Virtual Simulations in a Practice Based Teacher Education

Catherine O’Callaghan and Jody S. Piro

Western Connecticut State University

Abstract

For two decades, the field of teacher education has been shifting towards the medical model of teacher education (Doyle, 1990). Despite efforts to use case study methods and clinical rounds, the field has struggled to provide a cohesive, integrated curriculum that prepares candidates for the classroom. Practice-Based Teacher Preparation (PBTE) provides a model for programs to situate practice within the context of use. Part of the challenge facing teacher educators is the act of teaching itself. In order to teach effectively in today’s diverse classroom, pre-service teachers need contextualized preparation on high leverage practices in a supportive environment (Matsko & Hammerness, 2013). The use of virtual simulations such as TeachLivE (Dieker, Kennedy, Smith, Vasquez, Rock, & Thomas, 2014) in pre-service education has the potential to bridge the theory to practice divide for situated cognition, supporting the notion that what is learned cannot be separated from how it is learned and used (Brown, Collins, & Duguid, 1989). TeachLivE simulations enhance the clinical experience by providing a virtual situated learning environment with avatar students prior to clinical experiences with live students.
Teacher preparation in the 21st century continues to be a profession under siege. During the past two decades, calls for more accountability in teacher education have led to increased federal regulation of the profession and exploration of alternative pathways to teaching (Lewis & Young, 2013). In 2010, the National Research Council released its report on teacher preparation programs (TPP). The report noted the wide variety of teacher preparation programs and the lack of a national outcome driven accountability system. Critics of traditional teacher education programs also argued that beginning teachers were woefully underprepared and therefore radically new models were needed to address today’s diverse classrooms (Bullough, 2014; Zeichner, 2010). Further, it has been contended that teacher education needs to situate learning to connect the theory of learning to the actual practicing of teaching (Washburn-Moses, Kopp, & Hettersimer, 2012).

The critical question facing the profession is what should these new models of teacher preparation entail? Critics contend that the traditional model of teacher preparation is too generic and has not resulted in impact on student learning (Cochran-Smith & Zeichner, 2005; Haberman, 1996). Part of the challenge facing teacher educators is the act of teaching itself. The complex, inchoate nature of teaching involves situated cognition and performance (Janssen, Westbrock & Doyle, 2014). In order to teach effectively in today’s diverse classroom, pre-service teachers need contextualized preparation on high leverage practices in a supportive environment (Matsko & Hammerness, 2013). This has resulted in a shift towards a practice-based teacher preparation program.

**Practice-Based Teacher Education**
Practice-Based Teacher Education (PBTE) is a model that focuses on high leverage practices in the situated context of use (Grossman, Hammerness, & McDonald, 2009; Zeichner, 2012). Practice-based teacher education programs are defined as preparation pathways with a systematic focus on developing pre-service teachers’ abilities to implement high leverage practices that impact student learning (Grossman, 2011; Zeichner, 2012). PBTE programs represent the shift in teacher preparation towards a medical model of education where pre-service teachers explore the contextual nature of their profession and understand the nature of the content they teach (Matsko & Hammerness, 2014).

*Transforming Teacher Education through Clinical Practice: A National Strategy to Prepare Effective Teachers* (2010), a report by the National Council for Accreditation of Teacher Education’s (NCATE) Blue Ribbon Panel on Clinical Preparation and Partnerships for Improved Student Learning, posited that teacher preparation programs need to be “fully grounded in clinical practice and interwoven with academic content and professional courses” challenging programs to meet the needs of 21st century classrooms by creating “a system built around programs centered on clinical practice that offers shared responsibility for teacher preparation, supports the development of complex teaching skills, and ensures that all teachers will know how to work closely with colleagues, students, and community” (p. ii)

This report and successive supporting documentation (Berry, Montgomery, Curtis, Hernandez, Wurtzel, & Snyder, 2008; Darling-Hammond, 2005; Elliott, 2010; Howey & Zimpher, 2010; NCATE 2010a, 2010b; National Governors Association, 2010; NGSS Lead States, 2013) undergirds the practice-based framework and its focus on high-leverage core practices.
The program’s focus on high-leverage core practices is to enable pre-service teachers to learn how to use knowledge in action and to reflect the situated decision-making that in-service teachers perform daily (Forzani, 2014). High leverage core practices used in this program have the following characteristics as defined by research:

