe how a subset of early adopters took up a new approach to PBTE, and to understand 1) how PBTE resources and activities can be designed to facilitate adoption and adaptation and 2) what supports teacher educators need to adopt new practice-based approaches.

To preview our findings: there is a long history of research that takes a developmental perspective on teachers' adoption of new practices. For instance, in the 1990s, during the Apple Classrooms of Tomorrow project, Dwyer, Ringstaff, and Sandholtz, (1991) observed that teachers proceeded through a series of phases—Entry, Adoption, Adaptation, Appropriation, Invention—in introducing new technologies into their classroom routines. Most teachers need to experiment with modest, standardized implementations of technology before developing the comfort, fluency, and motivation to experiment with more substantial, customized changes. Over the course of the fellowship, we found these developmental perspectives illuminating in making sense of the experiences of our fellowship partners. Maximizing adoption and integration of our practice spaces required supporting teacher educators in small-scale experiments as a bridge to more ambitious implementations.

Background and Context

Developmental Perspectives on Teacher Adoption of New Technology and Practice

Researchers, reformers, and innovators are always trying to encourage teachers to adopt new practices (e.g. Ball & Forzani, 2009; Lampert & Ball, 1999), and adoption is often uneven (Cohen & Mehta, 2017; Cuban, 1998): new practices stagnate in some places, plod ahead in others, and occasionally take-off. Teacher characteristics are often used to explain this variation (Clotfelter, Ladd, & Vigdor, 2007; Nye, Konstantopoulos, & Hedges, 2004; Rockoff, 2004), although context, community, student, and other factors are no doubt implicated as well (Ni, 2009; Somekh, 2008; Van Driel, Beijaard, & Verloop 2001).

Two common perspectives on teacher approaches to innovation are *essentialist* models and *developmental* models. Essentialist models posit that teachers have innate, invariant stances towards new technology and practice. The Rogers Adoption Curve or diffusion of innovation model (Rogers, 1962; 2003), developed to explain agricultural technology adoption, is sometimes used to explain teacher innovation. In this Rogers model, people can be classified as innovators, early adopters, early majority, late majority, and laggards. A folk adaptation of this model for education technology is the “pencil metaphor” with “leaders” and “sharp” ones who adopt new technologies early, the “wood” who would implement a new approach with some help, “ferrules” who hang on to the past, and “erasers” who try to undo progress (McKeown, n.d.). In these models, innovation proceeds from more innovative people through to less innovative

people, while trying to constrain the influence of luddites. In some respects, [PROGRAM NAME] fellows can be fairly considered “early adopters” of practice spaces, and as we later describe, other innovative approaches to practice-based teacher education.

The alternative to this essentialist perspective are developmental perspectives on the adoption of new practices. In developmental models, teachers are positioned as learners who proceed through a series of stages when encountering new technologies. New versions of these schemes are published every few years; Dwyer, Ringstaff, and Sandholtz, (1991) framework from the Apple Classrooms of Tomorrowwork, Levels of Technology Implementation (LoTi; Moersch,1995), the SAMR model (Puentedura, 2012), among others.

New variants are mostly derivative of Dwyer and colleagues (1991) work: in the early stages of Entry and Adoption, teachers take new technologies and use them to extend existing practices. Over time, as teachers become more proficient with new technologies, practices, and approaches, they proceed through phases like Adaptation, Appropriation, and Innovation, where teachers develop more comfort modifying technologies and classroom patterns and practices to create new kinds of learning experiences for students. In these models, advanced practice is characterized by extensive customization of technology, classroom routine, curriculum, and practice to support novel approaches to teaching and learning. Dwyer and colleagues’ (1991) model has five phases, the Levels of Technology Implementation (LoTi; Moersch,1995) has seven, SAMR (Puentedura, 2012) has four, but they all emphasize a progression. Several important features of these development trajectories are that teachers can start

at different places, they can proceed at different rates, and these slopes and intercepts can vary across technologies and practices.

In higher education, Wild (2013) created a similar model for adoption of Open Education Resources (OER): textbooks and learning materials that are openly licensed and can be freely adopted and remixed by educators, programs, or entire institutions. Like advocates of PBTE, advocates of OER have a new approach to teaching and learning in higher education with several simultaneous lines of research: how best to design OER, how to evaluate how well OER works, and how to spread adoption. Wild's framework parsimoniously includes just three stages, Piecemeal Adoption, Strategic Adoption, and Embedded Adoption, sometimes described as low, medium, and high. In Table 1, we provide a visual that summarizes these various frameworks.

<Insert Table 1>

During the course of the fellowship program, we began revisiting our practice spaces and the [PROGRAM NAME] program through the lens of Wild's developmental framework. As we detail in our findings below, we observed teachers and institutions evolving over the course of the fellowship, and these developmental models help explain this evolution. We chose this framework—instead of the other similar teacher innovation development frameworks--both for its simplicity, and for the several parallels between OER and PBTE: the symmetry in higher education context, the attention to both individual and institutional adoption, and, as we discuss below, the recognition that open licensing can play a key role in creating adaptable resources. This developmental

framework illuminates how we supported fellows in adopting our approach to practice-based teacher education.

Practice Spaces and Practice-Based Teacher Education

To best prepare the next generation of teachers, teacher education researchers argue we must address “an imbalance of theory and practice” (e.g. Levine, 2010, p.39) in teacher preparation programs. A lack of meaningful opportunities to practice is a “problem of enactment” (Kennedy, 1999), or “a gap between what novices can consider and what they are able to do” (McDonald et al., 2013, p. 379). The movement for PBTE seeks to provide meaningful opportunities for novice teachers to practice core skills, competencies, and professional judgment.

Practice-based teacher advocates in the last decade have made substantial progress on questions of *what teachers should practice* and *how teachers should practice*. Research programs like high-leverage teaching practices (TeachingWorks, 2018) and core practices (Core Practice Consortium, 2019) provide sets of answers to the “what” question—sets of instructional moves of various grain sizes that have an empirical track record of efficacy. For example, Teaching Works has codified a set of “high leverage teaching practices” (HLTPs)-- basic and commonly used fundamentals of teaching that are critical to helping students learn content, central to students’ social and emotional development, and are used across grade levels and contexts. Some examples of

HLTPs include leading a group discussion, explaining and modeling content, and eliciting and interpreting student thinking (TeachingWorks, 2019).

