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Immersive virtual reality and education: a study into the effectiveness of using this technology with preservice teachers.

Shannon R. Putman
University of Louisville

IMMERSIVE VIRTUAL REALITY AND EDUCATION: A STUDY INTO THE EFFECTIVNESS OF USING THIS TECHNOLOGY WITH PRESERVICE TEACHERS

By

Shannon R. Putman
BS, University of Tampa, 2000
M.A.T., University of Louisville, 2009

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A Dissertation Approved on

July 27, 2021

by the following Dissertation Committee:

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Dissertation Director
Justin Cooper

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Ginevra Courtade

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John Finch

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Jason Immekus

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Dar-Jen Chang

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ABSTRACT

IMMERSIVE VIRTUAL REALITY AND EDUCATION: A STUDY INTO THE EFFECTIVNESS OF USING THIS TECHNOLOGY WITH PRESERVICE TEACHERS

Shannon R. Putman

July 27, 2021

Immersive virtual reality (IVR) is a rapidly advancing technology utilized across varying education fields for learning and educational applications. IVR provides the capabilities of computer simulations and embodied cognition experiences through a hands-on activity, making it a natural step to improve learning. Creating educational applications in IVR for use with students and preservice teachers could be a laborious and costly endeavor and require teacher belief in its effectiveness, so research is essential to investigate whether these applications are useful in advancing prekindergarten through Grade 12 (P-12) student learning. Research in this field is new, limited, and practically void of its use in P-12 learning environments. This inquiry expanded upon the literature on IVR technology in education and preservice teacher use of technology. Specifically, the purpose of this study was to investigate the impact of IVR technology on preservice teachers through an experience focused on the American Civil Rights Movement, specifically on knowledge attainment, lesson planning effectiveness, and motivation for future use in their instructional practice. Participants were 21 elementary preservice teachers in a diverse metropolitan university. Results indicated participants in the IVR

group significantly increased scores on a content test, reported engagement with the experience, and indicated likelihood to use IVR with their future students.

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CHAPTER 1

INTRODUCTION

Background and Need for the Study

Immersive virtual reality (IVR) is a continually emerging technology that has the potential to enhance how teachers deliver instruction and engage students in their learning. Virtual reality (VR) technology began in the mid-1950s when Morton Heilig created the Sensorama, a sensory cinematic experience (Boas, 2013). The user would sit in the machine and watch a short movie, and the chair would move; there was a color display, fans, odor emitters, and stereo sound. The Sensorama laid the foundation for amusement attractions and modern VR, which has since evolved into IVR.

VR technology morphed from an enclosed box encompassing its user to a head-mounted display (HMD). The first HMD was the "Sword of Damocles," invented by Ivan Sutherland in 1968 (Boas, 2013). Credited as the first experiment with an HMD, the Sword was the first encompassing head-worn device that tracked the user's head position and changed perspective in reaction to that movement. An HMD can be a pair of goggles or a full helmet containing a tiny monitor in front of each eye. Improvements made to the HMD technology eventually led to the creation of IVR technology.

As VR technology has developed and improved over the decades, no one agreed-upon definition has emerged, and there are various levels of immersion (Hixon & So, 2009). Bryson (1996) defined VR as using computer-based technologies to replicate the effects of the three-dimensional (3D) world by using interactive objects to produce a strong sense of virtual presence. With the development of more immersive technologies, like the HMD, Riva and Mantovani (2012) developed an updated definition of IVR as using a computer capable of generating interactive 3D visualization, an HMD, and trackers that sense the user's position and orientation. This study uses the definition of IVR provided by Eden and Bezer (2011) as the "ability to immerse the user in a virtual world with the use of head-mounted display (HMD) and interactive controllers, aimed at capturing the user's input in real-time" (p. 339). The author chose this definition because it contains the HMD and real-time interactions with the virtual environment.

To date, much of the educational research on IVR has been either situated in clinical settings or based on low-incidence populations, such as children with autism spectrum disorder (ASD), cognitive delays, or attention-deficit hyperactivity disorder (e.g., Adjorlu et al., 2017; Beach & Wendt, 2014; DiCarlo, 2020; Ghanouni et al., 2018; Park et al., 2020). There is emerging work about the use of IVR with college-aged students (18 and older) and effects on performance, emotion, and engagement (Allcoat & von Mühlenen, 2018) and use in the psychology classroom (Coxon, 2013). Research is limited involving preservice teachers and IVR. According to their systematic literature review focused on IVR and use in teacher education, Billingsley et al. (2019) reported only seven articles related to the topic, and some of those included current practicing educators. Due to the lack of research, the potential of IVR to transform classroom practices and impact student learning is still relatively unknown.

There is emerging research on the effects of VR on student learning (Southgate et al., 2019). Most researchers conducting studies using IVR with children and young people have done so in highly controlled clinical or experimental settings, often with relatively small samples. Nonetheless, the emerging empirical evidence suggests a promising potential to promote increased levels of sharing (Bailey et al., 2017) and allow students to experience instruction personalized to their needs (Passig & Eden, 2010) or visit new environments not possible in their physical world, such as interacting with fictional characters (Bailey et al., 2017). In collaboration with the Sesame Workshop, the creators of Sesame Street, Bailey et al. (2017) programmed a simulation in which 52 children (ages 4–6) interacted with a furry blue monster named Grover through either an IVR experience (i.e., VR headset) or a nonimmersive experience (watching on a two-dimensional [2D] television screen). Children in the IVR condition showed a significant deficit in impulse-control skills, as measured by their success in playing a game of Simon Says with Grover. In the game, children who saw Grover on the television screen were better able to suppress mimicking the gesture when Grover did not say, “Simon says,” but in IVR, the temptation to mimic Grover was harder to resist. The authors’ explanation for this finding was that the more realistic and compelling the character’s features become, as happened with VR Grover, the more challenging it may be for children to resist the urge to imitate the character.

As a significant IVR component is creation of an environment similar to the real world, Segovia and Bailenson (2009) tested whether preschool and elementary school-age children could differentiate virtual experiences from real ones. In a preliminary study of 55 preschool and elementary school-age children, the researchers told participants stories of two events that did not occur. Afterward, children were assigned to one of four memory prompts: (a) idle, in which the experimenters did not prompt participants; (b) mental imagery, in which researchers asked the participants to imagine themselves participating in the false events; (c) other avatar, in which the participants saw another child avatar participate in the false events; and (d) self-avatar, in which the participants watched themselves participate in the false events via a virtual doppelgänger (an avatar that looked like them but was controlled by a computer). For preschool children, the memory prompt did not affect their false memories; all conditions evoked relatively equal amounts of false memories.

Despite a significant amount of research regarding IVR and adults, the quantity of empirical research related to children is limited. Bailey and Bailenson (2017) noted that even less evident in the literature is research with young children, specifically those under 7. Although companies develop new technologies for adults and older adolescents, young children often get access and experience. With the growth of VR in the consumer market, understanding the uses and effects of IVR among young children will be essential to inform regulatory guidelines for access and content development (Bailey & Bailenson, 2017).

Finally, studies have focused on clinical populations and clinical uses. With limited research dedicated to addressing developmental issues and nonclinical populations, questions linger regarding the physical, social, and psychological relationship between typical human development and IVR. In general, the studies involved simulated classrooms or other everyday environments, and students were required to complete tasks in and outside of the IVR. Continued research is needed into IVR and its effectiveness on participants in an educational setting. According to

Southgate et al. (2019), research on IVR with HMDs in schools is scant, and there is a distinct gap in the literature on IVR for educational purposes.

Research involving IVR use with preservice teachers varies depending on the type of IVR utilized and the desired outcome of using the technology. The University of Central Florida has been conducting work in VR in the Center for Research in Education Simulation Technology (CREST). According to the University of Central Florida CREST (n.d.), TeachLivE, a patented VR, is an innovative approach that allows people to practice their human-to-human interaction skills, including those associated with teaching. According to the University of Central Florida CREST website,

> TeachLivE is a mixed-reality classroom with simulated students that provides teachers the opportunity to develop their pedagogical practice in a safe environment that does not place real students at risk. The use of TLE TeachLivE Lab has also been instrumental in developing transition skills for students with significant disabilities, providing immediate feedback through bug-in-ear technology to preservice teachers, developing discrete trial skills in preservice and in-service teachers, and preparing teachers in the use of STEM-related [science, technology, engineering, and mathematics] instructional strategies. (para. 1)

Even though the TeachLivE system is not a fully IVR system as defined by this paper, the work using this technology has laid the foundation of research for VR with preservice teachers.

O'Connor and Worman (2019) focused on "data gathered from an avatar-based immersive experience where teacher-education students gathered in VR spaces for synchronous meetings, learning how to maneuver within the environment, modify their avatars' appearances, and develop preliminary 3D building perspectives" (p. 292). Students developed trust and camaraderie during the problem-solving experiences, relying on the help of peers (O'Connor & Worman, 2019). Students enjoyed the experience and considered VR applications for their classrooms.