- Occur with high frequency across different contexts
- Focus on impacting student learning
- Reflect the complex nature of the act of teaching
- Occur across different curricula or instructional methods

(Grossman, Compton, Igra, Ronfeldt, Shahan & Williamson, 2009). As teacher education moves towards a practice-based preparation program in alignment with medical school residencies, the danger is to create a ‘technician’ model that fails to recognize the messy complexities and inchoate nature of teaching (Grossman, 2011; Zeichner, 2012). Therefore a new curriculum design for PBTE is needed that presents these high leverage practices within the context of use.

**Program and Curriculum Design**

Effective practice-based teacher education programs are grounded in research and provide pre-service teachers with the opportunities to enact high leverage core practices (Forzani, 2014). An innovative curriculum design incorporates the characteristics of effective PBTE programs with a learning cycle that provides pre-service teachers with myriad opportunities to engage in situated practice. Effective PBTE programs include a learning cycle with the following components: representations of practice, approximations of practice, enactment of practice, and investigation of practice (McDonald, Kazemi, & Kavanagh, 2013). Representations of practice enable pre-service teachers to view videos of exemplary teachers
modeling high-leverage core practices such as facilitating student led discussions. In the second component, *approximations of practice*, pre-service teachers try out the high-leverage core practice with their peers or in simulated scenarios through immersion software with coaching by their teacher educator. *Enactment of practice* is the implementation of the practice in the classroom situation with coaching and feedback by the mentor teacher. The final component, *investigation of practice*, is a reflective, collaborative analysis where pre-service teachers view videos of their instruction and dialogue with their mentor teacher and teacher educator. Furthermore, the Teacher Work Sample, a summative performance assessment at the end of the program is an in-depth *investigation of practice* that requires all pre-service teacher residents to implement a unit of study, collect student artifacts, video their teaching, and reflect on student achievement.

**Pre-service Teachers and Situated Cognition**

The myriad opportunities to implement high-leverage practices in context of use entails situated cognition. Situated cognition is defined as the contextualized nature of knowledge, bound by agent and situation (Brown, Collins & Duguid, 1989). Situative theorists posit that the physical, social context of the activity where knowledge is constructed and interaction during it are critical to transfer and application to new settings (Putnam & Borko, 2000). Teacher education programs for the past decade have shifted towards residency programs and professional development schools to enable pre-service teachers to construct knowledge within the context of use.

**Pre-service Teachers’ Knowledge Structures**

Pre-service teachers construct and apply knowledge in different ways from expert practitioners. The instructional strategies that teachers utilize are derived from their problem-
solving abilities. The inchoate nature of teaching has complicated the issue of teacher problem-solving. Research on novice/expert teachers’ problem solving confirms that experts organize their instructional strategies/solutions into problem type schemata (Bernardo, 1994). Their rich, deep representational knowledge based allows them to ‘chunk’ problems into categories and to process information (Bruer, 1993). Conversely, novices due to their inexperience, depend upon the surface level of the problem and utilize lower level reasoning skills (Ericsson & Simon, 1993).

Teaching, as in medicine and law, contains many problems that demand novel solutions. According to Leinhardt & Greeno (1986), teaching is a set of complex cognitive skills that further complicates the process. In order to problem solve, the teacher must attend to incoming data and organize it into existing schemata, which depends upon types and context of prior experiences. Pre-service teachers’ knowledge base is therefore often inadequate due to lack of experience (Reynolds, 1995).

Re-conceptualizing Pre-service Teachers’ Problem-Solving Abilities

Re-conceptualization of pre-service teachers’ problem-solving during instruction is facilitated when they are given opportunities to verbalize their ‘reflection in action’ within the context of use (Schon, 1983, 1987). Reflection in action entails pre-service teachers’ examining their cognition while teaching in the context of use. Approaches to develop situated cognition entail the use of case studies where pre-service teachers discuss multiple perspectives and pedagogical practices (Doyle, 1990).

