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Three Approaches to Using Mixed Reality Simulations for Teacher Preparation and Recruitment of Future Teachers

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Abstract: Mixed reality simulations have versatility in both the preparation as well as the recruitment of future teachers. We describe three approaches that have led to successful outcomes for general and special education preservice teachers, as well as in the recruitment of future teacher candidates from the high school level. First, we explored the use of TeachLivE™ to enhance special education teacher candidates' behavior observation skills when conducting functional behavior assessments. Second, we studied the impact of different simulation methods on early childhood candidates' preparedness to communicate with parents and caregivers about sensitive topics. Finally, we utilized TeachLivE™ as a recruitment tool to engage current high-achieving high school students in the teaching and reflection process as part of their on-campus dual credit program. In all cases, candidates and students valued the simulation experiences, recognizing the opportunity to deliver instruction in supportive environments with immediate feedback, coaching, and practice opportunities.

Keywords: mixed reality simulation; TeachlivE; teacher preparation; teacher recruitment; virtual reality simulation

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1. Introduction

Teacher preparation programs have a role in addressing two separate complexities that face the field of education in the United States. Both the quality and supply of teachers should be top priority when recruiting and preparing future educators. In a dwindling pool of individuals who are interested in teaching, we must employ new and creative methods to not only pique the interest of potential teacher candidates (i.e., preservice teachers) but also ensure, once enrolled, that they are well prepared to enter the field with the knowledge, skills, dispositions, as well as self-efficacy that is needed to be successful.

Ideally, during their preparation programs, teacher candidates receive numerous opportunities to engage in high-leverage teaching practices such as instructional planning, assessment, behavioral interventions, and collaboration. Brownell and colleagues [1] describe a framework whereby teacher candidates are provided with a continuum of opportunities to engage in these practices and that by purposefully engaging in these teaching practices, over time, in increasingly authentic settings, a sense of competence is more likely to develop. This "pedagogies of enactment" process, suggested by Brownell et al., is not always the norm, unfortunately. That is, educator preparation programs often rely on more traditional methods of disseminating coursework, assigned readings, in-class discussions, and other less realistic methods to prepare teacher candidates to do many of the practices we expect of an inservice teacher (e.g., conduct functional behavior assessments, collect assessment data, communicate and collaborate with parents, engage with students and families from diverse backgrounds [2–4]. Candidates who have limited opportunities to practice these skills may show feelings of unpreparedness, which may lead to avoidance, errors, or even attrition, e.g., [5,6].

Well-prepared teachers who are armed with the ability to implement evidence-based practices are not only more effective [7,8] but remain in the teaching profession longer with less attrition, i.e., [9]. Thus, we must identify effective preparation practices that not only

emphasize good teaching but provide candidates with ample opportunity to use those practices [1,10]. First, however, we must get them through the door. That means that educator preparation programs must also focus on recruiting quality candidates in the first place. Craig et al. [11] state that "practitioners and teacher educators must learn to be nimble, inventive, and open to new ways of tackling teacher shortages with innovative ideas throughout the teacher education pipeline…" (p. 209). Harnessing the power of technology may be one flexible and innovative approach to address the issues of both recruiting and preparing ample high-quality, well-prepared teachers to enter the workforce. Specifically, mixed reality simulation technology may meet this call.

2. Mixed Reality Simulations in Educator Preparation

It is imperative that teacher candidates are provided with structured experiences where they can learn and practice the professional skills needed for success. One preparation method is for teacher candidates to engage in simulations. Simulations provide more realistic experiences whereby preservice teacher candidates can practice newly learned skills in a supportive, low-stakes, and structured environment. Simulations not only provide opportunities to practice but can be paired with immediate feedback and coaching on newly learned skills to produce mastery learning and generalization of needed skills. Technology-based simulations have been successfully used in many fields such as nursing [12], mental health [13], and customer service [14] in addition to teaching [15]. One of the first technology-based environments of this kind for teachers, TeachLivE™, was developed through the work of Dieker and colleagues [16] to provide a virtual classroom experience by combining both "real" and synthetic assets. By using live interactors, virtual students, and carefully curated classroom scenarios, teacher candidates can engage student avatars with and without disabilities, as well as avatar adults (i.e., parents or colleagues) in a simulated environment that is "safe, constant, and predictable" [15], p. 1. TeachLivE™ allows for synchronous responding due to the "human in the loop". The human is an unseen professional actor (interactor) that controls the avatars remotely while hearing and seeing the teacher candidate live via a video conferencing platform (e.g., Skype or Zoom); thus, responses are immediate. The teacher candidate cannot see the interactor, but rather, they can hear and see the simulated classroom and avatars on a large TV screen or computer monitor. The simulation can be paused at any time so that a teacher educator can provide feedback, coaching, or request a repeated attempt by the candidate.