Many professional organizations in education have encouraged educators to reform the curriculum and incorporate more technology into classroom instruction. As technology continues to develop and advance and society becomes more reliant on the use of technology, a new set of skills is required by students to be successful. Almost all college-level classes require access to a computer at the bare minimum. Assignments are no longer handwritten; they are emailed or submitted via an online service. This instruction method has spread into high, middle, and even elementary schools. In 1983, the computer-to-school ratio in schools averaged 1:125; that number increased to 1:9 in 1995 and 1:6 in 1998 (Russell et al., 2002). There is a literature gap about what evidence is compelling enough to encourage teachers to integrate technology in their classrooms. The researcher designed the IVR experience created for this study through an instructional integration lens, with the idea that teachers would do the experience first and then implement it in their classroom instruction. When working with preservice teachers, it is critical to understand not just what type of technology they plan to use but also how they intend to use it to enhance student learning.

The formation of tolerance among young people has become an important aspect of psychological and pedagogical research. This is due to aggressive acts shown by students at schools and universities (Nagovitsyn et al., 2018). *Tolerance* may be interpreted in different ways, including a dialogue between cultures in search of "peaceful coexistence in diversity" (Nagovitsyn et al., 2018, p. 755). Nagovitsyn et al. (2018) stated, "The most important characteristic of tolerance is not that it is associated with friendship, respect, acceptance, but that excludes hatred (Leont'yev, 2009)" (p. 755).

Recent events that have occurred across the United States have led to the demand for a shift in curriculum. Young students are growing up in a society where they hear their generation's calls for racial justice, whether it is "Say Her Name" for Breonna Taylor, "I can't breathe" for George Floyd, or simply "Black Lives Matter." The Year 2020 was filled with chaos, racial tensions, a global pandemic, and physical school closures. Students (and teachers) have had to adapt to learning and teaching under these new and uncertain situations. Organizations like Teaching Tolerance (2020a, 2020b) are working to educate teachers on the importance of this moment for a true and meaningful change in not only how they teach, but also the information they choose to teach young students. Founded in 1991, Teaching Tolerance (2020a) is a project of the Southern Poverty Law Center dedicated to helping teachers and schools prepare children and youth to be active participants in a diverse democracy. Teaching Tolerance has developed social justice standards that help and support educators. According to the Teaching Tolerance (2020b) website,

> The Social Justice Standards are a road map for anti-bias education at every stage of K–12 instruction. Comprised of anchor standards and age-appropriate learning outcomes, the Standards provide a common language and organizational structure educators can use to guide curriculum development and make schools more just and equitable. Divided into four domains—identity, diversity, justice, and action (IDJA)—the Standards recognize that, in today's diverse classrooms, students need knowledge and skills related to both prejudice reduction and collective action. Together, these domains represent a continuum of engagement in anti-bias, multicultural and social justice education. The IDJA domains are based on Louise Derman-Sparks' four goals for anti-bias education in early childhood. Each of the IDJA domains has learning outcomes and school-based scenarios organized by grades K–2, 3–5, 6–8, and 9–12. (para. 1)

When deciding what educational topic to focus on for this study, the researcher wanted to choose something with the potential for significant impact on preservice teacher thoughts about what topics they teach and what activities they use to engage their students on a deeper level. Through an informal questionnaire, the author learned that out of 29 currently enrolled college juniors, only 4 could identify who Representative John Lewis was, and only 3 had heard of the Bloody Sunday march on the Edmund Pettus Bridge. These factors, combined with the demand for teacher education faculty to recognize the need to prioritize preparing preservice teachers to work with an increasingly diverse K–12 student population (Anderson & Stillman, 2013; Bennett, 2012; Larson, 2016; Sleeter, 2001), formed the research basis for the decision to create the Boy From Troy.

Purpose of the Study

The purpose of this study was to investigate the impact of IVR technology on preservice teachers through an experience focused on the American Civil Rights Movement, specifically on knowledge attainment, lesson planning effectiveness, and motivation for future use in their instructional practice. The IVR technology was the Boy From Troy, an IVR learning experience, designed to improve instructional strategies among preservice teachers preparing to teach prekindergarten through Grade 12 (P-12). The study explored how preservice teachers integrate technologies into their lesson plans. The professor designed these lesson plans as a course assignment. Both descriptive statistics of students' lesson plan evaluations and content analysis of lesson plans were employed to address this research question. The researcher reviewed the qualitative aspects of preservice teachers' work. The participants in this study were required to keep a digital interactive notebook throughout the semester. In the syllabus, the professor explained the digital interactive notebook as follows:

> During this course, you will be maintaining a detailed, electronic interactive notebook that includes all Notebook Items (class activities), class notes, handouts,

> taught lesson plans, etc. Purpose and teaching procedures for the activities should also be documented. The notebook will be a modified version of the model described by the History Alive curriculum. The purpose of the notebook is not only to document the social studies activities in class, but also to be a resource to you in your teaching. A reflection component embedded in most face-to-face classes will provide an opportunity to think about the social studies activities and integrate the research from course readings. The notebook is due at the end of the last class. Several electronic versions will be shown in class as potential models for your own notebook.

The researcher analyzed the participants' digital notebooks for any items related to the Boy From Troy IVR experience and any other technology themes. The researcher adopted the grounded theory approach when analyzing the lesson plans and digital notebooks. In 1967, Glaser and Strauss established systematic and scientific guides in qualitative methods called grounded theory in contrast to quantitative methods (Dunne, 2011). According to Glaser and Strauss (1967), grounded theory is a research method influenced by symbolic interactionism for developing a theory that conceptualizes the specific social concepts, patterns, and structures through constant comparative methods. Researchers using grounded theory are interested in knowledge or reality founded on empirical data (B. Johnson & Christensen, 2012).

After the participants viewed the Boy From Troy, they received their assignment from the professor to create a lesson plan, which they used to teach part of the civil rights movement. They met in their professional learning communities (PLCs) to discuss various instructional methods they learned. Astuto et al. (1993) described a PLC as a professional community of learners in which the teachers and administrators in a school continuously seek and share learning and then act on what they learn. These actions aim to enhance teacher and administrator effectiveness as professionals so that students benefit. The arrangement also has been called a community of continuous inquiry and improvement. The students were allowed to discuss and reflect on their experience as part of the PLC lesson-planning process (Little, 2002). Little (2002) reported that research supports the PLC as an important contributor to instructional improvement and school reform. Seashore Louis et al. (1995) found that in schools with a genuine sense of community, an increased sense of work efficacy led to increased classroom motivation and work satisfaction and greater collective responsibility for student learning.

This study's secondary purpose was to determine the extent to which an IVR learning experience affected preservice teachers' learning of content knowledge. IVR is not necessarily equally suitable for all subject areas; visualizing benefits is more significant in some subjects than others (Allcoat & von Mühlenen, 2018). As such, VR and IVR applications may be more suited to some areas of education than others. This exploratory study aimed to identify the areas of education in which IVR could be most beneficial.

This study's final purpose was to determine preservice teachers' intentions of using IVR in their future instruction. Many researchers have devoted their work to investigating teachers' technology integration (Ertmer et al., 2012; Kim et al., 2013; Messina & Tabone, 2011). This study investigated IVR technology and preservice teachers' intention for future use and what factors affect that decision.

Research Questions

1. Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience?
2. To what extent does the instructional method affect the learning outcomes of preservice teachers?

3. To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction?

Definition of Terms

For this study, the author lists several key terms and their definitions for the sake of clarity:

Linowes (2015) defined a *complete virtual experience* as when the user wears an HMD that completely blocks out all aspects of the physical world. The user cannot see any part of their world, including their own body. The only way the user can interact with the virtual environment is through a virtual representation of their specific body part (hand) or tracked movements.

Computer head-mounted display (HMD) is defined as any headset that requires a connection to a stand-alone personal computer (PC) to function (Ghanouni et al., 2018). This is differentiated from a standalone HMD.

Empathy is the process "whereby one person tries to understand accurately the subjectivity of another person, without prejudice" (Wispe, 1986, p. 320).

Engagement while learning refers to the sense of involvement, connection with, and enjoyment of the content (Wiebe et al., 2014).

Eye tracking is defined as the fast and accurate monitoring of eye movements (Clay et al., 2019).

Head-mounted display (HMD) is defined as a device that creates a 360-degree continuous capture of visual stimuli, using full-body tracking technology to deliver a compelling rendering of the virtual environment (Cummings & Bailenson, 2016; Freeman et al., 2018). When worn, the HMD blocks the view of the actual world, enabling the user to look 360 degrees around them, seeing only the virtual environment. As noted in these definitions, an HMD may be computer attached or standalone.

Presence and engagement can become even stronger in IVRs that elicit embodiment. In such settings, the user experiences the perspective of another individual (Puvirajah & Calandra, 2015). This situation may elicit feelings of embodiment of the virtual body to the extent that the user may perceive that body as being their own, a phenomenon dubbed the *illusion of virtual body ownership* (Cummings & Bailenson, 2016; Petkova & Ehrsson, 2008).

Immersion refers to the technological quality of media delivery, or the extent to which the system presents a vivid virtual environment while shutting out physical reality (Cummings & Bailenson, 2016, p. 274).

Immersive virtual reality (IVR) was defined by Eden and Bezer (2011) as the “ability to immerse the user in a virtual world with the use of head-mounted display (HMD) and interactive controllers, aimed at capturing the user’s input in real-time” (p. 339).

Steuer (1992) defined *interactivity* as “the extent to which users can participate in modifying the form and content of a mediated environment in real time” (p. 84).