Research on *how to practice* has flourished as well, with advances in rehearsals, digital simulations, mediated field experiences, instructional activities and other kinds of “pedagogies of approximation” (e.g. Dotger et al., 2010; Dottin, 2009; Kaufman & Ireland, 2016; Lehman & Richardson, 2017; Mursion, 2017). We observe that many of these approaches to approximation invite novices to practice the full complex assemblage of teaching. Rehearsals provide novice teachers the chance to practice teaching an instructional activity over 20-40 minutes, with peers playing the role of students, and teacher educators providing real time questions, suggestions, and feedback (Kazemi, Franke, & Lampert, 2009). Digital simulations, such as those using the Mursion platform typically ask novice teachers to teach a ten-minute mini-lesson to digital avatars (puppets) controlled by a remote actor. Mediated field experiences bring teams of education students into cooperating K-12 classrooms to practice team teaching mini-lessons to small groups. This kind of complete practice is an important part of teacher development, but we see room for more granular forms of practice. Drawing from these observations, we are developing and studying approaches to PBTE that emphasize the development of discrete practices that can be rehearsed, improved, and integrated back into the complex assemblage of teaching. We see an unexplored design space (illustrated in the third quadrant of Figure 1) at the intersection of digital approaches to PBTE and approaches that focus on more fine-grained approaches to practice.

<Insert Figure 1>

We develop practice spaces, learning environments [Program name]d by games and simulations that help teachers rehearse for and reflect upon important decisions in teaching. Some are digital, and some are analog, and all of them are designed to be incorporated in professional learning sequences that include briefing and orientation, gameplay or simulation, and then debrief and reflection. In Table 2, we summarize six practice spaces, and map their learning goals onto the TeachingWorks model of High Leverage Teaching Practices (HLTP). Several of our practice spaces are designed to be played in brief rounds, so they can be repeated multiple times. For instance, Eliciting Learner Knowledge, ELK, is a chat-based game about questioning strategies. The game is played in 7-minute rounds, so that instructional designs can incorporate short, repeated cycles of instruction, practice, reflection, and feedback. TeacherMoments is a platform for digital clinical simulations, where participants are immersed in vignettes of classroom life and then called to improvisationally respond to challenging scenarios through recorded audio. These practice spaces are integrated into cycles of prediction enactment, and reflection so that participants can practice targeted skills, judgments, and dispositions, and integrate new competencies back into more holistic forms of rehearsal or into authentic teaching practice. In Figure 2, we show the number of implementations that fellows completed for each practice space and the number of participants.

<Insert Table 2>

<Insert Figure 2>

Open Licensing and Practice Space Authoring

We make all of our practice spaces freely available under a Creative Commons license for analog components or an MIT license for software and code. These licenses allow and encourage others to reuse, and importantly, to remix our materials. As we shall see, this flexibility has important interactions with teacher educator development in terms of their fluency with practice-based approaches to teacher education. OER researcher David Wiley (2002) has observed what he called the “reusability paradox,” highly-effective learning resources are typically highly context-dependent, and pedagogical value and potential for reuse are inversely related. Well-designed learning resources are attuned to the needs of particular contexts, and highly flexible learning resources tend to have limited pedagogical utility. A Wikipedia article is potentially somewhat useful in lots of courses, a case study of a teaching in a local school district is very useful in nearby contexts, and rapidly less useful further afield. Wiley proposed that the open licensing of learning resources provides one potential route to untangle this paradox. If learning resources can be modified to suit local contexts, then they can be both widely re-used and highly useful. In Figure 3, we show a visual representation of the Reusability Paradox.

<Insert Figure 3>

Methods

Context and Participants

[PROGRAM NAME] fellows. Our context is a six-month fellowship program for teacher educators called Innovative New Spaces for Practice and Research in Education, or [PROGRAM NAME], that began in August of 2019. We distributed a call for participation widely among teacher educators through announcements at conferences, word of mouth, and our organization's website. We had 17 teacher educators apply, and we selected 11 fellows on the basis of interests and commitment to implementing new practice-based approaches. In fellow selection, we also aimed to create a cohort that included teacher educators from diverse institutions (R1 versus teaching; public versus private), geographic regions of the US, career position (assistant professor through deans and department chairs), and a range of specialities, including STEM, general education, special education, and inservice teacher preparation. Selected fellows worked with undergraduates, graduate students, and inservice teachers who were preparing to be teachers in elementary, middle, and high school. In Table 3, we include a summary of participant characteristics. In Table A1 in the appendix, we include a description of activities that were included in the [PROGRAM NAME] program.

<Insert Table 3>

Data collection. Our data sources included the participants' fellowship application, interviews of participants at the beginning and end of the project, a teacher educator survey that was completed after each implementation of a practice space, and review of documents and research plans completed by participants. We reviewed the workshop application and discussed participants' goals and past experiences during initial phone interviews in June of 2018. Themes that emerged during the applications and initial interview were tabulated on a spreadsheet to create holistic views of each individual within the program. During the workshop, each participant created a written research plan. Participants engaged in monthly conference calls and documented their progress through an online teacher educator survey. We conducted hour-long exit interviews in January of 2019 via phone or video conference. During these interviews we discussed their progress on implementation of the practice spaces during their course, any work around each iteration of participants' research plans, and interactions with other participants and program staff related to practice spaces. The exit interviews were recorded and transcribed.

Qualitative analysis. We used a thematic approach (Braun & Clarke, 2006) to data analysis through both inductive (data based) and deductive (theory based) cycles of theme development and review (Fereday & Muir-Cochrane, 2006). Our inductive process (*emic*) included continual review of data sources during the project. We created memos to establish possible codes and triangulated the codes across different data sources in order to ensure team consensus on the themes and to establish trustworthiness in the analysis (Nowell, Norris, White & Moules, 2017). Through this

process, we identified *teacher educator development* as an important lens for understanding participant experiences in the fellowship program. As part of our deductive process (*etic*), we adapted the theoretical framework developed by Wild (2012) to describe higher education faculty adoption of Open Education Resources. We modified the OER framework to describe teacher educators' adoption of practice spaces.