According to Dieker et al. [17], technology-based simulations provide "situations and participants who look like, feel like, and act like they would in real-life scenarios" (p. 51). For example, one TeachLive™ classroom is comprised of five student avatars who each have their own personality, interests, strengths, and challenges. Depending on the focus of the simulation, student avatars can interact as well-mannered and engaged students or they can be off-task and unresponsive to "teacher" requests. A student avatar might easily understand newly taught material or struggle with concepts and make errors during a lesson. Teacher candidates can also interact with an avatar parent. For example, a teacher candidate can practice having a parent–teacher conference to discuss student performance or field questions about the child. Depending on the planned scenario, the parent can be easy-going or confrontational. As Dieker and colleagues [17] suggest, a simulated environment provides an immersive setting where teacher candidates can learn and practice skills that do not put real people at risk, offering repeated practice and opportunities for feedback.

Brownell and colleagues [1] identified "virtual reality simulations" as one effective practice-based approach that can be used when introducing a new skill or practice that has a strong degree of authenticity. Inservice teachers report that technology-based mixed reality simulated classrooms are realistic representations of their classrooms [18]. Thus, these "classrooms" may provide not only an opportunity for teacher candidates to gain valuable practice opportunities, but also allow those who are considering the teaching profession

(e.g., high school students) a realistic glimpse into their future to help in postsecondary decision making.

As a preparation program that has been educating teachers since 1871, our institution embraces innovation and continually strives for ways to ensure quality and preparedness; mixed reality simulations have become part of that innovation in recent years. We will share three approaches as to how we used mixed reality simulations to enhance current and future candidate knowledge, skills, and dispositions. First, we will describe using TeachLivE™ to enhance special education teacher candidates' behavior observation skills when conducting functional behavior assessments. Second, we will summarize a comparison study of different simulation methods on early childhood candidates' preparedness to communicate with parents and caregivers from diverse backgrounds, emphasizing the outcomes noted during the TeachLivE™ condition. Finally, we will demonstrate how TeachLivE™ may be used as a recruitment tool to engage current high-achieving high school students who are considering a career path in teaching.

3. Improving Behavior Observation Using Mixed Reality Simulation

Teachers must be comfortable and fluent in their ability to identify and evaluate challenging behaviors in the classroom, particularly when individualized interventions are required. These skills are needed not only when conducting functional behavior assessments, but also during everyday instruction for successful classroom management. A teacher who can identify, define, observe, and monitor student behavior is better able to understand the function of the behavior, as well as validate the effectiveness of an intervention or instructional practice [19,20].

Despite the importance of these skills, teacher candidates often leave their preparation programs with limited opportunities to practice them; in some cases, field experiences are not aligned to courses where such behavioral content is taught. Thus, candidates are unable to practice and receive feedback on the skills that they learn in the college classroom, leading to feelings of under-preparedness and limited fluency in such skills. In a synthesis of special education teacher burnout, Brunsting et al. [21] reported that dealing with behavioral challenges influences both student outcomes and teacher attrition. The skillset to address difficult behavior can be taught during preparation programs, but there are often limited opportunities to practice and use these newly learned skills.

To help address this challenge, we employed the mixed reality simulation technology TeachLivE™ to create an opportunity for graduate teacher candidates to practice their direct observation skills, including how to operationally define behavior and calculate inter-observer agreement (IOA) in a scaffolded manner, with opportunities for practice and feedback. Candidates practiced how to select and use the appropriate recording instruments based on the target behavior (i.e., event recording instruments, partial interval recording instruments) and discussed challenges and modifications to improve their accuracy.