Mixed reality (virtual learning environment) is defined as the combination of real and virtual worlds, providing users with a sense of presence. Mixed-reality environments enable participants to perceive a virtual environment as authentic, much like the real world (Straub et al., 2014).

Nonoptical tracking uses various sensors that are often attached to the body for motion tracking but also can involve magnetic fields or sound waves (Virtual Reality Society, 2018).

Optical tracking is where an imaging device is used to track body motion (Virtual Reality Society, 2018).

Preservice teacher is defined as any individual who is being educated or trained prior to entering into service as a teacher. Preservice teachers are typically completing required coursework, practicum, and other program-specific requirements prior to completion of a teaching degree leading to teacher certification.

Professional learning community (PLC) is a professional community of learners in which the teachers in a school and its administrators continuously seek and share learning and then act on what they learn (Astuto et al., 1993).

Rendering is defined as displaying a digital representation of the world to reflect the user's representation (Lanier, 2001).

According to the Virtual Reality Society (2018), there are six types of motion that an object can move in a 3D space, referred to as the *six degrees of freedom*. This term refers to the ability to move in six directions, namely pitch, yaw, and roll, around the x, y, and z axes (Virtual Reality Society, 2018).

Simulator sickness was explained by Kennedy et al. (1993) as a byproduct of modem simulation technology using high-fidelity visual simulators. Symptoms are similar to those of motion sickness, but simulator sickness "tends to be less severe, to be of lower incidence, and to originate from elements of visual display and visuo-vestibular interaction atypical of conditions" that induce motion sickness (Kennedy et al., 1993, p. 203).

Kennedy et al. (1993) developed the *Simulator Sickness Questionnaire (SSQ)* to test for individual's susceptibility to simulator sickness in VR.

A *standalone HMD* is a standalone headset that works directly out of the box and does not require the user to purchase or create any extra components (Ghanouni et al., 2018).

TeachLivE is a mixed-reality, virtual learning environment that provides participants the opportunity to learn teaching skills and craft experiences during the learning process, while incorporating components of personalized learning. TeachLivE offers preservice teachers the opportunity to become immersed in an environment in which everything looks like a typical classroom, including props, whiteboards, and simulated students (Dieker et al., 2014).

Technology-enhanced learning refers to the implementation of technological tools that facilitate preservice teacher experiences in real classroom environments through observation or simulated learning environments. Benefits associated with technology enhanced learning include (a) being exposed to various teaching and learning environments, (b) creating shared experiences, (c) promoting reflectivity, (d) preparing students cognitively, and (e) learning about technology integration (Hixon & So, 2009).

Technological, Pedagogical, and Content Knowledge (TPACK) is a framework including knowledge of the interaction of content, pedagogy, and technology. Teachers should be able to teach a specific content with specific techniques and methods and appropriate technologies (Mishra & Koehler, 2006). *Technological knowledge*, part of the

TPACK framework, is knowledge of basic technologies (i.e., books, chalks) and digital technologies (i.e., Internet, hardware, software) to accomplish the targeted task (Mishra & Koehler, 2006). *Technological content knowledge* is knowledge of understanding the technology and content harmoniously and the fact that they influence and constrain each other (Mishra & Koehler, 2006). *Technological pedagogical knowledge* is knowledge of how to use specific technologies in specific ways to change learning and teaching as well as the pedagogical benefits and constraints of technologies (Mishra & Koehler, 2006).

A *360-degree video* is accomplished when 360-degree cameras videos can be captured with an all-around view, enabling multiple angles or viewpoints (Aguayo et al., 2017).

Tracking in the context of this study is defined as using sensing equipment to measure movements and behavior in real time (Lanier, 2001). A *tracked movement* is accomplished when a sensor is placed on a certain body part and is tracked via the HMD, so that when a person lifts their arm, their virtual body lifts their arm (Eden & Bezer, 2011).

Mikropoulos and Natsis (2011) described a *virtual learning environment* as a "virtual environment that is based on a certain pedagogical model, incorporates or implies one or more didactic objectives, provides users with experiences they would otherwise not be able to experience in the physical world and redounds specific learning outcomes" (p. 770).

Virtual presence (or more simply, *presence*) is the psychological perception of being in another environment although physically situated in reality (Slater et al., 1998).

Virtual reality (VR) was defined by Bryson (1996) as using computer-based technologies to replicate the effects of the 3D world by using interactive objects to produce a strong sense of virtual presence.

CHAPTER 2

LITERATURE REVIEW

A key component to realizing IVR's effectiveness to improve the learning environment and promote student learning outcomes is teachers' willingness to accept this technology and integrate it into their practice (Bailenson & Bailey, 2017). The purpose of this chapter is to identify the different types of IVR, provide a comprehensive review of literature on IVR in education, describe teacher technology acceptance, and identify the gap of current research specific to the use of IVR environments with college-aged students as learners and preservice teachers. By highlighting current literature gaps regarding IVR use with preservice teachers, this researcher provides a springboard for subsequent research on factors associated with IVR use by preservice teachers in the classroom and its associated outcomes. The subsequent section discusses the current status of technology in education. Next, the author presents a review of teacher perceptions and acceptance of technology and its usefulness. Then, literature on identifying IVR and its corresponding components is presented, followed by a review of IVR research involving preservice teachers and university-aged learners (18 years or older). The author then presents a review of lesson plan rubrics and a description of the rubric she utilized for this study. The process of qualitative scanning of student digital notebooks is explained next. The author then details the research used in developing the survey and content test. Lastly, the author gives a detailed description of the IVR learning experience she created and the research to support her decisions. To understand the degree to which IVR can affect educational practices, readers need to understand the two types. Correspondingly, this literature review includes identification and description of the two types of IVR, a review of current relevant research, and subsequently areas for future research that can help guide IVR implementation in educational settings.

Current Status of Technology in Education

Globally competitive and engaged citizens require exposing students to learning experiences that will directly contribute to their attainment of 21st-century competencies (e.g., collaboration, communication; Alismail & McGuire, 2015). The U.S. Department of Education Office of Educational Technology (2017) reported that the country had made significant progress over the previous 10 years in leveraging technology to transform learning in a variety of ways. This is evident within P-12 environments by the increase in the use of digital games in the classroom. Digital games can allow students to try out varied responses and roles and gauge the outcomes without fear of negative consequences (Durlak et al., 2011). Furthermore, empirical evidence has suggested that virtual environments and games can promote various outcomes that are noncognitive (e.g., self-awareness, social awareness), behavioral (e.g., behavioral referrals), and cognitive (Spitzer & Aronson, 2015).

For example, to promote student engagement, teacher education and professional programs are changing how preservice teachers are taught by increasingly focusing on building educators’ skill set to effectively implement classroom technology (Graves & Bowers, 2018). Monaghan (1993) and Watson (1997) argued that the way preservice teachers are trained, whether they use technology or not during this learning phase, can influence their positive or negative beliefs about technology throughout their careers. IVR is a rapidly developing technology, and the author sought to add to that research by investigating what effects using IVR during the learning phase had on preservice teachers' beliefs.

Within the context of P-12 education, the National Center for Education Statistics report (Gray et al., 2010) indicated 98% of schools had one or more instructional-related computers in their classrooms, and 58% of schools had accessible laptops, with 91% used for instructional purposes. More recently, a survey of 2,500 teachers and administered by Front Row Education (Sharp, 2016) on technology in the classroom indicated that more than 50% of teachers reported a 1:1 student-to-device ratio. Consequently, the conversation on the influence of technology on learning has shifted from whether technology improves learning to ensuring that all students have access to high-quality educational experiences. The goals developed by the U.S. Department of Education Office of Educational Technology (2017) for school districts reflect this shift as well, by advising districts to improve not only the types of technology they implement but also how they use the technology. Merely providing students access to technology (e.g., laptop, tablet) is not enough, as students must develop the relevant skills needed to effectively use technology to accomplish a designated task (U.S. Department of Education Office of Educational Technology, 2017). Teachers need to utilize technology to improve critical competencies, including the development of critical thinking, complex problem solving, self-confidence, collaboration, and adding multimedia communication into the teaching of traditional academic subjects. IVR is one form of technology already being used to address some of these areas. For example, based on their systematic review, Mesa-Gresa et al. (2018) found moderate evidence about VR-based treatments' effectiveness with children with ASD.

As technology develops into a cornerstone of education, it provides a pathway for access to IVR. Students can utilize their increased access to technology to learn in virtual spaces and create their own virtual content. Dib and Adamo-Villani (2016) conducted a study involving engineering students and noted that unlike the physical steel sculpture, the interactive virtual tool is accessible to students and educators 24/7 in the United States and abroad. The limitations of the real world are nonexistent in the virtual world and remove barriers to learning. For instance, students can use tablet- or laptop-based software such as CoSpaces (https://cospaces.io/edu/) to create virtual worlds, VR experiences, and VR games, as well as to develop their knowledge of coding and other STEM-related skills. This VR instructional driven approach has much potential to transform the way knowledge is transferred to kindergarten through Grade 12 (K-12) students, enabling them to have a greater comprehension of difficult subjects. According to the U.S. Department of Commerce (as cited in Southgate, 2018), these STEM-related subjects have great promise for job creation and are significant because STEM job creation is expected to outpace non-STEM job creation. According to Jang (2015), STEM workers need competencies to use computers and equipment to compile, code, categorize, calculate, and verify information or data; write software; and set up functions.