We focused on participant exit interviews to characterize teacher educator development during the fellowship, and the transcribed exit interviews were input into MaxQDA qualitative analysis software along with the established coding system. Two researchers coded a subset of the interviews, reviewed and discussed discrepancies, and updated the codebook. A third rater independently coded a new subset of data using the new code system as a check on the reliability of the coding (Miles & Huberman, 1994). One researcher completed the remainder of the coding, with periodic cross-checking from the second reviewer. In Table A2 in the Appendix, we include our codebook.

Case study development. We organize the findings by first presenting a case study of one participant, Jane, and her journey from more isolated and simple implementation of practice spaces to more ambitious implementations with more programmatic changes. After this extended view of one teacher educator's developmental trajectory with practice spaces (as one approach to practice-based teacher education), we then present a Practice-Based Teacher Education Engagement Ladder that offers a three-step developmental trajectory for teacher educators adopting PBTE approaches. We then illustrate these three steps with additional case studies of

participants at each of these three levels. We describe Samantha's integration of a practice space into her course (Adoption), Kamila and Thomas's respective assignments to preservice teachers to modify a practice space (Adaptation), and Danielle's restructuring of her course around practice spaces (Redesign). This allows us to explore the conditions and possible mechanisms of outcomes among participants (George & Bennett, 2005) in adoption of practice spaces.

Findings

Jane: One Teacher Educator's Development from "Off-the-Shelf" Implementation, to Curriculum Redesign and Programmatic Change

Jane had learned about Committee of N through a colleague, and she had implemented Committee of N in her own methods class the spring before the fellowship. We provided her with a link to purchase pre-printed card decks, and links to slideshows and handouts that faculty in another education program had used to pilot the game. Jane used the cards "as-is", making some modest changes to the slides to fit within her own class norms and schedule. The original slides were made available under a Creative Commons license, so Jane had no concerns with intellectual property issues in making her own adaptation. We encouraged her to apply for the fellowship, and Jane joined the program.

Jane's participation in the [PROGRAM NAME] fellowship coincided with a transition in her career, where she moved to a new university, a small, private university in the south, and inherited a course that she described as "mostly text and lecture

based”. Jane used her planning time during the [PROGRAM NAME] summer workshop to create a plan to center her entire class around practice-based teaching. She implemented five practice spaces in her course: Committee of N, Teacher Moments, Reality Check, ELK, and MetaRubric. Jane stressed that she is cognizant of “course flow”, and part of embedding practice spaces in her course was to match practice spaces to the topics already on her syllabus and integrate speakers, readings, and practice spaces around specific themes. For example, when her students did the Teacher Moments simulation about Darius, an African-American boy who thought his teacher was biased, she paired it with a class on unconscious bias. Jane noted the ability of the practice spaces she used to help address historical and contextual challenges that are salient in her rural, Southern university.

I really think there is there is a lot of value to teacher education programs to have opportunities for students to investigate important issues, issues of our time, such as racism and and how teachers in practice should respond or could respond to potentially painful and definitely powerful conflicts in the classroom.

In addition to using practice spaces in her own classes, Jane also began to share these ideas with her colleagues. She helped two of her colleagues at her institution incorporate the ELK game into their courses by facilitating the game during their classes.

[My colleagues] see a lot of need for infusing different kinds of experiences, different learning experiences, [into the classroom] to get our students to understand that there are different ways of approaching content. So they played

right along with me, and, after experiencing the course this semester, the way I had set it up, they've expressed to me that they're extremely excited about continuing to build on what we've started.

Sharing these activities sparked conversations between Jane and her peers about their approach to teaching, and, more broadly, about how practice spaces could help preservice teachers re-envision their own teaching.

We haven't looked back from them [practice spaces], because these two colleagues...are now fully convinced that you're doing these critical changes, transformative changes, where we're really having students in the teacher education program participate in games and simulations [in a way that makes them] want to experience a practice of teaching differently.

Jane believed that these games and simulations would also have an impact on teacher candidates' ideas of how they might run their future classrooms. Her experience with the practice spaces has [Program name]d her to plan to share these ideas with an audience even beyond her institution.

I'd surely like to be a part of working with a broader base of teacher educators...[I'm] really trying to get the word out, for lack of a better phrase, about the things that are that are being developed and the things that are

possible inside of those practice spaces because I really do think that many of them are really ready to be tried [at a] large scale.

Through an essentialist perspective, Jane might be fairly considered an “early adopter”-- ready and willing to try ambitious changes in her teaching approach and to experiment with early prototypes of new tools. However, a developmental perspective reveals how even as an early adopter, Jane’s journey started with simple implementations. First, she implemented one practice space in one lesson of one course, as is. Next, she sought to make more substantial changes to her entire course in order to accommodate a sequence of practice-based approaches. Then, she expanded her change work beyond her own course and towards engagement with colleagues in her department and beyond, becoming an evangelist for practice-based approaches to teacher education.

Practice-Based Teacher Education Engagement Ladder

Jane’s developmental journey as a teacher parallels the teacher development found in prior research on technology integration, OER integration, and other complex teaching practices, routines, and approaches. We generalized from Jane’s experience and the experiences of her [PROGRAM NAME] fellow colleagues to create a three-step developmental trajectory for educators adopting practice based approaches to teacher education. In Table 4, we summarize this framework, with a summary heading for each of the three levels, examples of activity types within each level from teacher educators integrating practice spaces, and then codes used in data analysis to identify indicators

of activity at each level. We illustrate each level with examples from our efforts to support integration of practice spaces, and we propose that this developmental trajectory can be generalized to PBTE approaches in general. We include the codes and themes that we used in our analysis of data from the [PROGRAM NAME] fellowship to classify our participants at each of the three levels at particular time points in their development. Below, we summarize each of the three levels, and then we illustrate each level and progression between levels with individual case studies.

<Insert Table 4>

Adoption. At the low-integration level of *Adoption*, teacher educators take existing practice spaces and integrate them into existing lessons or units of their curricula. When teacher educators review practice spaces for adoption, they are particularly interested in modularity and relevance. Modularity here refers to the potential for a practice space (and associated teaching materials for briefing, debriefing, reflection, and feedback) to be seamlessly integrated into an existing course. Teacher educators at the Adoption level are looking for low-risk, low-time-cost ways to test new ideas within PBTE, so they are attracted to resources that can be implemented with minimal changes. Relevance is another key criteria for teacher educators at the Adoption level: teacher educators are interested in identifying matches between existing practice spaces and existing themes and goals in their curricula and courses.