We utilized an explicit model of instruction during a simulated classroom session that included After Action Reviews, where the instructor and candidates could debrief on the effectiveness of data collection procedures, determine the accuracy of their operational definitions, calculate inter-observer agreement with fellow observers, and then identify what could be improved in the future. We examined the phenomenological aspects of candidates' experience in the TeachLivE™ lab, including their comfort level with various direct observation skills, instrument selection, and inter-observer agreement procedures. Based on survey results from 12 graduate special education teacher candidates enrolled in an Applied Behavior Analysis course, a paired sample *t*-test indicated significant differences in their perceived "comfort level" in using several tools and procedures related to their behavior observation skills (see Table 1). When comparing pre- to postsimulation responses, candidates reported feeling much more comfortable doing things such as selecting a data recording method, recording classroom behavior, and calculating inter-observer agreement.

Table 1. Results of paired *t*-test and Descriptive Statistics for Comfort Level.

Outcome	Pretest		Posttest		n	95% CI for Mean Difference	r	t	df
	M	SD	M	SD					
Operationally defining target behaviors	2.67	.651	2.92	.515	12	−0.729	0.181	−1.149	11
Selecting appropriate type of data recording method	2.25	0.452	3.25	0.622	12	−1.469	0.081	−4.690 *	11
Collecting data on occurrences of behavior observed in the classroom	2.75	0.622	3.17	0.389	12	−0.744	0.564	−2.803 *	11
Calculating interobserver agreement	2.33	0.888	3.42	0.669	12	−1.716	0.204	−3.767 *	11

* $p < 0.05$.

The structured format of the simulation included modeling, guided practice, and multiple opportunities to practice with feedback, which were deemed to be essential to building fluency and comfort in these skill areas. Most candidates (93%) who participated in the simulation found it to be a positive experience and provided insightful commentary about the process. One candidate reported that "...so far in grad school this was the most effective class experience I have had"; another stated that "Practicing the data collection with students in real time was most valuable for learning. It was true hands-on learning an atmosphere conducive for immediate discussion and feedback".

Although this simulation does not guarantee generalization into the "real world" classroom, the realistic nature of the experience may help narrow the generalization gap. Additional data and further study would be needed to determine if these practices carry over; however, anecdotally, many candidates utilized the behavior observation procedures and tools used during the simulation when gathering data for their applied intervention capstone projects one to two semesters later.

4. Improving Parent–Teacher Interaction Using Mixed Reality Simulation

Educator preparation programs can utilize technology to expand candidates' opportunity to engage in real (or realistic) parent–teacher interactions, even when those opportunities are somewhat limited or restricted within a program. For example, there are preservice teachers who complete their programs without a formal opportunity to communicate or collaborate with families (parents, guardians, caregivers), particularly as it relates to seemingly sensitive topics such as the academic, behavioral, or social challenges of their child. Moreso, depending on geographic location, candidates may also have limited experience interacting with families from diverse backgrounds. Despite the recognition of the value and importance of communication and collaboration between families and teachers, this content is often not covered in programs, i.e., [22], and candidates are rarely given a formal opportunity to take part in low- or high-stakes parent–teacher meetings (e.g., conferences, IEP meetings, discussions about necessary accommodations, etc.) [23,24].

In addition to improvements in teaching or assessment skills, as noted in our first example, feelings of preparedness may also be impacted through technology-based simulations. Driver, Zimmer, and Murphy [25] reported significant shifts in preservice teachers' perceptions of their readiness to work in collaborative settings, as well as improvement in communication skills, following the use of a TeachLivE™ simulation experience. Accardo and Xin [26] utilized TeachLivE™ to promote teacher candidates' collaboration with a parent avatar during a special education planning conference. This experience led to improved self-reflection and self-assessment in teacher candidates' evaluation of their parental collaboration skills and the ability to make appropriate instructional decisions during parent–teacher conferences, compared to candidates who did not engage in the simulation. Similarly, Kelley and Wenzel [27] utilized TeachLivE™ to improve preservice teachers' interaction with parents during reading conferences. These examples suggest that

mixed reality simulations offer a promising approach to addressing this gap in experience and preparedness to engage and collaborate with families.