Students engage with technology in and out of the classroom (Madden et al., 2018). In the current media landscape, youth gain greater access to media technology and demonstrate that they use media at an early age (Bailenson & Bailey, 2017). For example, children under the age of 8 use screen media for an average of 2.5 hours a day, and half of 2- to 4-year-olds have their own tablet or smartphone (Rideout & Robb, 2020). Technology is common practice in most of their lives, and to stay engaging, educators need to look not only at how to increase the amount of technology students use, but also at how they use that technology and how to prepare students for life and the workforce. With IVR, there is potential, but research and evaluation of the technology are required to identify how people should use the technology and which technology will be the most effective. According to Broekhuizen (2016), students are not actively using technologies for learning despite technologically well-equipped classrooms. As teachers control how and when students use technology, it is critical to understand what influences teachers to decide when to use technology and what forms they are willing to incorporate into their practice. This study was designed to discover what factors are essential for preservice teachers when deciding whether to use IVR.

Teacher Acceptance of Technology

Although technology in the classroom is typically deemed to be a positive shift in the betterment of students' postschool skills, simply placing technology in the classroom is not enough (Burke, 2000). As Cuban (2001) argued, access to technology does not translate into the use of that technology by classroom teachers. Therefore, to effectively measure technology integration, evaluators need to focus on how educators implement the technology in the classroom, not merely document available materials (Dockstader, 1999). Given that technology is of growing importance to schools and that sizable portions of operating budgets are focused on technology purchases, administrators must better understand how teachers are using technology to support instruction and enhance student learning (U.S. Department of Education, 1999). IVR can enhance immersion, improve spatial capabilities, promote empathy, increase motivation, and possibly improve learning outcomes. However, the extent to which teachers capitalize on these potentials in the future depends on their perceptions of IVR and their behavioral intentions to use it (Bower et al., 2020).

As technology develops and becomes more accessible, there is a corresponding increase in demand to incorporate it into classroom practices (Alismail & McGuire, 2015). The adoption of the Common Core State Standards serves to promote students' acquisition of skills (e.g., critical thinking, problem-solving) necessary to acquire the multidimensional abilities required in the 21st century (Alismail & McGuire, 2015). These skills are essential for students entering college or the workforce because people in any industry need to be familiar with diverse technologies and be willing to learn them. According to the Simmons Consumer Study (Experian Marketing Services, 2014), millennials spend, on average, 35 hours per week on digital media, yet 58% have low skills in solving problems with technology. An international comparison of millennials' performance on the Programme for International Assessment of Adult Competencies technology test ranked the United States last out of 19 participating countries (Educational Testing Service, 2015). Educational institutions must incorporate technology into how students learn to tackle problems to ensure their success at the next level. Even when other characteristics that affect earnings are held constant, the benefits of possessing the required technical skills are critical. On average, a person at the highest technical skill level earns almost 40% more than someone at the lowest level, even if both are of the same gender, race, and education level and have roughly the same literacy and numeracy skills (Goodman et al., 2015). These results reinforce that using technology to address challenges is a defining characteristic of work in the 21st century.

Students must be exposed to and develop the technical skills that will prepare them to enter a technologically driven workforce within education. Ultimately, exposure to and engagement with technology within the classroom begins with teachers and requires teachers to include more technology in their instruction (Alismail & McGuire, 2015). The teacher must increase the amount of time students have with technology in their hands rather than merely watching the teacher use technology. Education’s aim to develop digitally literate citizens who can cope with the complexities and dynamics in societies necessitates the meaningful inclusion of technology in teaching and learning contexts (Organisation for Economic Co-operation and Development, 2015; Siddiq, Hatlevik, et al., 2016; Siddiq, Scherer, & Tondeur, 2016). To promote digital literate citizens, teachers must expose students to a curriculum that will tie their learning to the real world to prepare them for college and career readiness (Lombardi, 2007). In particular, digital literate citizens possess the cognitive skills to obtain a more in-depth understanding to solve complex problems in the real world (Alismail & McGuire, 2015).

Technology is an integral component of how teachers deliver instruction and students engage in learning. A majority of states participated in preparing common standards in 2010 to provide students with the academic knowledge and skills needed in the future (Alismail & McGuire, 2015). The Common Core State Standards and integrated 21st-century education framework was prepared by the Partnership for 21st Century Skills (as cited in Alismail & McGuire, 2015). The Partnership for 21st Century Skills advocated integrating core academic knowledge, critical thinking, and social skills in teaching and learning to help students master the multidimensional abilities required in the 21st-century (Alismail & McGuire, 2015).

Multiple factors are associated with teachers' adoption of technology, and one model used to determine teacher acceptance of technology is TPACK. Developed by Koehler and Mishra (2008), the TPACK framework consists of seven domains that reflect teacher knowledge: content knowledge, pedagogical knowledge, technological knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and TPACK. Koehler and Mishra explained each knowledge domain, as shown in Table 1.

Table 1

Elements of Technological Pedagogical Content Knowledge (TPACK)

Knowledge	Explanation
Content knowledge	Knowledge about actual subject matter that is to be learned or taught. Understanding the fundamentals of disciplines.
Pedagogical knowledge	Knowledge about processes and methods of teaching and learning. Knowledge about student learning, classroom management, techniques used in classroom, strategies for assessing the understanding of students.
Technological knowledge	Knowledge of information and emerging technologies to accomplish the targeted task.
Pedagogical content knowledge	Knowledge of understanding subject matter and finding different ways, methods, and techniques and adapting and tailoring the materials to help students better understand the subject matter.
Technological content knowledge	Knowledge of understanding the technology and content harmoniously and the fact that they influence and constrain each other.
Technological pedagogical knowledge	Knowledge of how to use specific technologies in specific ways to change learning and teaching. Knowing the pedagogical benefits and constrains of technologies.
Technological, pedagogical, and content knowledge	Knowledge of interaction content, pedagogy, and technology. Being able to teach a specific content with specific techniques and methods and appropriate technologies.

The central role of technology in learning and teaching practices has been explored in various studies (e.g., Hughes, 2004; Koc, 2011; Kopcha, 2010; Zhao & Frank, 2003). However, there was no unified consistency among these studies in naming or representing the role of technology in learning and teaching until Mishra and Koehler (2006) initially put forward the TPACK framework, which explicitly represented technology as a knowledge domain for teachers that interrelates with content and pedagogy. For these reasons, select TPACK components were chosen for this study and included on the rubric.

Researchers have developed many theories and models to explain and predict whether people will use information system technologies (Teo & Noyes, 2014). Early work included the development of the theory of reasoned action (Fishbein & Ajzen, 1975); its successor, the theory of planned behavior (Ajzen, 1991); and its extension and the decomposed theory of planned behavior (Taylor & Todd, 1995). Out of this early work has come a model that arguably represents recent thinking in technology use (Teo & Noyes, 2014): the unified theory of acceptance and use of technology (UTAUT; Venkatesh et al., 2003). In this study, the second-generation UTAUT model (UTAUT2; Venkatesh et al., 2012) was used to quantitatively gauge preservice teacher perceptions of IVR along each dimension. Data have shown that each of the model's dimensions is relevant to teachers' IVR use (Bower et al., 2020). For instance, performance expectancy—or belief that IVR will assist in the future performance of teachers—has been validated in research demonstrating improved student problem-solving performance and analogical thinking in geometry (Hwang & Hu, 2013; Passig, 2015) and enhanced creative problem solving (Wang et al., 2018). The author used UTAUT2 (Venkatesh et al., 2012) to address Research Question 3, as one of the most established and robust frameworks for investigating technology perceptions. The broad conceptualization of behavioral intention to use technology provided by the UTAUT2 model, including its robust theoretical and methodological underpinnings, has led to its application in educational contexts (Bower et al., 2020). The author details the survey used with Research Question 3 in the methodology section.

IVR Technology

IVR encompasses a broad range of devices to immerse a user in a virtual environment. The shared feature is that the user wears a headset or HMD to engage with the virtual environment, despite variability in available devices. Thus, once the user (e.g., student) puts on the HMD, their entire "real" world is visually blocked out by the device. The user can look 360 degrees around them and only see the virtual environment; via tracked movement, the user can interact with the virtual environment. *Immersive* is a word experts use throughout the VR industry, but it has multiple meanings. PlayStation VR (2020) uses this idea to immerse a player in the video game. Second Life is a computer-based program that allows its users to create virtual avatars. The user can use this avatar to live in a virtual world, have interactions with other avatars, and complete daily activities, all through a computer screen. While some consider this to be immersive, others say the user is simply represented in the world and not immersed (Bailenson, 2018).

A different form of VR is the cave automatic virtual environment. A cave automatic virtual environment is a specially designed room where the walls, ceiling, and floor are covered with a screen that projects virtual images. The virtual environment surrounds the user; however, the user cannot change how their body is represented in the virtual space (Cruz-Neira et al., 1992). Linowes (2015) defined a *complete virtual experience* as when the user wears an HMD that completely blocks out all aspects of the physical world. The user cannot see any part of their world, including their own body. The only way the user can interact with the virtual environment is through a virtual representation of their specific body part (hand) or tracked movements. A tracked movement is accomplished when a sensor is placed on a certain body part and is tracked via the HMD, so that when a person lifts their arm, their virtual body lifts their arm.