Adaptation. The medium-integration level of *Adaptation* describes teacher educators' who begin modifying practice spaces, courses, or both simultaneously to

support more extensive, sophisticated integration of practice spaces. These adaptation processes typically occur in tandem with reflection about the goals and needs of novice teachers, and how revised, practice-based learning experiences can help meet those goals. Teacher educators at this stage begin engaging colleagues in discussion about PBTE approaches, sharing their new efforts and adaptations and encouraging close colleagues to collaborate.

Redesign In the high-integration level of *Redesign*, teacher educators are making substantial changes to entire courses, curricula, sequences of courses, or other program elements to make practice-based approaches to teacher education central to the program. Teacher educators may be making substantial modifications to practice spaces and related activities, or may be developing new practice spaces. Teacher educators begin advocating for practice spaces and practice-based approaches with colleagues around their institution and in their fields (including both subfields like special education and the field of teacher education more broadly). Since these more substantial changes require the collaboration of multiple stakeholders--other instructors, department heads, deans, clinical staff and coordinators--engagement with these diverse actors to lead substantial change is a key part of the process.

In the case studies that follow, we describe [PROGRAM NAME] fellows who integrated practice spaces into their programs at each of the three levels, and how some of them traversed between levels.

Samantha: Adoption- Simple Integration of Practice Spaces

Samantha chose to integrate the practice space Teacher Moments, a mobile web app for digital clinical simulations, into her course. Samantha is the director of the clinical teaching program at a medium-sized, urban public school in the northeast. She had previous experience with practice-based teacher education in creating and using full-length case studies for her class. She and her colleagues obtained a grant to develop case studies for their classes. These multidimensional in-depth case studies included video of parents, documents, and readings, as well as the recruiting of volunteers to do in-person role plays for scenarios such as Individualized Education Plan (IEP) meetings. The concept of practice-based teaching already aligned with Samantha's personal objectives and fit well with the objectives of her colleagues in the school of education.

Samantha described how she saw Teacher Moments as an opportunity to "expand and update my case study for classes and improve the technology to enhance simulation delivery and participation." Samantha implemented two Teacher Moments scenarios in her special education one credit seminar course in the Fall of 2018. The seminar was focused on practical discussion about professional interactions and planning. A key factor in her choice of those two scenarios was their relevance to existing course work; the concept of working with families was already a theme in the course. She noted that the Teacher Moment simulations were easily accessible to newcomers, "something [a teacher educator] can learn in 15 minutes."

Initially, Samantha had her students try the Teacher Moments simulation for homework, however, many of her students had difficulty accessing the platform.

The first time around, I had them do it on their own and it didn't go very well. A lot of them experienced technical difficulty and sort of gave up and emailed me. I couldn't help them really over email.

In her second implementation, she paired students with each other so they could do the simulations together during class time. Having a partner allowed the students to discuss ideas about their interactions in the simulation with each other and made the experience more enjoyable. She explained, "All of them completed [the simulation], they had fun with it, they were laughing. I think when they came back, because they had a partner, they didn't think of it as too stressful."

One of Samantha's original goals for using Teacher Moments was to "enhance simulation delivery and participation." In her exit interview, she noted that the technology-based simulation was advantageous to an in-person simulation (e.g. role play) because it formalized the interaction, making the conversation "more formal and real feeling than just talking to a person they already know." Additionally, she felt that prompting students to speak their responses made the simulation realistic:

I think the tool of having them actually speak and record their voices was powerful for my students. They wanted to know where that voice recording was going, and what is happening to it, and who was listening to it. If I just had them jot down their ideas, or think about it, it takes the stakes down a little bit to another rehearsal activity.

After the experience of coordinating in-person simulations, Samantha found the low cost and availability of the application-based simulations appealing.

Some of my colleagues are doing simulations where they're like, hiring actors and getting a lab, and doing videoing, and it's going to be very powerful, but the amount of work and expense that is going into it, eventually, the cost-benefit is problematic. So I think the fact that you've made these things free and accessible is really appealing.

Samantha integrated the practice space in her course “off the shelf” with minimal changes. The Teacher Moments scenarios were relevant to her courses, making it easy to integrate the practice space into her existing syllabus. Samantha was able to incorporate the simulations even within the time limitations of a weekly seminar that had previously been primarily discussion and readings. In her own personal trajectory of using practice-based pedagogy, practice spaces allowed her to extend her existing work on case studies using focused simulations with minimal modification into a weekly seminar with limited time. Samantha continues to incorporate Teacher Moments scenarios into her courses, and is partnering with the practice space designers to use natural language processing techniques to investigate how students’ respond to Teacher Moments scenarios.

Kamila: Adaptation - Modifying Practice Spaces for a Specific Course

Kamila is a professor at a large public, suburban university adjacent to a gateway city with a large immigrant population. In her initial interview, she described a goal of having her teacher candidates to be ready to respond to the needs of culturally and linguistically diverse students and their families. Before [PROGRAM NAME], she had teacher candidates create and enact drama and role play to explore challenging

situations they may face as novice teachers. She was interested in [PROGRAM NAME] because the practice space concept fit her existing aims for infusing practice based education into her courses. Her goals in participating in the workshop were to build on her existing use of role play, learn new practice spaces, and integrate more practice-based teaching into her courses.

One of the practice spaces Kamila used during her course was Committee of N. She incorporated the game in a class on sociolinguistics that already included a number of high-level theoretical concepts. Engaging in this design-based activity started a discussion about different and sometimes conflicting ideas about education such as learning theories (constructivism, behaviorism) and purpose of schooling (college preparation, developing individual knowledge). As her students started playing the game, she noticed how their interpretations of terms such as “whole child education” were represented very differently in their school designs.

It was interesting to observe for everyone how some of the design perspectives based on “whole child education” approach, in practice, would reflect a behaviorist approach to teaching and learning, while others would reflect rote-learning or direct instruction.