To explore the potential of mixed reality simulation as a tool to enhance parent–teacher interaction skills and allow candidates to practice professional conversations in a collaborative manner, [ewe] conducted a study comparing three different simulation methods: *peer-to-peer, parent actor*, and *mixed reality simulation with a parent "avatar"* using TeachLivE™ [28]. In this study, 25 teacher candidates who were enrolled in a senior-level course in an Early Childhood preparation program participated in all three simulation conditions in a counterbalanced, within-group repeated-measures design. Candidates were randomly assigned to one of the three groups to start and rotated through all three simulation types, where they were provided with scenarios that set the stage for the meeting, involving a classroom teacher and a parent, guardian, or caregiver. Each scenario described an academic, behavioral, social, and/or other familial challenge that prompted the meeting between the two. The focus for each "meeting" emphasized topics that were important but that might feel uneasy to discuss and that require empathy, active listening skills, or other problem solving abilities (i.e., academic intervention, bullying prevention, excessive absences, unique parent requests, or other behavioral concerns). In addition, several scenarios included families from diverse backgrounds (i.e., race, ethnicity, and socioeconomic status) that would be mostly different from the candidates who participated.

In the TeachLivE™ simulation condition, the teacher candidates engaged with what appeared to be an actual parent/guardian, albeit an avatar, who was able to see, talk, and respond in real time. Each candidate played the role of the teacher and had an opportunity to interact with the female parent avatar using one of the 12 scenarios while their peers observed. The scenarios were developed with input from our university's clinical educators based on challenges that they have experienced in their own classrooms. Based on the situation, the parent/guardian may have presented as angry, overwhelmed, downcast, apathetic, or irritated. In some cases, the parent/guardian may have been confrontational and engaged in unreasonable requests of the teacher. The avatar interactor was provided with the detailed scenarios in advance and was directed by the research team not to exceed a "moderate" level of anger or disapproval when interacting with the teacher candidates if the scenario called for that.

Across all simulation methods, the peer-to-peer and real parent actor groups had the same details about how to react and were briefly "trained" to engage in similar types of behaviors as the avatar parents. Despite this plan, the researchers noted that the TeachLivE™ interactors seemed much more realistic and consistent in their affect. They did not "break character" nor pause to offer any advice or coaching during the meeting. In a few cases, the interactor cried or engaged in realistic body language that indicated that she was unhappy with what the teacher was saying (crossed arms, sighing, etc.). During the TeachLivE™ simulation, on multiple occasions, candidates requested to "pause the meeting" to re-group or ask their peers for some advice or support for how to respond, although no formal coaching took place. In the other simulation groups, the "pause" was less formal and often involved just stopping to chat or get input from a peer or parent actor, who tended to offer natural insight and coaching to the candidate.

We examined how teacher candidates rated their preparedness (skills and confidence) for communicating and collaborating with families, as well as their concerns before and after the simulation sessions via pre and post surveys and anecdotal observations. Overall, candidates felt more confident in their abilities to engage with parents/caregivers following the interventions. A *t*-test revealed that this difference was statistically significant: $t\ (23) = 2.07$, $p < 0.001$.

Specifically, a small majority of candidates reportedly felt that the "parent actor" simulation method was most effective (52%), followed by the TeachLiveE™ method (32%). Through their comments, candidates appeared to appreciate the parent actor's personal experience and willingness to "work to help find a solution". Several students reported the TeachLivE™ simulation to be more realistic but felt that it was intimidating or intense

and added a layer of stress to the process; they felt that it was a good experience to prepare them for a "real human" interaction in the future, but some found the avatar to be mean or rude. Anecdotally, the two researchers who observed the avatars during this study found the avatar responses to be very realistic in their own experience when having "crucial conversations" with some families.