The author uses the definition of IVR provided by Eden and Bezer (2011) as the "ability to immerse the user in a virtual world with the use of head-mounted display (HMD) and interactive controllers, aimed at capturing the user's input in real-time" (p. 339). The author employs this definition because it contains the components of the HMD, the interactivity, and the creation of a complete virtual experience for the user. The HMD, the ability to interact with the virtual environment, and creating a complete virtual experience are critical components of interest. In their meta-analysis on the effectiveness of IVR using HMDs on learning performance, Wu et al. (2020) reported that IVR using HMDs is more effective than nonimmersive learning approaches. Wu et al. continued that the key findings of the moderator analysis were that HMDs have a greater impact (a) on K-12 learners, (b) in the fields of science education and specific abilities development, (c) when offering simulation or virtual world representations, and (d) when compared with lectures or real-world practices. The meta-analysis also suggested that HMDs can improve knowledge and skill development and maintain the learning effect over time (Wu et al., 2020). The author chose the HMD and interactivity as mandatory components for the literature review and the planned study based on this research. There are currently two forms of IVR, as defined above, readily used in classroom settings, standalone and desktop. This section details and describes each of these IVR types to show their potential for promoting student engagement and learning in classroom settings.

Standalone VR

The first type of IVR is standalone VR, representing a standalone headset that works directly out of the box and does not require the user to purchase or create any extra components. An example is the ClassVR standalone headset (Avantis Systems, 2021). A user interacts with a virtual environment using a standalone HMD and tracked movement via hand controls. In this way, the user can pick up objects, throw footballs, and play musical instruments, among many other hand-based movements.

Depending on the brand (e.g., Oculus, HTC VIVE), standalone devices have either one or two controllers that allow the user to interact with the virtual environment, taking the user from a passive observer to an active participant. Multiplayer experiences and controlled movements throughout the virtual space are possible with the standalone unit. A classroom could have up to 30 students on standalone units yet occupy a shared virtual classroom. As such, a user can be in a completely different location on their headset and join the virtual lesson, providing opportunities for students who have disabilities, are confined to hospital care, or cannot physically attend school to participate in their education without missing instructional time.

The increased processing power and interaction make the standalone unit a more expensive option. Oculus (2021) as of January 2021 offers three standalone options: Go, Quest, or Quest 2. An individual unit of the Go sells for $199, and the Quest2 starts at $299. However, if more than one unit is required (a class set of 30, for example), then an enterprise license is required. The license for the Quest raises the price of each headset to $999. HTC (2021) VIVE also has two options for a standalone unit, and according to their website, the Focus is $599, and the Focus Plus is $799.

Desktop VR

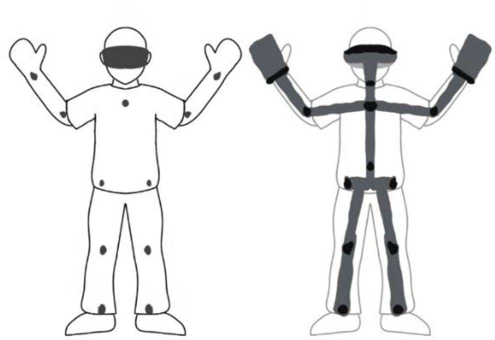
Desktop VR is the second type considered immersive and requires a computer to run the software required for the HDM, which is wired directly into the computer. Desktop IVR requires a powerful PC and a large open room dedicated to VR. The HMD has built-in headphones and an improved picture with more pixels. The system is set up using motion-tracking base-station sensors that have a wider field of vision and create up to a 20-by-20-foot VR space. Desktop VR units have two controllers, and since an external PC is required, the price significantly increases (e.g., $1,599 for an HTC VIVE Pro Eye). Units cost between $600 and $1,500, with the average PC required to run the HMD costing around $1,000. The desktop VR also requires the user to have a higher level of technical knowledge beyond what the typical teacher might possess.

Tracked Movements

Tracked movements are unique to the standalone and desktop units. This technology is so new to the standalone unit that it has continued to develop and become more dynamic during the process of writing this dissertation. Figure 1 illustrates how the system accomplishes the tracked movement. According to the Virtual Reality Society (2018), an object can move in a 3D space with six types of motion, referred to as the six degrees of freedom. Any tracking systems that intend to provide a complete motion tracking experience must measure movement along all these degrees (Virtual Reality Society, 2018).

Figure 1

Motion Tracking Using Sensors Placed at Different Points of the Body



There are two broad categories of how a device tracks movement: optical and nonoptical tracking. Optical tracking is where an imaging device is used to track body motion. Nonoptical tracking uses various sensors that are often attached to the body for motion tracking but can also involve magnetic fields or sound waves (Virtual Reality Society, 2018). The dots in Figure 1 show micro-electromechanical sensors such as accelerometers, gyroscopes, and magnetometers. According to the Virtual Reality Society (2018), these microscopic devices can measure the lateral, rotational, and compass orientations of whatever they are attached to, such as different body parts. The gyroscopes measure 360-degree rotation; accelerometers measure movement along the x, y, and z axes; and magnetometers can determine a magnetic field orientation. This means the sensors can tell which way magnetic North is, for example.

In September 2019, Facebook (owners of the VR standalone headsets Quest and Go) announced hand tracking. Debuting on the Quest in 2020, this update to the headset allows users to interact with the virtual environment sans controllers. When the user's hands enter the cameras' field of view, they are displayed on screen using 3D rendering.

Software maps out the hands and approximates where the joints and knuckles are located, which helps to mimic finger motion (Nguyen, 2019). According to the Oculus (2019) blog:

> True hand-based input for VR will unlock new mechanics for VR developers and creators alike. Hand tracking on Quest will allow people to be more expressive in VR and connect on a deeper level in social experiences. Not only will the current community of VR enthusiasts and early adopters benefit from more natural forms of interaction, but hand tracking on Quest will also reduce the barriers of entry to VR for people who may not be familiar or comfortable with gaming controllers. Even better, your hands are always with you and always on—you don't have to grab a controller, keep it charged, or pair it with the headset to jump into VR. From entertainment use cases to education and enterprise, the possibilities are massive. (para. 1)

Hand-tracking capability will allow a broader range of users to effectively participate in lessons with an IVR component. Students with fine or gross motor limitations will not have to struggle with squeezing or lifting the controller's extra weight and pushing buttons or squeezing triggers. There are fewer components requiring batteries, upkeep, or additional technical knowledge from the teacher or user.

Also, hand tracking is making communication in IVR more accessible for deaf users. Daniel Beauchamp, head of VR at Shopify, has created an experimental piece of software using the Normcore networking software development kit. The author of this dissertation participated in the beta testing of the app. Across multiple sessions, the author worked with Beauchamp, Ian Hamilton (head writer at UploadVR.com), and two other users to explore his app's functionality for use with sign language users. One of the two users the author worked with was hearing with extensive American Sign Language knowledge, and the other user (Christopher Roe) identified as a Deaf individual fluent in American Sign Language. Tests revealed some severe limitations to the current technology. Hands in front of one another can block the view of the cameras on the headset used to track the hands, resulting in tracking loss or misrepresentation. Ambient lighting can affect the tracking quality, and fingers cannot cross one another. Some fundamental handshapes used to represent letters like P, Q, K, M, N, and E were hard to sign or distinguish (Hamilton, 2020). After the test, Mr. Roe commented,

> Even as rough as it was, it's awesome. Sure, you could have some kind of group video chat or FaceTime dealie instead, but what VR brings is a sense of actual proximity and presence. That's something I remember missing a lot in my youth, because I went to a residential school for the deaf in Riverside, CA. A fully functioning VR sign language chat system would make the world much smaller and far more comfortable for a lot of deaf people who grew up under similar circumstances. They'd get the feeling of being WITH people, not just signing at a Brady Bunch grid of choppy webcam streams on a tiny screen. Throw in customizable environments and stuff like that, and you've got a virtual party venue where deaf people can actually communicate as first citizens rather than struggling with awkward text inputs or being completely left out of spoken conversations because nobody else wants to mess with crappy virtual keyboards either. (as quoted in Hamilton, 2020, para. 9)

The continuously developing VR technology components demonstrate a belief by developers in the technology and the potential for success in multiple areas in the future.

Eye tracking is another desktop VR capability that has enormous research potential and can be used to answer further questions about human cognition and behavior (Clay et al., 2019). Due to the development of small, high-quality cameras for devices like smartphones, light and convenient eye-tracking systems can fit into a VR headset or portable glasses. These allow for fast and accurate monitoring of eye movements, delivering a considerable amount of data. Eye tracking has received increased attention in various experimental designs due to the close relationship between eye movements and cognition (Deubel & Schneider, 1996; Hoffman & Subramaniam, 1995). With the technological advances and the increasing amount of research, eye tracking has advanced to a technology that can be fruitfully used in a wide variety of setups to investigate human cognitive processes (Clay et al., 2019). Researchers have the ability to track not only where a participant is looking, but also for how long and how that relates to recall of information.

According to Tobii Pro (n.d.), users can leverage both technologies' benefits when working with eye tracking in VR. VR allows creation of any simulated environment, where visual stimuli and scenarios can be quickly switched or easily repeated. At the same time, eye tracking gives insights into where the participant's visual attention is at each moment of the experience and what visual elements trigger individual responses and behaviors. Researchers are utilizing this technology in various ways to study behavioral aspects of individuals with ASD and discover more effective ways to diagnose ASD.