However the profession has only recently begun to explore how technology may be used to augment these efforts. In 1998, early efforts by Lampert and Ball explored how to use hypermedia to explore pedagogical problems related to math. The Casebook of Project Practices
(CaPP) was another endeavor to use multimedia case studies to showcase innovative pedagogy in science for in-service teachers (Marx, Blumenfeld, Krajcik, & Soloway, 1998). Limited research has investigated the use of technology to develop pre-service teachers’ schemata in regard to problem-solving. According to Carter & Doyle (1989), expert teachers’ knowledge is event structured or episodic, context-based, and is organized according instructional features or patterns. Situated cognition takes place in the “context of task-related inputs and outputs (Wilson, 2002, p.626). Mixed reality immersive simulations, such as TeachLivE, are a new tool for the profession to explore for pre-service teachers to develop their schemata regarding instructional problem solving within situated learning environments that resemble a real classroom.

**Situated Learning through Mixed Reality Simulations**

Virtual learning has been used in other disciplines, such as in law enforcement and health care (Richards & Szilas, 2008) and in aviation (Salas, Bowers, & Rhodenzier, 1998). Virtual learning has been under-employed in educational contexts (Dodd & Antonekko, 2012), yet it holds great promise for teacher education. The use of technology in teacher education continues to develop and TeachLivE is an emerging innovation in that expansion (Dieker, Kennedy, Smith, Vasquez, Rock, & Thomas, 2014). TeachLivE was originally created in 2008 with an interdisciplinary team of education and computer science faculty at the University of Central Florida in Orlando (Dieker, Hynes, Hughes, & Smith, 2008). According to Nagendran, Pillat, Kavanaugh, Welch, & Hughes (2013), TeachLivE is an avatar-mediated teacher training system that operates with a “human-in-the loop approach” [that] combines digital puppetry (Hunter and Mapes, 2013; Mapes, Tonner, & Hughes, 2011) with basic Artificial Intelligence processes.
Milgram & Kishino (1994) proposed a reality-virtuality continuum that traverses a complete physical reality to a complete virtual reality. In the middle of the spectrum is augmented reality. Augmented reality (AR), also known as mixed-reality (MR), combines both real and virtual realities for an interactive learning environment (Milgram and Kishino, 1994). Mixed reality denotes an environment that is both virtual and real, allowing students to connect with prior learning (Squire & Klopfer, 2007) and to contextualize learning beyond the classroom (Liu, Tan, & Chu, 2009).

Lindgren and Johnson-Glenberg (2013, p. 447) suggest that there are two characteristics of mixed reality environments. First is that they situate the student inside the simulation and, as in the case of TeachLivE, the students become a part of the simulation. Second, the technology is responsive to the student’s movements within the simulation. TeachLivE satisfies both requirements for mixed reality learning environments. As the teacher trainee enters the TeachLivE simulation, on the television screen is a virtual classroom with five avatar students. A camera and speakers allow the off-site interactors who control the avatar students to see the teacher trainees as they interact with the avatar students. In TeachLivE, the Kinect X Box tracks the teacher trainees’ actions so that they appear to move through the avatar mediated space on the screen, shifting closer to an avatar student to address her individually or addressing the class as a whole group. Teacher trainees experience a sense of immersion that feels like a real classroom with real students. This sense of immersion into the virtual classroom necessitates that the teacher trainees experience situational plausibility—the possibility that they could actually be teaching a real class—and place illusion—the feel that the mixed reality space has the sensation of a real classroom (Hughes, 2014)—as they negotiate a seemingly physical environment that mingles both real and virtual spaces.
TeachLivE utilizes virtual characters involving human interactors who control the personality of the student avatars acting as students in a classroom with the human teacher trainees. The interactors—who regulate the avatar students—have previously studied and prepared for the teacher trainees’ lesson and objectives and respond as typical students. Avatar classroom behaviors may be modulated on a scale from 1 to 5 (with 5 representing the most intense behavior problems), depending on the goals of the session.