She noted that playing the Committee of N game gave students a concrete example that enabled them to unpack the different possible interpretations of “whole child education” and come to a shared understanding of those ideas.

Kamila initially used Committee of N with the given “rules.” As a follow-up assignment, she had her preservice teachers create their own games similar to Committee of N using abstract concepts in sociolinguistics. Her preservice teachers

found the open-ended nature of the assignment very challenging, especially because they often wanted clearly defined answers and were wary of the “chaos” that could result from inquiry-based approaches. Part of the goal Kamila had in presenting the game was modeling the type of teaching she hoped her preservice teachers would use in their classrooms. She explained,

Their teaching doesn't have to be traditional, because that's something that we constantly try to teach and change in their practice as well. So allowing them to adapt the games to the context of the education courses also helped them to see how games can be adapted in their own classroom context with their own students. It allows teachers and teacher candidates ownership over these tools.

Kamila also incorporated the lesson planning game, Reality Check, into her course. After playing the game, she had her preservice teachers take the same mechanic and create a new version of the game with content they had learned in class. By sharing the inner workings of the practice space, she was not only helping her students learn the skills of lesson planning, but also showing her preservice teachers how to teach with games. Learning new practice spaces in her course gave Kamila new ideas of how to incorporate practice based teacher education into her courses.

Thomas: Adaptation- Preservice Teachers Write Scenarios to Elicit Learner Knowledge

Thomas is a professor at a medium, public, suburban university, located in the midwest. Thomas entered the workshop with significant experience with PBTE. He had recently redesigned his entire local secondary teacher education program around High

Leverage Teaching Practices (HLTP), and he was part of the Michigan Program Network, a network of teacher educators who had an ongoing partnership with TeachingWorks. At Thomas's institution, the faculty decided to target five HLTP: (1) explaining and modeling content, practices, and strategies (2) Appraising, choosing, and modifying tasks and texts for a specific learning goal, (3) Selecting and using particular methods to check understanding and monitor student learning (4) Eliciting and interpreting individual students' thinking and (5) Leading a group discussion. Each HLTP "unit" takes two weeks, and then the preservice teachers have to "enact the HLTP in their classroom, collect evidence about their enactment, and then make evidence-based arguments about their proficiency with the practice and their areas for growth". These enactments includes videorecording of their enactment during their K12 classroom visit, bringing videos to class for review and discussion, and creating mini lessons for students to enact in the classroom and receive peer feedback.

During the final interview, Thomas described how the relevance of practice spaces to the focus on HLTP in his current work was important; he saw clear connections in the practice spaces and the teaching practices that were already incorporated into his program.

We've got these streams going on with these five different high leverage [teaching] practices [and] the things you're working on are actually pieces of what we're already doing. They snapped right into what we're already doing in really meaningful ways.

In particular, the practice space Eliciting Learner Knowledge or ELK enriched Thomas's unit on Eliciting and Interpreting Learner Knowledge.

ELK offered that piece that I was missing...it was a perfect addition to what we needed as a program and what I needed personally in my class.

ELK is a game where two players, one role playing a "teacher" and one role playing a "student" engage in a 7 minute conversation about a specific topic. Each role has a pre-written profile sheet: the teacher has a set of learning objectives around a topic and the student has a student profile with what the student knows about that topic.

Although ELK was well suited to Thomas' needs, the initial game included only science and math student profiles and teacher learning objectives, and Thomas's area of interest is social studies. Thomas decided he wanted to have his students create student profiles and teacher learning objectives. In the past, Thomas had his students design a set of interview questions, interview a student about the topic while recording themselves, and then review the video. Thomas replaced that assignment with having students select a topic in history, imagine a teacher learning objective around that topic, and create a student profile in ELK. To introduce the assignment, Thomas created an example teacher learning objective and student profile. Then students brought their profiles to class and they played ELK in groups of 3 - a "student", and "teacher", and an "observer", who was the author of the learning objective/ profile that was being played. In thinking back to the implementation in his class, Thomas noted that the practice space met his learning goals for eliciting learner thinking in such a way that it did not feel like a traditional assignment.

I think one of the one of the biggest problems that teacher ed has had and we have had [at my institution] is that no matter how much we have changed, and tweaked and improved, things still feel like assignments that they do with the university. And then they get into real teaching. And we have not made much progress in that I'm telling you, it's a nut we have been working to crack for five years, and we're still not there. But the practice spaces, I think, are a way to get out of the feel of the assignment type feeling. And my big question is going to be now is if we can move them out of the assignment feel.

Thomas hypothesized that the playful nature of the practice space would help his preservice teachers appreciate the importance of eliciting and interpreting student thinking.

I think if they can engage in the practice in this playful way to see why that practice is so critically important, then when we really dig in on the practice itself, they're going to be more engaged, because they'll understand the practice better and understand the value of the practice better. So that's what I'm wondering if ELK is gonna do.

Through his modification of the ELK scenarios, Thomas demonstrates a medium level of practice space integration or *Adaptation*. He helped envision and develop a new aspect of ELK in having students write and review student and teacher profiles. He also began to reflect about what it would look like to integrate more practice spaces into his course and his institution, with a nod towards the *Redesign* phase of practice space integration and practice-based approaches.

Danielle: Redesign- Rewriting a Course with a Game-Based Approach

Danielle is a professor at a medium-sized, public school in the southern U.S. Danielle first encountered practice spaces at a workshop. She immediately had interest in and began to use Committee of N in her class. In her application, Danielle mentioned the challenges of providing her preservice teachers with opportunities to practice. Even though the preservice teachers analyzed video of their classroom teaching, did a 50 hour placement, and designed a lesson with support from an instructor, she noted that the preservice teachers continually asked for more field experiences. On her application, Danielle elaborated,

Unfortunately, we have reached saturation in our partner K-12 schools and are unable to provide preservice teachers with additional field experiences. I believe Teacher practice spaces will help bridge the gap between course concepts and student need for authentic opportunities to practice teaching.

Before joining the [PROGRAM NAME] workshop, Danielle had already incorporated two practices spaces into her class. She used Committee of N as a way to add a design and application angle to the unit on learning theories and structure of school. Danielle gave her students the cards for the game with brief descriptions of learning theories, the purpose of schooling, and instructional approaches, and theories of intelligence, and asked them to design a school. Danielle described her thoughts in crafting the classroom experience in a blog post.