Hosozawa et al. (2012) examined 25 young children (average age of 3) with ASD, 25 age-matched children with typical development (also known as neurotypical), 27 adults with ASD, and 27 neurotypical adults. The individuals viewed the same brief video clips taken from films and TV programs for young children. Hosozawa et al. based their hypothesis on observations in past research that adults with ASD look more at a person's mouth than the eyes. However, these observations were inconsistent when studying children with ASD (Nakano et al., 2010). After analyzing their data, Hosozawa et al. concluded that the theory appeared to hold for adults. The neurotypical group spent more time looking at the eyes than the participants with ASD. However, results pointed to the opposite conclusion in the child group, with neurotypical children looking more at the mouth than the children with ASD. Hosozawa et al. discovered a pattern in their data that showed the neurotypical control groups share similar gaze patterns, whereas those with ASD show atypical gaze behaviors that differ from one subject to another. The participants' behavior with ASD differed significantly and showed no pattern, consistent with what researchers already know about ASD and why researchers deem it a spectrum disorder (Baron-Cohen, 2000).

In this section, the two types of IVR were described, including price points for each type and eye-tracking technology description. All IVR forms have unique aspects; however, the potential benefits to classroom practices require further research.

IVR Use With Preservice Teachers

TeachLivE

Research involving IVR use with preservice teachers varies depending on the type of IVR the participants use and the desired outcome of using the technology. The University of Central Florida has been conducting significant work in VR. According to the University of Central Florida CREST (n.d.), TeachLivE is an innovative approach that allows people to practice their human-to-human interaction skills, including those associated with teaching. According to the University of Central Florida CREST website,

> TeachLivE is a mixed-reality classroom with simulated students that provides teachers the opportunity to develop their pedagogical practice in a safe environment that doesn't place real students at risk. The use of TLE TeachLivE Lab has also been instrumental in developing transition skills for students with significant disabilities, providing immediate feedback through bug-in-ear technology to preservice teachers, developing discrete trial skills in preservice and in-service teachers, and preparing teachers in the use of STEM-related instructional strategies. (para. 1)

Even though the TeachLivE system is not a fully IVR system as defined for this dissertation, the work being done using this technology has laid the foundation of research for the use of VR with preservice teachers. The University of Central Florida CREST (2020) website described the system as follows:

> In the TLE TeachLivE Lab, pre-service and in-service teachers walk into a room where everything looks like a middle- or high-school classroom, including props, whiteboards, and of course, children. However, unlike the brick-and-mortar setting, the lab is a virtual setting, and the students in the classroom are avatars. The virtual students may act like typically developing or not-typically developing students, depending on the objectives of the experience. Participants can interact with students and review previous work, present new content to students and provide scaffolding or guided practice in a variety of content areas, and monitor students while they work independently. In this environment, prospective teachers can learn the instruction and management skills needed to become effective teachers, and practicing teachers can hone and refine their skills. (para. 3)

The researchers at CREST conducted various studies over 3 years in coordination with the Bill and Melinda Gates Foundation. After those 3 years, they reported different outcomes utilizing the TeachLivE system. The outcomes and some key findings are reported in Table 2.

Table 2

Three Years of Research of the University of Central Florida With TeachLivE

Outcome	Year 1	Year 2	Year 3
Develop a plan to incorporate college-ready work instructional strategies and effective teaching practices into TLE TeachLivE research cadres.	Created a study framed in middle school mathematics with the TLE avatars. Collaborated with partnership universities to increase the number of TLE users, while contributing to the research	Expanded to focus on high school biology using the new TLE avatars. The team created a classroom of five high school avatars using a new coding structure and in a new format that allowed for more flexibility. The team replicated Year 1 findings with positive changes in teacher practice and in student learning using concept maps.	Based on positive changes in teacher practices in Years 1 and 2, the team conducted exploratory studies in (a) teacher preparation, (b) student learning, and (c) preparation of other education professionals (e.g., administrators, counselors). Commercialized the work across varying industries.
Develop and manage TeachLivE research with a focus on increasing teacher effectiveness and student learning.	Many university partners could not provide the teachers needed, so the team relied on partnership with Central Florida school districts.	Locations struggled with a true partnership with local districts	Studies were small and relied on targeted partnerships. Unforeseen challenges emerged due to the commercialization of the product through Mursion.
Establish TeachLivE as a self-sustaining collaborative or business model and expand from 10 to 30 partners.	This outcome was met in the first 12 months of grant funding.	Over 80 partners within 24 months. Developed work using the simulator to help teachers understand how nonverbal communication related to their body poses can influence their teaching effectiveness. Interest in exploring the nonverbal communication, brain waves, and neurophysiological state of a teacher's body in the simulator and in the classroom.	Mursion took over as the licensing agent and commercialization partner of TLE. Researcher work was more experimental, whereas Mursion was providing clients standardized services. Researchers explored ways to increase automation and use more advanced technologies (e.g., VIVE, Hololens, Oculus, automated feedback, and more immersive environments).

Note. Information from *History: A Brief History of TeachLivE*, by University of Central Florida Center for Research in Education Simulation Technology, n.d., https://sites.google.com/view/teachlive/history

Researchers at CREST partnered with the company Mursion (n.d.-b) to expand how many people used the TeachLivE system. According to Mursion (n.d.-b), the program works as follows:

> Powered by a blend of artificial intelligence and live human interaction, Mursion provides immersive VR training for essential workplace skills. By using trained professionals who orchestrate the interactions between learners and avatar-based characters, Mursion simulations achieve the realism needed to deliver measurable, high-impact results. (para. 1)

Mursion (n.d.-a) has utilized the TeachLivE system to work with preservice and current practicing teachers to improve their instructional practices, behavior management, and improve learner outcomes. The participant conducts the lesson with a varying range of student avatars. A blend of real humans and artificial intelligence (computer simulation of intelligent behavior) controls the avatars. The artificial intelligence combined with trained human actors creates interactive avatars that react in ways that a student might, allowing the teacher participant to react and practice in life-like scenarios. Even though Mursion has defined the program as an IVR experience, it does not fit the definition of immersive stated for this study. The participants do not don an HMD; instead, they look at a screen. The participant wears a camera used to track facial features and movements along with a microphone.

Mursion (n.d.-a) stated on the website, "More than 80 higher learning institutions have implemented Mursion simulations into their programs to prepare teacher candidates and provide professional development for in-service teachers. They isolate skills—such as behavior, pedagogy, or building rapport with students—for mastery" (para. 3). One specific use case referenced is Aurora Public Schools. According to Mursion (n.d.-a),

> Four customized scenarios have been developed, and over 40 simulations have been delivered. At least 31 teachers have engaged in the cycle at more than 10 schools over the course of the study. The principal turnover rate for 2017-18 was 31%, and in 2018-19, the turnover rate dropped to 20%, the first year APS [Aurora Public School] implemented Mursion. Many of the initial goals of the project were achieved: creating motivated engagement, seeing a new openness in their participants to challenge themselves and self-reflect deeply, as well as generating excitement for the product and the program. (para. 6)

The Mursion and TeachLivE system creates a starting point for how educational institutions can apply IVR to preservice teacher training. The interactive scenarios and avatars allow participants to craft their instructional practice in a safe environment where an instructor can provide instant feedback. Providing this technology on an HMD is worthy of continued research to discover its effect on teacher performance.

Systematic Literature Review

Billingsley et al. (2019) conducted a systematic literature review focused on using IVR technology in teacher education. Their systematic review of literature examined eight studies where IVR was utilized to increase learning opportunities during courses that prepared preservice teachers or in-service teachers taking advanced coursework in education (Billingsley et al., 2019). Preservice teachers gain practical teaching experience through various methods, and technology provides opportunities at different levels. Related to field experiences, Hixon and So (2009) conceptualized a division of technology-enhanced educational experiences into three categories of concreteness, arranged in a graduated sequence from reality to virtuality, Type I through Type III. Type I field experiences include concrete, direct experiences in reality typical of traditional approaches where teacher education students are placed in or virtually visit real classrooms. Technology is then used to facilitate supervision, reflection, or communication (Billingsley et al., 2019). In Type II experiences, teacher education students remotely observe teachers and students through video conferencing or audio-cuing technology. Type III field experiences are entirely virtual (e.g., technology-based for all aspects of the experience). Such experiences include VR and computer-enhanced simulations.