As teacher trainees engage in the immersive mixed reality lab, they interact with the five middle school level or high school level avatars. The avatar-students are based in descriptions of adolescent development using William Long’s classification of adolescent behavior, combined with Rudolf Driekur’s theory of adolescent maladaptive behavior and other developmental theorists (Andreasen & Hacimeroglu, 2009), allowing teacher trainees to practice instructional problem-solving and reflection in a mixed-reality, immersive classroom that is based upon a real classroom with live students. Two extremes of the personality types of the avatar students within TeachLivE are Sean—who is the aggressive-dependent style and who requires ample teacher attention from the teacher trainees, and Maria—who is the passive-independent style and who does not appear to demand any attention from the teacher trainees (Hughes, 2014). The other avatar students—Ed, Cindy (CJ), and Kevin—are comprised of various personalities within the dependent-independent and aggressive/passive polarities. Ed is the passive-dependent who desires the teacher trainee’s attention but is too polite to demand it; CJ is the aggressive-independent avatar student who is a class leader, but who has disregard about the teacher trainee’s rules or expectations; and Kevin, who is the dependent-aggressive style and who relies on CJ’s attention within the immersion experience (Hughes, Nagendran, Dieker, Hynes, & Welch, 2015, p. 136). Figure 1 (TeachLive, n.d.) depicts the middle-school student avatars (Ed in
the front left and Sean in the front right; Maria in the back left; CJ in the back middle; and Kevin in the back right).

Figure 1: Middle School Avatars

The avatar-students will respond to questions and join in multiple forms of pedagogy at an individual, paired or classroom level approach (Hayes, Hardin, & Hughes, 2013), resulting in an a sense of deep presence, immediacy, and immersion (Bronack, 2011) and with that engagement, the development of cognitive flexibility in classroom situations (Dieker, et.al., 2013). Teacher trainees may practice higher-order questioning, classroom management, or other high leverage instructional skills based upon the professor’s goals for the session.

A further extension of situated cognition within TeachLivE concerns the time constraints that may be built into the simulation in the virtual classroom (for example, requiring a fifteen minute lesson) that allow a real-time application of teaching; this is known as “time pressure” in situated cognition (Brooks, 1986; Pfeifer & Scheier, 1999) and it suggests learning that occurs as it would happen within a classroom where time is a crucial challenge facing teachers. A teacher trainee can practice repeatedly until mastery is achieved without any harm to actual students and without students remembering the learning curve toward mastery of a high leverage practice (Judge, Bobzien, Maydosz, Gear, & Katsioloudis, 2013; Katsioloudis & Judge, 2012).
Following the mixed reality immersive session with avatar students, teacher trainees may then employ “reflection in action” (Schon, 1983, 1987) within the context of their virtual classroom experience. Through coaching and peer feedback that can occur before, during (e.g. Elford, Carter, Aronin, 2013) or after the TeachLivE immersive simulation, teacher candidates begin to develop instructional problem solving abilities before they enter their clinical placement through the simulations.

The use of TeachLivE in pre-service education has the potential to bridge the theory-to-practice divide for situated cognition, supporting the notion that what is learned must be presented within the context of use (Brown, Collins, & Duguid, 1989). Situated learning from a learner-centered perspective (Koc & Bakir, 2010) provides a useful framework for virtual environments (VE’s) in teacher education contexts. TeachLivE has been found to provide a safe place to practice and to provide corrective advice (Dieker, et al., 2013) in a simulated learning environment. Figure 2 pictures a teacher trainee interacting with a high school class of avatar students.