I wondered how much knowledge of educational theories, history of American schooling and instructional approaches pre-service teachers needed prior to

playing the game. Should I assign readings or let them find answers to their questions on their own as they played the game? Essentially, should pre-service teachers learn these ideas *through* playing the game instead of *for* the game...Despite my concerns, I decided to experiment with learning *through* the game.

Her students pushed back on the assignment, as they were not used to having to do the research to learn more about learning theories and school design - they were used to having the information given to them. In her application to [PROGRAM NAME], Danielle shared how she was thinking more deeply about not just which practice spaces she would implement, but how she would tailor them to the needs of the class.

I also plan to improve pre-service teachers' opportunities to practice teaching by improving my implementation Committee of N and MetaRubric. I was thrilled with the levels of student engagement I observed during class time and as preservice teachers engaged with these playful learning experiences. Although preservice teachers indicated they both enjoyed and learned from these experiences they provided feedback that indicated changes in my implantation of these games are needed to fully capitalize on their learning potential.

During the workshop, Danielle formed a group of teacher educators who were interested in using many different practice spaces in their courses. Danielle's goal was to completely redesign her class to embody a game-based approach. Danielle described her intentions in the written project plan.

In the fall I will organize my course to maximize students experiences with playful learning and the professional practices of teachers. I am developing my own wraparound curriculum to ensure the practice spaces are embedded meaningfully into my course. I will implement Committee of N, Reality Check, MetaRubric and ELK, as a way to introduce preservice teachers to professional practices of teachers.

In the fall of 2018, Danielle implemented five practice spaces: Committee of N, Teacher Moments (three scenarios), MetaRubric, Eliciting Learner Knowledge (ELK), and Reality Check. During the final interview, Danielle noted that each practice space was different, with some being introductory activities and other aligned more towards repeated practice.

[Practice space implementation] is also an experience, it was an experiential learning [activity], but it's more like this is the idea of practice of having opportunity to redo and do and do again, and, you know, improve upon how you are performing and thinking about particular skills related to teaching.

Discussion

Our model of PBTE engagement, illustrated through the preceding case studies, has four important features. First, we assume that adopting complex PBTE teacher education methods is a developmental process: teacher educators in our fellowship

program did not start with complex plans for redesigning their curriculum through PBTE approaches. If teacher educators got to those more ambitious efforts, it was after initial, more modest efforts at piecemeal implementation. Second, in the simplest levels of adoption, modularity and relevance were key drivers of teacher educator adoption decisions. [PROGRAM NAME] fellows chose approaches that aligned with their existing curriculum and could be implemented with minimal changes. Third, when teacher educators advanced beyond changes to a single lesson or unit, they typically made substantial changes to a whole course before attempting wider changes to an entire program. Later stages in PBTE engagement are characterized by modifications to existing PBTE approaches, modifications to courses and programs to allow for more PBTE integration, recruitment of local colleagues into PBTE experiments, and then recruitment of departmental school leadership and wider networks of colleagues in PBTE-based reforms. Finally, we emphasize that even though our self-selected group of fellows could be considered “early adopters” in an essentialist view of technology/pedagogy adoption, our fellows still started at the lowest level of integration before proceeding to more ambitious reform efforts.

From these findings, we offer four design hypotheses for developers of PBTE approaches and advocates for PBTE-based reforms. First, PBTE advocates should develop multiple, low-effort points of entry. We found that resources that can be taken and used “off-the-shelf” encouraged teacher educators to get started right away in integrating the resources into their existing course structures, assuming the resource was relevant and aligned to the teacher educator’s existing content. We found that

teacher educators wanted to test existing, modular approaches before developing and adapting ideas to their specific local contexts.

Second, relevance was a crucial driver of teacher educators' early adoption. Fellows that were already using case studies gravitated towards Teacher Moments simulations (e.g. Samantha), while fellows that had been using games were interested in game-based practice spaces like Committee of N (e.g. Jane and Danielle). PBTE advocates should develop materials that are aligned to existing approaches and content areas in methods courses.

Third, because of the tremendous diversity in teacher education programs, curricula, and context, PBTE approaches should be adaptable. Open licensing and authoring tools can support this process by encouraging teacher educators to make changes to existing tools to fit their local context. Adaptability is the bridge between low-effort and likely low-impact initial implementations, and more substantive programmatic reforms. In our future research, we are interested in identifying what features of practice spaces teacher educators are most likely to change and adapt, and what features they are most likely to host constant across context, so we can give more targeted advice to teacher educators about the adaptation process. Other advocates for PBTE approaches might consider how elements of their tools and resources can be designed for adaptability.

Finally, we found that providing fellows a supportive community with a built in space to reflect on implementations, collaborate with peers, provide examples and feedback facilitated teacher educators' progression on their personal trajectory. Fellows met in-person for a two-day co-design workshop, and then met virtually once a month

for six months. During virtual meetings, fellows shared their successes and challenges around implementing practice-based approaches. Further investigations should identify the most important features of communities of practice that support advancement up the PBTE engagement ladder.

As PBTE approaches have been developed, the natural focus on research has been on the teacher as learner. As PBTE advocates work to spread and scale promising tools and strategies, the focus of research should expand to include the teacher educator as learner. The PBTE Engagement Ladder offers one framework for modeling the developmental process of teacher educators who adopted new PBTE tools and approaches.

Figures and Tables

Figure 1. Approaches to approximation of teacher practice.

Figure 2. Practice space implementations.

Figure 3. Reusability paradox.