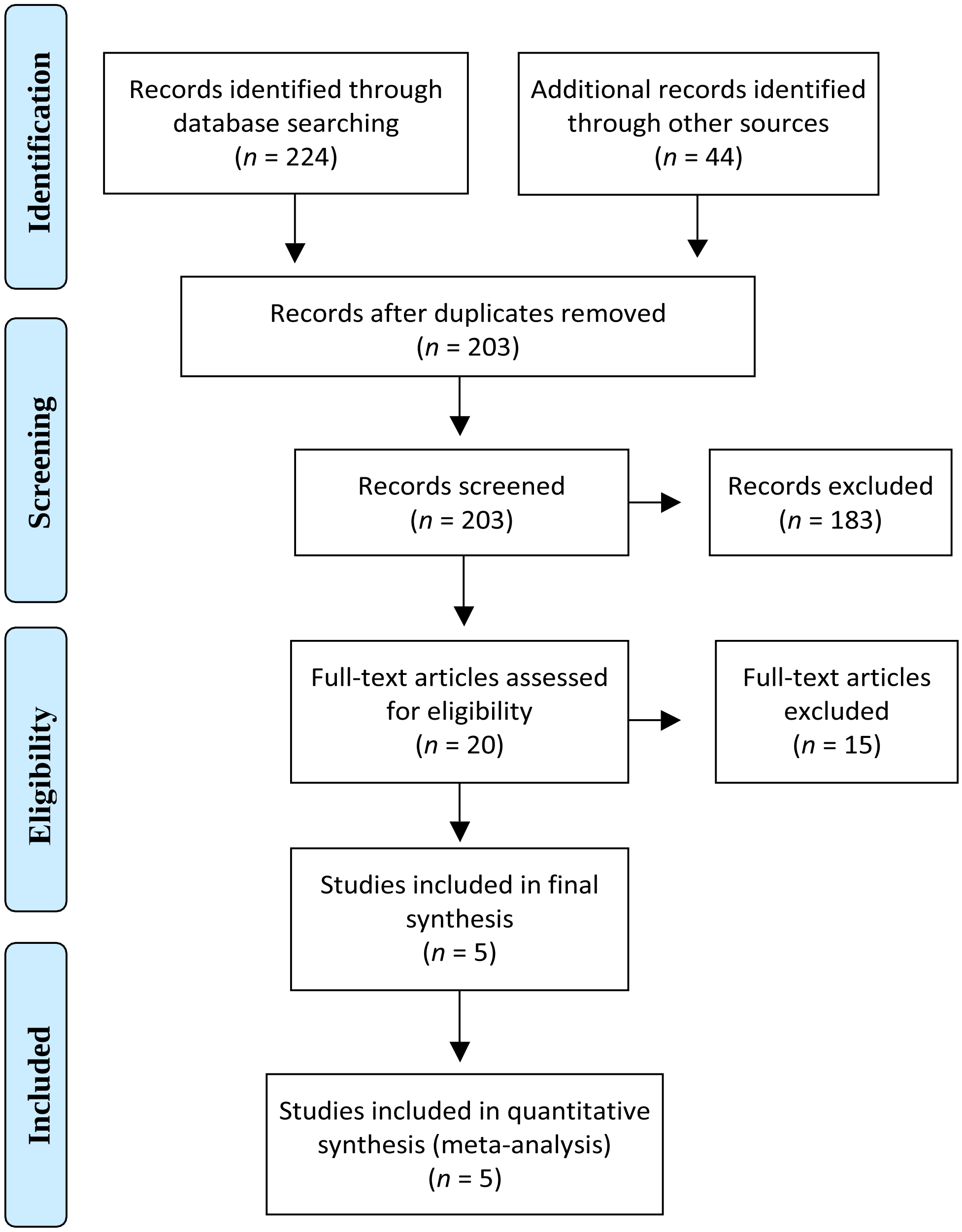
A significant research base exists for the first two categories of technology-enhanced field experiences; however, research on the third type's virtual and simulated environments is limited (Billingsley et al., 2019). For their review, Billingsley et al. (2019) focused on the use of Type III experiences, specifically IVR. They applied Riva and Mantovani's (2012) definition that IVR is achieved using a computer capable of generating interactive 3D visualization, an HMD, and trackers that sense the position and orientation of the user. Billingsley et al. added that conceptually, IVR is "an advanced form of human–computer interface that allows the user to 'interact' with and become 'immersed' in a computer-generated environment in a naturalistic fashion" (Schultheis et al., 2002, p. 379). To solicit studies for a systematic literature review of IVR research with preservice teachers, the author chose to modify the method used by Billingsley et al. to include newer research and slight modifications to selection criteria. The inclusion and exclusion criteria, along with justifications for any changes, are included in Appendix A.

Similar to Billingsley et al. (2019), a systematic, thorough review of multiple sources was used to conduct this comprehensive literature review. The author searched six electronic databases: Education Source, Educational Resources Information Clearinghouse (ERIC), Psychology and Behavioral Sciences Collection, Psych INFO, Journals, and Dissertations & Theses. The search did not include ProQuest because the index sources are far too broad and therefore generate too many false hits (H. Cooper et al., 2019). Limiters narrowed the search for peer-reviewed academic journals, periodicals, or articles, as well as a Boolean limiter of NOT "Second Life." The author entered the following terms into the keyword fields in pairs utilizing Boolean operators and truncation: "virtual reality" paired with "teacher education," "teacher training, " “preservice teachers, ” “teacher preparation, ” and “educator preparation" (e.g., “virtual reality*” AND “educat* prepar*”). These search parameters produced 224 articles. Next, in the same process as Billingsley et al., an internet search of Google Scholar was conducted using the same terms and limiters as those described above, resulting in an additional 44 articles. The author omitted duplicates resulting from the use of multiple databases. A resulting pool of 203 article titles and abstracts seemingly matched inclusion criteria.

The author met virtually with a university librarian to refine the search. Additionally, the author conducted expanded searches via a specific online database, Research Gate, and directly contacted experts in the field of IVR and education (Jeremy Bailenson, David Passig, and Dilek Erbas) to ensure thorough data gathering. The author screened the titles and abstracts of the 203 articles for inclusion and then screened the resulting 20 full-text articles. After removing the seven original articles noted by Billingsley et al. (2019), five articles met the inclusion criteria. Per the guidelines set by Billingsley et al., the journals that published these five articles were referenced to determine if they were indexed in the electronic databases listed above. All were indexed in the searched databases, so none of the journals necessitated a hand search. Finally, the author conducted an internet or manual search of the three most recent journals that published these five articles. This search yielded no additional articles. Figure 2 illustrates the full search and screening process using a flow diagram (see Moher et al., 2009).

Figure 2

Flow Diagram Showing Selection of Articles



The five articles that met the stringent criteria for investigating ways in which IVR is used with preservice teachers were summarized according to the following variables: (a) participant description, (b) description of the intervention and purpose of the study, (c) study methodology, (d) dependent variable, and (e) outcomes of the study (see Billingsley et al., 2019). A descriptive summary of the included studies is in Appendix B.

Participant Descriptions

Two of the five articles described studies conducted in Australia, one study was conducted in the Netherlands, and one study was conducted in the United States. A total of 359 participants were included in these studies: all 359 participants were undergraduate students; 78 (22%) were primary education majors; 25 (6%) were secondary education majors; 54 (15%) were science education majors; and 41 (11%) were undergraduate students, but the researchers did not explicitly state their majors. The 141 participants from the Theelen et al. (2020) study were from eight different domains (history, geography, economy, Dutch, German or English language, mathematics, and physics).

One study (Lamb & Etopio, 2020) included an average age for participants, which was 25.8 years of age. Bower et al. (2020) noted that participants had completed an average of 45 practicum days, and Theelen et al. (2020) reported 27 had little teaching experience, and 87 had no teaching experience. G. Cooper et al. (2019) and C. Lee and Shea (2020) broke down participants' year of school (see Appendix B).

Purpose and Study Description

The studies included in this review employed IVR technologies to extend knowledge and create learning experiences for preservice teachers enrolled in education courses, focused on improving teaching skills, intent to use IVR in future teaching practice, and perceptions of IVR as a learning tool. The purposes for which IVR was used to provide learning experiences to teachers varied. Four of the studies (80%) included investigations that measured preservice teachers' intention to use IVR in their future teaching. One study (20%) intended to advance learners' knowledge of special education topics. One study (20%) used IVR to increase content-area learning (science) and investigate, compare, and characterize interactive IVR-based clinical teaching environments with those of real-life teaching environments. One study (20%) focused on using IVR classrooms and their effect on preservice teachers' interpersonal knowledge structure.

Study Methods

Of the five studies that met search criteria, only one (Lamb & Etopio, 2020) used a control group. C. Lee and Shea (2020) used an experimental study design that included a pre- and posttest. Bower et al. (2020) used mixed methods with a volunteer sample who used IVR creation tools to measure predicted future use of IVR. Theelen et al. (2020) used a mixed-methods design to examine one pre- and posttest questionnaire regarding 360-degree video experiences. G. Cooper et al. (2019) utilized a case study approach to measure preservice teachers' perceptions of IVR use as a teaching and learning tool. Two of the studies (40%) utilized preservice science teachers as their participants (Lamb & Etopio, 2020; C. Lee & Shea, 2020).

Dependent Variables

Studies included in this review assessed various factors, including physical reactions and qualitative and quantitative measures. Bower et al. (2020) assessed intention to use IVR in future teaching, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, and behavioral intention. G. Cooper et al. (2019) assessed preservice teachers' use of IVR, self-efficacy to use it in their pedagogy, perceptions of IVR as a learning and teaching tool, and concerns about IVR. Lamb and Etopio (2020) assessed various physical reactions, including measures of cognitive dynamics, autonomic nervous system measures, measures of heart rate variability, and eye tracking. They also utilized a paper measure—the Student Teacher Assessment Record (see University at Buffalo, 2021)—to determine if both psychological and sensory immersion levels as measured through psychophysiological data and retrospective survey differed between IVR and field experiences in student teaching. C. Lee and Shea (2020) assessed quantitative measures of self-knowledge and self-efficacy as well as classroom feasibility. The qualitative measures assessed were factors that preservice teachers perceived as necessary when using IVR apps, changes in knowledge and self-efficacy of preservice teachers, and preservice teachers' attitudes toward using IVR and computer-based technology in the classroom. Theelen et al. (2020) assessed the effect of the virtual classroom on preservice teachers' theory-based interpersonal knowledge structures and interpersonal knowledge development and how preservice teachers applied their theory-based interpersonal knowledge after the virtual classroom.