Figure 2: Teacher trainee in TeachLivE

TeachLivE within Practice Based Teacher Education
Coupled with research based practices (e.g. Lowenberg-Ball, 2012) and traditional clinical placements, mixed reality simulations such as TeachLivE can provide a powerful application of situated learning for pre-service candidates. For example, making content explicit through modeling and explanations is one of Lowenberg-Ball’s (2012) high leverage practices. A TeachLivE simulation that focuses on this practice prior to implementation in a clinical placement increases the effectiveness of the practice in a clinical placement at a later time. Similarly, pre-service students may practice appraising, choosing, and modifying a learning goal (Lowenberg-Ball, 2012) within a specific learning segment with the avatar students before implementation with live students. Situated learning within an immersive learning environment connects high leverage practices and clinical placements. TeachLivE can be used in a Practice-Based Teacher Preparation Program to prepare candidates for the field as illustrated in Figure 3.

<table>
<thead>
<tr>
<th>High Leverage Practice (Lowenberg-Ball, 2012)</th>
<th>edTPA</th>
<th>TeachLivE Simulation</th>
<th>Clinical Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making content explicit through modeling and explanations</td>
<td>Task 1: Planning a Learning Segment</td>
<td>Implement content specific learning segment with avatars.</td>
<td>Implement content specific learning segment in field placement.</td>
</tr>
<tr>
<td>Appraising, choosing, and modifying a learning goal</td>
<td>Task 1: Planning a Learning Segment Task 2: Instruction</td>
<td>Differentiating a learning segment with avatars</td>
<td>Differentiating a learning segment in field placement.</td>
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Figure 3. Implementing high leverage practices with TeachLivE

Simulation learning within a mixed reality environment such as TeachLivE provides teacher candidates with a “safe space” to be introduced to the high leverage practices (Lowenberg-Ball & Forzani, 2011) that impact student learning, such as making content explicit.
Teacher trainees may practice critical high leverage strategies without risk to real students. The situated learning that accrues through the immersive learning instructor between teacher-trainees and avatar students serves as the conduit for those high leverage practices to dependably emerge in the clinical setting.

TeachLivE delivers a mixed-reality environment in which novice teacher education candidates may immerse themselves in high leverage classroom practice with avatar students. Specifically, TeachLivE provides McDonald, Kazemi, & Kavanagh’s (2013) representations of practice, approximations of practice, enactment of practice, and investigations of practice. Additionally, unlike the situated learning within traditional clinical placements, TeachLivE supports a laboratory learning environment where teacher trainees may practice their instruction with low risk to both the trainees and to human students. While the situated learning of simulations such as TeachLivE has the potential to promote learning, the specific activities that teacher trainees perform within TeachLivE “must be designed such that they engineer the desired instances of understanding” (Lindgren & Johnson-Glenberg, 2013, p 448). To design a PBTE, the four phases of learning need to be incorporated into TeachLivE as a mediation system that bridges the classroom learning and the systematic use of high leverage practices in clinical field experiences. The following components of the learning cycle of a PBTE program reflect this linkage. Figure 4 depicts the learning cycle with TeachLivE outcomes and edTPA tasks.
Representations of practice are experiences that help novices in a profession see and understand their future profession (Grossman, Compton, Igra, Ronfeldt, Shahan, Williamson, 2009). Previous technologically oriented uses of situated learning employed videos of practicing teachers to represent professional practice. In TeachLivE, the student-trainees see a virtual representation of a classroom with students, desks, bulletin boards, etc. If the laboratory accommodates the space, an entire class can observe a master teacher implement a lesson with the avatar students and then debrief to unpack the session. Through a ‘think-aloud’ master
teachers can share their rationale for selecting specific core practices in response to avatar students’ behaviors. This dialogic process provides teacher trainees with a more transparent representation of practice.

**Approximations of Practice**

Approximations of practice allow teacher trainees to repeatedly try the more complex skills of the profession within a safe environment where they are coached and supported (Grossman, et al., 2009). Teacher trainees try out the high-leverage core practices in simulated scenarios; they receive feedback from their professors and peers from the simulated classroom. Feedback may occur during the simulation through bug-in-ear coaching (Elford, Carter, Aronin, 2013), in “freeze classroom” mode—where the trainees may step out of the simulation, acquire coaching, step back into the simulation and “start classroom” again—and in post-simulation instructional sessions. Teacher trainees may then self-reflect upon their experiences within TeachLivE after the coaching, challenging their previous assumptions and formulating future action plans based upon their experience and feedback (Kitychenham, 2008). Through this approximation of practice, teacher trainees are able to repeat complex, high-leverage practices within their context of use to gain confidence and mastery.