Table 1. Models of Teacher Technology Integration

Model	Levels of technology integration	Sample on which model was developed
The Rogers Adoption Curve or Diffusions of Innovation Theory (Rogers, 1962; 2003)	Laggards Late majority Early majority Early adopters Innovators	Developed from a synthesis of studies across anthropology, early sociology, rural sociology, education, industrial sociology and medical sociology
The Pencil Metaphor	The hangers on	Educators

(McKeown, n.d.)	<p>The erasers</p> <p>The ferrules</p> <p>The wood ones</p> <p>The sharp ones</p> <p>The leaders</p>	
Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991).	<p>Entry</p> <p>Adoption</p> <p>Adaptation</p> <p>Appropriation</p> <p>Invention</p>	Apple Classroom of Tomorrow teachers in k-12 classrooms
Moersch, C. (1995). Levels of technology implementation (LoTi)	<p>Nonuse</p> <p>Awareness</p> <p>Exploration</p> <p>Infusion</p> <p>Integration</p> <p>Expansion</p> <p>Refinement</p>	K-12 school districts
SAMR (Puentedura, 2012)	<p>Substitution</p> <p>Augmentation</p> <p>Modification</p> <p>Redefinition</p>	K-20 educational institutions

Wild (2013)	Piecemeal adoption Strategic adoption Embedded adoption	Higher education institutions
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Table 2. Examples of Practice Spaces

Practice Space	Description	Related High leverage teaching practices (HTLPs)
Teacher Moments	A mobile web application for digital clinical simulations that immerses teachers in vignettes of classroom life, and then calls on participants to improvisationally respond to challenging moments through recorded audio.	HLTP 10: Building respectful relationships with students HLTP 11: Talking about a student with parents or other caregivers
Eliciting Learner Knowledge (ELK)	A chat-based simulation for developing effective questioning strategies for understanding student conceptions and misconceptions.	HLTP 3: Eliciting and interpreting student thinking

MetaRubric	A playful learning experience where teachers explore the challenges of complex performance assessment through creating rubrics, grading each other's creative work, and creating a rubric for rubrics.	<p>HLTP 16: Selecting and designing formal assessments of student learning</p> <p>HLTP 17: Interpreting the results of student work, including routine assignments, quizzes, tests, projects, and standardized assessments</p>
Reality Check	A lesson planning game designed by colleagues at the Woodrow Wilson Academy of Teaching and Learning about rapidly responding to unexpected events and circumstances that impede on school routines.	<p>HLTP 14: Designing lessons and sequences of lessons</p> <p>HLTP: Analysing instruction for the purpose of improving it</p>
Committee of N	A card game about school design where students learn about theories of learning, the purpose of schooling, and school structure through creating a school.	

Table 3. [PROGRAM NAME] Participant Characteristics

Pseudonym	Region	Public/ Private	Rural/Subu rban/Urban	Size	Practice Spaces used before [PROGRAM NAME]
Jane	Southern	Private	Rural	Small (<10k)	Games and simulations
Laura	Southern	Public	Rural	Small (<10k)	Games
Steve	Northeastern	Public	Rural	Medium (10-30k)	
Kamila	Northeastern	Public	Suburban	Small (<10k)	Theatre/ Role Play
Arthur	Northeastern	Public	Suburban	Small (<10k)	
Danielle	Southern	Public	Suburban	Medium (10-30k)	Games
Thomas	Midwestern	Public	Suburban	Medium (10-30k)	Focus on High Level Teaching Practices

Larissa	Northeastern	Public	Suburban	Medium (10-30k)	Simulations (Mursion)
Samantha	Northeastern	Public	Urban	Medium (10-30k)	Case studies
Patrick	Midwestern	Public	Urban	Large (>30k)	MetaRubric
Sandra	Southern	Public	Urban	Large (>30k)	Games

Table 4. Practice-Based Teacher Education Engagement Ladder

Practice-Based Teacher Education Engagement Ladder	Examples of Practice Space-Based Activities	Codes Used in Data Analysis
Low- <i>Adoption</i> of “as-is” PBTE approaches in lessons or units.	Teacher educators take existing practice spaces and integrate them into existing lessons or units. Integration is “isolated” rather than course or program-wide. Practice	<i>Modularity</i> -- TE’s identify PBTE approaches and resources that fit in their existing lessons, units, and programs <i>Relevance</i> -- TE’s selected PBTE on the basis of

	spaces and courses are minimally modified.	alignment with existing curricular themes; they choose PBTE that will work with their existing curriculum, rather than modifying the PBTE resource or the curriculum
Medium- <i>Adaptation of</i> PBTE approaches and courses	Teacher educators modify existing practice spaces--creating new scenarios or new briefing and reflection protocols--to integrate into existing lessons or units. Or, teacher educators begin more extensive revision of their courses to allow for greater integration of practice spaces. Teacher educators begin sharing their approaches with colleagues in their institutions and fields.	<i>Adaptation reflection-</i> Through experience with PBTE, teacher educators identify new goals and needs for their learners that can be met by changing courses <i>PBTE Resource adaptation--</i> taking existing PBTE resource and approaches and modifying them for a local context <i>Course Adaptation-</i> Changing courses--with new units, themes, topics,

		<p>or routines-to allow for greater integration of PBTE tools and resources</p> <p><i>Sharing PBTE-</i> introducing new colleagues to PBTE approaches, suggesting resources, soliciting feedback</p>
High- <i>Redesign</i> of curricula and programs to incorporate PBTE	<p>Teacher educators design new practice spaces to address curriculum needs. They engage colleagues in more systematic transformation to integrate practice spaces throughout curriculum (sequences of courses) and entire programs (other co-curricular learning experiences). Teacher educators work with colleagues within and</p>	<p><i>Redesign reflection:</i></p> <p>Through experience with PBTE, teacher educators identify goals and needs for learners than can be met through substantial programmatic change</p> <p><i>PBTE Design:</i> Teacher educators substantially modify or create new PBTE resources and approaches to address curricular and programmatic goals</p>

	beyond their institution to encourage more widespread adoption of practice spaces and related approaches.	<p><i>Curricular/Program Design:</i> Teacher educators modify whole courses, curricula and program elements to integrate new PBTE approaches.</p> <p><i>Spreading:</i> Teacher educators lead colleagues at their institution and in their fields in the adoption and adaptation of PBTE approaches</p>
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Appendix

Table A1. [PROGRAM NAME] Program Activities

Activity	Description
Application	Participants were selected from a pool of applicants based on their alignment with the program's goals.