Given the format of this study, it was beneficial to compare different methods and the preferences noted by the candidates. From a feasibility perspective, obtaining well-trained parent actor volunteers on a regular basis semester after semester could prove challenging. Similarly, the TeachLivE™ simulation method has viability issues, given the costs associated with this approach. Thus, peer-to-peer simulations may be the most sustainable; however, as discussed previously, they may not offer the most realistic experience and were not preferred by candidates. As Brownell and colleagues [1] point out, enacting the various practices that are required of a teacher during their preparation programs may require a "continuum of opportunities to use teaching practices in increasingly authentic settings. . ." (p. 331). Thus, preparing candidates to collaborate and interact with parents might start out with peer-to-peer role play, but perhaps culminate with a mixed reality simulation if a real opportunity is not presented.

5. Addressing Teacher Shortage and Recruitment Using Mixed Reality Simulation

Not only can mixed reality simulation be used for the preparation of current teacher candidates, but it has potential as an effective recruitment tool for future teachers as well. A current study is underway to examine the impact of using TeachLivE™ to pique the interest of current high-achieving high school students and to engage them in the teaching process during an Education Pathways Academy. The academy is a one-year, senior-level, highly academic program that allows students to explore the field of education while earning high school and college credits. We invited seven students to our campus to take part in education-related coursework and other experiences that would provide them with first-hand knowledge of a career in teaching over the course of the year.

The high school students participated in various teacher trainings such as Dignity for All Students (DASA) and coursework, where they learned about classroom management techniques, cooperative learning strategies, and literacy education. During this time, the students engaged in planning mini lessons based on a content area of their personal interest; however, they had few opportunities to carry out the lessons or apply the strategies and management procedures that they were learning about. Prior to this, most students only engaged in brief peer-to-peer teaching of their mini lesson or participated in P-12 classroom activities in a helper role (i.e., reading a book to one to two students, offering 1:1 assistance during independent work time, assisting with materials during a hands-on activity). Therefore, despite the high school students' interest in teaching and enrollment in the Education Pathways Academy, few had ever engaged in direct "teaching" to whole or small groups. To provide an opportunity to carry out a portion of their planned lesson and get a feel for being in front of the classroom, we utilized a mixed reality simulation where each student was able to be in front of an inclusive "classroom" and engage with the student avatars for one to two five-minute sessions.

One area of focus that all students learned about in their coursework was how to utilize surface management strategies to respond to minor undesirable behaviors while teaching, regardless of content. Strategies such as redirecting, planned ignoring, interest boosting, and use of humor are some examples of nonintrusive methods to prevent, interrupt, or stop minor behaviors. While high school students have likely experienced these strategies as students themselves, they had never practiced using them nor made decisions about when to use them. These proactive approaches seemed feasible for students to "try out", allowing them to see what teachers may experience while delivering instruction. According to experts from The IRIS Center's Classroom Behavior Management module [29]), "With so many surface management strategies, it may seem overwhelming to decide which is best to use in a given situation. Successfully applying surface management strategies

takes time and practice" (p. 7). We used this notion as our rationale and invited the high school students to deliver their planned mini lessons in the TeachLivE™ classroom while encouraging them to practice some of the surface management techniques that they had learned about in coursework. The student avatars were controlled by a live interactor who was instructed to display a low level of challenging behaviors that could be easily redirected and were judged to be typical in a middle school classroom. We used the After Action Review process to debrief with each student following their teaching session, offer opportunities to try it again, and together identify examples of when various strategies were used or could have been used. The feedback was kept brief and "light", emphasizing the positive attributes of their teaching.

We administered a pre and post survey to explore the impact of this mixed reality simulation on the students' perception of teaching and feelings of preparedness. We also tracked the number of students who selected teaching as their chosen professional path upon completion of the year-long academy program, of which the TeachLivE™ experience was one component. Preliminary data suggest that these students not only valued the TeachLivE™ experience but were able to identify specific teaching practices that they used and would like to use to improve their future teaching.

On average, students rated their comfort level of teaching in front of a whole class higher before they participated in the simulation compared with after (3.4 before vs. 3.0 after on 5-point rating scale). Three out of the seven students dropped their comfort level rating one point once they participated in the simulation. While this is not a significant decrease, it provides insight into the self-efficacy that students may come in with vs. how they feel once they have "taught" in front of a live class; perhaps a minor level of false confidence existed prior to the simulation. The students' awareness of some common classroom challenges that they may not have anticipated were captured in their reflections. For example, several students reflected on the unexpected ways in which the avatar students responded. This included unanticipated questions, disclosure of personal information, refusal to comply, "attitudes", and students who seemed overly talkative, as well as those who were extremely quiet or nonresponsive to questions posed.