**Enactment of Practice**

Enactment of practice provides teacher trainees with opportunities to apply their pedagogical skills in classroom settings (McDonald, Kazemi, & Kavanagh, 2013). Teacher trainees use the knowledge and skills they gained through TeachLivE and apply them in the diverse field setting. If problems arise, the TeachLivE simulation lab provides a vehicle to remediate those skills. Coaching within TeachLivE can additionally be garnered from professionals in clinical settings and from school district personnel for practicing teachers. A
student teacher’s mentor teacher or a practicing teacher’s supervisor or instructional coach may provide coaching before, during or after a TeachLivE session that specifically focuses on remediation of a high leverage practice. This practice supports university/school district partnerships.

**Investigation of practice**

Investigation of practice entails reflection on action and the use of data as evidence of impact on student learning (McDonald, et al., 2013). Teacher trainees complete a teacher work sample such as the edTPA (SCALE, 2013) to analyze their planning, implementation, and impact on student learning. Each of these skills may be practiced or remediated in a TeachLivE simulation. Working with their mentor, the teacher trainees analyze their actions from recorded TeachLivE sessions and determine changes in practice based upon the evidence, coaching and the after session reflection. This investigation of practice completes and re-generates the pedagogical cycle as their analysis often points to the need for teacher trainees to further develop their high-leverage practices outside of the TeachLivE mixed reality immersion.

**Conclusion**

Ideally, teacher education programs will provide multiple clinical experiences that span years and milestones in learning as candidates learn to teach—from early field experiences to pre-student teaching field experiences, and then to the capstone experience of student teaching. Yet, virtual simulation experiences provide one more layer of situated learning experiences within a clinical setting that is not quite “real”, but that provides the feel of reality and immersion for the teacher education candidate. TeachLivE simulations situate the learning that will support subsequent clinical placements. Whether they are planning and implementing the pedagogy of a lesson or focusing on content, teacher trainees can use multiple forms of instruction within
TeachLivE. McDonald’s, et al., (2013) *representations of practice, approximations of practice, enactment of practice, and investigations of* ground a practice based teacher education when TeachLivE simulations precede and occur simultaneously in clinical experiences in schools. In essence, TeachLivE enhances the clinical experience by providing a virtual situated learning environment with avatar students prior to clinical experiences with live students. When augmented with a focus on research based practices, mixed reality simulation experiences provide situated learning experiences prior to clinical experiences as part of Practice-Based Teacher Preparation Program.

Catherine O’Callaghan is a Professor of Education and Chair of the Education Department at Western Connecticut State University. She entered the teaching profession as a classroom teacher and continued her career with New York State literacy specialist certification. Teaching in New York City within diverse settings afforded her a wide range of teaching experiences. Her doctoral degree from Fordham University in Language and Literacy initiated her research interests in new literacies, critical literacies, teacher education, and intervention plans for helping striving readers and writers. O’Callaghan began working with pre-service and in-service teachers at St. Joseph’s College in the Child Study Department and as an adjunct at Fordham University. She also taught in the literacy specialist program at Iona College for twelve years before moving on to Western Connecticut State University. She has published numerous articles and books.

Jody Piro, Ed.D. is an Associate Professor in the Doctor of Education in Instructional Leadership program. She has been involved in education for over twenty-five years in K-12 as a social studies teacher and as a dean and principal, and in higher education as a professor and dissertation director. Dr. Piro has also served as a faculty member at Austin Peay State University and the University of Central Florida. Dr. Piro’s current research focuses on accountability outcomes for educators and problematizing discussion for critical analysis and civil discourse. She has authored dozens of peer reviewed articles and book chapters and has presented nationally and internationally on current educational issues. Dr. Piro earned her B.S. in Secondary Education and her M.S. in Educational Leadership at the University of Illinois and her Ed.D. in Curriculum and Supervision at Northern Illinois University.
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