Introductory interview and call	Accepted participants completed one-on-one introductory calls to discuss their research interests and expectations for the program. These calls informed the development of the [PROGRAM NAME] workshop.
Workshop	A two-day, in-person workshop, hosted at our institution, introduced participants to existing practice spaces through hands-on demos and provided planning time for multi-institutional research teams.
Research plans	During the workshop, teams of participants used a template to define research questions and create an implementation timeline.
Revised research plans	Revised research plans were submitted two months after the workshop to incorporate updates based on feedback from each participant's department and Internal Review Board.
Monthly calls	Monthly video calls gave participants the opportunity to share implementation and research updates.
Small group calls	Participants were supported by practice space staff through small group calls, by request.
Weekly emails	Participants received a weekly emails with updates and reminders.

Exit interview	All participants participated in an hour-long exit interview conducted by video conference or phone call.
Final report	After the program's conclusion, participants submitted written reports such as blog posts to document their experience and learning in the program.

Table A2: Attributes of Practice Space Use

Experimental	
Modularity	PS, as is, can be “dropped in” to a class; participant may have made small logistical and timing changes but didn’t adapt content of the PS; discussed in reference to the PS
Relevance	PS, as is, fits class needs/topics; discussed in reference to the practitioner’s course.
Strategic	
Strategic Reflection	Participant asks questions or identifies new needs related to implementation; typically observation-based
PS Adaptation	PS is adapted, including changing content, changing the topic/subject, changing context/setting, etc

Sharing	Practitioner shows PS to colleagues, sharing at faculty meetings, etc; tends to be more informal (more than just showing it to one person)
Embedded	
Spreading	Practitioner facilitates PS in other's classes, training others; more formal than "sharing," this also includes publications and conference presentations
Embedded Reflection	Practitioner asks questions or identifies needs related to overhauling course/department/system; may be more evidence-based
Designing	Participant expresses interest in or active creation of new PS; also use for design work by the students of practitioners
Course Adaptation	Course is adapted by experienced practitioner to fit the needs of PS they have used in the past <i>in her interview</i> .

References

Ball, D. L., & Forzani, F. (2009). The work of teaching and the challenge for teacher education. *Journal of Teacher Education*, 60(5), 497–511.

Boyd, D. J., Grossman, P. L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*, 31(4), 416-440.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.

Brouwer, N., & Korthagen, F. (2005). Can teacher education make a difference? *American Educational Research Journal*, 42(1), 153–224.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review*, 26(6), 673-682.

Cohen, D. K., & Mehta, J. D. (2017). Why reform sometimes succeeds: Understanding the conditions that produce reforms that last. *American Educational Research Journal*, 54(4), 644-690.

Core Practices Consortium (2019). Retrieved from <https://www.corepracticeconsortium.com/>

Cuban, L. (1998). How schools change reforms: Redefining reform success and failure. *Teachers college record*, 99(3), 453-477.

Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education*, 53(4), 286-302.

Dotger, B. H., Dotger, S. C., & Maher, M. J. (2010). From medicine to teaching: The evolution of the simulated interaction model. *Innovative Higher Education*, 35(3), 129–141. doi:10.1007/s10755-009-9128-x

Dottin, E. S. (2009). Professional judgment and dispositions in teacher education. *Teaching and Teacher Education*, 25(1), 83–88.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership*, 48(8), 45-52.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5(1), 80–92.

George, A. L., & Bennett, A. (2005). *Case Studies and Theory Development in the Social Sciences*. MIT Press.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, 111(9), 2055-2100.

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching: Theory and Practice*, 15(2), 273-289.

Kaufman, D., & Ireland, A. (2016). Enhancing teacher education with simulations. *TechTrends*, 60(3), 260–267.

Kazemi, E., Franke, M., & Lampert, M. (2009, July). Developing pedagogies in teacher education to support novice teachers' ability to enact ambitious instruction. In *Crossing divides: Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 1, pp. 12-30). Adelaide, SA: MERGA.

Kennedy, M. M. (1999). The role of preservice teacher education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 54–85). San Francisco, CA: Jossey Bass.

Lampert, M., & Ball, D. L. (1999). Aligning teacher education with contemporary K–12 reforms. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 33–53). San Francisco: Jossey-Bass.

Lehman, J. D., & Richardson, J. (2017). Virtual field experiences: Helping pre-service teachers learn about diverse classrooms through video conferencing connections ... Classrooms through Video Conferencing Connections with K-12 Classrooms. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, 1727–1728.

Levine, A. (2010). Teacher education must respond to changes in America. *Phi delta kappan*, 92(2), 19-24.

McDonald, M., Kazemi, E., & Kavanagh, S. (2013). Core practices and pedagogies of teacher education: A call for a common language and collective activity. *Journal of Teacher Education*, 64, 378–386.

McKeown (n.d). The pencil metaphor. Retrieved from <https://web.archive.org/web/20070128192012/http://www.teachers.ash.org.au/lindy/pencil/pencil.htm>

Miles, M. B., & Michael Huberman, A. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. SAGE.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology*, 23, 40-40.

Mursion (2017). (n.d.). Increasing teacher preparedness and effectiveness. Retrieved May 9, from <https://mursion.com/industries/education.html>

Ni, L. (2009, March). What makes CS teachers change?: factors influencing CS teachers' adoption of curriculum innovations. In *ACM SIGCSE Bulletin* (Vol. 41, No. 1, pp. 544-548). ACM.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1), 1609406917733847.

PuenteDura, R. (2012). The SAMR model: Six exemplars. Retrieved August, 14, 2012.

Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review*, 94(2), 247-252.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Somekh, B. (2008). *Factors affecting teachers' pedagogical adoption of ICT*. In International handbook of information technology in primary and secondary education (pp. 449-460). Springer, Boston, MA.

TeachingWorks (2019). High Leverage Teaching Practices. Retrieved from <http://www.teachingworks.org/work-of-teaching/high-leverage-practices>.

Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 38(2), 137-158.

Wild, J. (2013). OER Engagement Study: Promoting OER reuse among academics. Retrieved from https://ora.ox.ac.uk/objects/uuid:eca4f8cd-edf5-4b38-a9b0-4dd2d4e59750/download_file?file_format=pdf&safe_filename=OER%2BEngagement%2BStudy%2BJoanna%2BWild_full%2Bresearch%2Breport.pdf&type_of_work=Report

Wiley, D. (2002). The Reusability Paradox. Retrieved from <http://opencontent.org/docs/paradox.html>