Prior to the simulation, when asked which surface management techniques they felt that they could implement themselves when in the role of a teacher, most high school students felt confident with redirection (n = 7) and proximity control (n = 6), but this expanded to include planned ignoring (n = 6), interest boosting (n = 6), and removal of an object (n = 7) once they had the mixed reality teaching experience. All high school students were able to reflect on changes that they might make in the future related to lesson planning, delivery, and overall classroom management. They also identified specific skills and knowledge that they would like to learn more about such as how to engage all students and boost the interest of the students when planning their lesson. Therefore, although students may have felt less confident in their comfort level in leading a group following the simulation, they seemed to be more aware of specific practices that they could implement themselves in their role as a teacher.

Two university faculty and the lead high school teacher who facilitated the simulation activity noted that the rich conversations and teachable moments that occurred during the After Action Review process surpassed any discussions or written reflections they had experienced in the college classroom with typical teacher candidates. This brief yet influential mixed reality simulation experience afforded an opportunity for high school students to truly glimpse into their future as teachers and gain valuable insight into their chosen profession with immediate concrete examples. We are optimistic that this simulation experience was a contributing factor to 100% of participants entering a postsecondary teacher preparation program at the conclusion of their senior year, two of whom chose special education as a result of their experiences. Allowing students to have this type of positive and supportive hands-on experience prior to selecting their career path may be helpful in the recruitment of future teachers.

6. Conclusions

The three case study approaches described above may offer value to others seeking to improve teacher preparation and recruitment by using mixed reality simulation methods. Specifically, TeachLivE™ is an easy-to-use technology that can be scheduled through the University of Central Florida's Center for Research in Education Simulation Technology and is accessible at home or on a university campus via the Internet and video conferencing software. Its uses are varied and can be individualized to meet the objectives of the user.

The generalization of the three approaches described may be limited by a small sample size at one institution and by the limited statistical analysis. Thus, further and larger-scale impacts should be explored. An additional limitation of relying on mixed reality simulation to address preparation and shortage issues is the potential cost involved. Current fees for one hour of TeachLivE™ use, for example, are USD 175 per hour. Despite the apparent cost, teacher candidates generally need far less time in a simulated environment compared with typical classroom experience. TeachLivE™ developer, Dr. Lisa Dieker, estimates that 10 min in the "simulator" is equivalent to one hour in the "real world" classroom [30]. While it is difficult to quantify the costs of field-based classroom experiences for teacher candidates, one must factor in travel time to schools, mentor compensation, and supervision as potential expenses in addition to the added classroom time. Thus, it is likely that TeachLivE™ use may result in fewer expenditures longer term.

Despite the limitations, we have outlined how our use of mixed reality simulation has the potential to contribute to the growing body of research highlighting its value in addressing common challenges in the field. Mixed reality simulation should never replace real-world clinical experiences for future teachers; however, the time and personnel cost savings (paired with the inherent effectiveness) should be considered when planning a continuum of practice opportunities.

Mixed reality simulation allows teacher candidates to practice skills and pedagogies in a supportive and low-risk environment where feedback and opportunities to practice abound. In many cases, this technology provides an opportunity to engage in practices that are otherwise unavailable to teacher candidates (or future candidates) before they enter the teaching field. In 2015, Kennedy and colleagues [31] called for innovation in the delivery of content knowledge in teacher preparation. They specifically cited Blomberg et al. [32], who noted that "exposure to complex situations can help preservice teachers develop flexibility and apply knowledge in problem solving" (p. 77). Using a mixed reality simulation tool, like TeachLivE™, to present "complex situations", such as how to collaborate with a parent/caregiver, how to identify appropriate data collection methods, or how to select what surface management strategy to use, supports this call. Mixed reality simulation in teacher preparation can be a useful and effective pedagogical approach.

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