Study Outcomes

All of the studies included in this review found that using fully IVR technologies increased knowledge or understanding, increased the skill level or performance of a particular technique or strategy, or positively influenced educators' attitudes. Bower et al. (2020) reported that regarding effort expectancy, some teachers identified that IVR was relatively easy to use, the previous experience was an advantage, and reliability of technology increased effort. Social influence from peers and the general education population was positive, and therefore the influence to use IVR was positive. However, a supervisor's negative opinion was a negative influence against IVR use. The facilitating conditions required to create an environment of unilateral IVR use was significantly dependent on the school, with preservice teachers noting private schools could use IVR but schools with limited resources could not (Bower et al., 2020). Some participants viewed the hardware as particularly problematic, wondering, for example, how to get 35 headsets into a classroom (Bower et al., 2020).

When discussing the results related to hedonic motivation, Bower et al. (2020) reported that preservice teachers rated hedonic motivation, or enjoyment of using IVR, higher than any other factor. They readily expressed that using IVR was stimulating, with numerous comments such as, "it's very exciting … it's so new and it's so visual and like you experiencing it yourself" (Bower et al., 2020, p. 2225). The participants' view on price value varied widely depending on the specific form used. Generally, preservice teachers did not feel that IVR was a habit because they did not integrate it into their lifestyle. The results that assessed behavioral intention were mixed, with some excited to use IVR and some thinking traditional instruction would be more effective. Bower et al. reported that some preservice teachers' intention to use VR was rooted in their view of it as a future trend, as "within the next couple of years, it would be something that every school has" (p. 2226). However, other participants saw IVR as just another approach, qualifying it as a valuable tool better than a textbook.

The results emerging from the Bower et al. (2020) study of IVR were quite different from other studies relating to technology acceptance and use. For instance, Bower et al. reported hedonic motivation (enjoyment) as rated highest of any factor in their IVR study (average rating across items between *agree* and *strongly agree*), but enjoyment was rated only fourth in the study of Google Classrooms (Jakkaew & Hemrungrote, 2017), fourth in the study of PowerPoint (Chávez Herting et al., 2020), and sixth in the study of mobile learning (Nikolopoulou et al., 2020). It is important to note that these findings are related to one set of preservice teachers in one university and country (Bower et al., 2020). As different results could be found for preservice teachers from a different background or setting, more research into preservice teachers' beliefs and intention to use IVR in their instructional practice is required. The author sought to address that research gap with this current study.

G. Cooper et al. (2019) utilized a case study approach to examine preservice teacher perceptions about IVR, including their beliefs about its capacity to be used as a teaching and learning tool. G. Cooper et al. (2019) noted that 36% (n = 12) of participants reported use of IVR, whereas 64% (n = 21) had never used IVR. Of the 12 who reported previous use of IVR, 11 used mobile, and only 1 had used desktop IVR. A key finding was that mobile VR does not meet the definition of IVR as defined by Eden and Bezer (2011). G. Cooper et al. (2019) employed Sherman and Craig's (2002) idea that VR can be broadly defined as an experience in which agents interact within a 3D world with movement of their body, experiencing images and sounds. Mobile VR utilizes a cell phone as the main computing device and is limited in its capabilities to create an interactive environment. When using mobile VR, there is no interaction with the virtual environment, and the user is a passive observer.

G. Cooper et al. (2019) investigated preservice teachers' self-efficacy to use VR in their pedagogy. There was a significant difference between preservice teachers' average amount of self-efficacy to teach using VR compared to other digital technologies. This could be directly related to the fact that preservice teachers' confidence to teach using digital technologies was, on average, higher when compared to their confidence to teach using VR (G. Cooper et al., 2019). Given limited use and research surrounding VR in education, more research is required to determine whether exposure and confidence in using the technology will result in higher adaption throughout education. Particularly because G. Cooper et al. (2019) discovered that VR perceptions as a learning and teaching tool were extremely positive, they noted that 32 out of 33 participants said they would use VR, with the major reason being that they felt it would be engaging. G. Cooper et al. (2019) assessed preservice teachers' concerns about VR and reported that 12 participants expressed concerns about their self-efficacy, as typified in the following response: "My fear would be that I am inexperienced in using virtual reality, and I think it would be hard to manage/control in a classroom" (p. 7). This statement supports the need for more research into when and how to effectively train preservice teachers in using VR in their instruction, something the current study was designed to address.

The purpose of Lamb and Etopio's (2020) study was to investigate, compare, and characterize interactive VR-based preservice science teacher clinical teaching environments with those of real-life teaching environments. Lamb and Etopio's study was built upon the work first developed by the University of Central Florida and the TeachLivE system by investigating the use of VR to practice teaching. Lamb and Etopio stated that providing consistent, high-quality clinical preparation for novice teachers remains a challenge for the education profession. Clinical experiences expose teacher candidates to the classroom's complexity and unpredictability, where they will practice (Hollins & Guzman, 2005). However, the quality of clinical experiences varies widely due to factors such as school demographics, organization of experiences, and differences in mentoring strategies and pedagogical approaches.

Lamb and Etopio (2020) focused explicitly on preservice science teachers. Beyond understanding science content and effective instructional practices, teachers are called upon to create productive learning environments for all children (Howard, 2016). One possible solution to better prepare science educators is providing quality clinical experiences, particularly in soft-failure environments (Lamb et al., 2018). Soft-failure environments place preservice science teachers in a context where failure is temporary and embraced as an opportunity to experiment and develop a high level of efficiency. According to Lamb and Etopio, one soft-failure environment that has risen in prominence is VR. VR is believed to have considerable potential for pedagogical applications and science teacher preparation (Tondeur et al., 2017). For their study, Lamb and Etopio employed a definition that VR uses 3D graphic systems in combination with various interactive interfaces to provide the effect of immersion and interaction. The equipment they utilized was desktop VR and therefore matched the Eden and Bezer (2011) definition of IVR.

The purpose of Lamb and Etopio's (2020) study was to determine whether levels of both psychological and sensory immersion as measured through psychophysiological data and retrospective surveys differed between IVR and field experiences in student teaching. Fifty-four college-aged students were assigned randomly to either real-life conditions or IVR conditions. The virtual classroom recording occurred in the charter school and classroom where preservice science teachers were assigned to help ensure the two conditions were similar. Teacher candidates in the real-life condition were in seventh-grade classrooms at a local charter school. The preservice teachers' final task was to establish room control and teach a 20-min lesson on matter and energy (Lamb & Etopio, 2020). There were three IVR scenarios; the purpose of the first IVR scenario was to have the preservice teacher conduct a familiarization with the classroom, the IVR controls, and identify educationally relevant materials and objects in the classroom. The second scenario's purpose was to provide the preservice teacher with the opportunity to practice greeting a class, bring the class under control, and begin the lesson. The third scenario's purpose was to provide the preservice teacher with an opportunity to teach a short microlesson of their design and interact with students, starting where the second scenario concluded. The IVR condition's main effect versus real life was not statistically significant in terms of the retrospective engagement survey, psychological measures, and composite neuroimaging. This finding suggested that the use of IVR, in terms of the realism of the environment for the preservice science teachers, allowed them to learn from modeled real-life situations to transfer skills from IVR to classroom use (Lamb & Etopio, 2020).

Lamb and Etopio (2020) reported their findings, and from the survey data, preservice teachers suggested that their experience in IVR promoted acceptance of IVR as a tool to assist with the development of teaching skills. The preservice science teachers were rated using a rubric called the Student Teacher Assessment Record (see University at Buffalo, 2021). The rubric results suggested that the supervisors who observed both the IVR conditions and the classroom conditions rated the student levels of the four practice domains of content knowledge, pedagogical knowledge, pedagogical content knowledge, and professional qualities at the same level (Lamb & Etopio, 2020). Extended experiences in real-life classrooms remain essential, but this study supported the belief that IVR yields early clinical preparation possibilities. The results of Lamb and Etopio's study also supported previous work suggesting from a cognitive and physiological perspective that the brain does not distinguish between highly realistic simulations and real-life interactions. Therefore, IVR environments enable realistic simulations for learners engaged in teaching (Nelson & Annetta, 2016). During immersion in IVR, the realism of the novice science teachers' environment allowed them to learn how to approach classroom management and short lesson presentation skills from modeled situations. Lamb and Etopio's work involving preservice science teachers and the use of IVR adds to previous work that IVR promotes meaningful use of technology in teacher education programs and provides a means to train and assess specific skills in interactive scenario-based environments.

C. Lee and Shea (2020) investigated VR by preservice elementary teachers for teaching science in the elementary classroom. The researchers conducted the study with two groups of preservice elementary teachers (*N* = 38) in a pre- and posttest within-subjects design. C. Lee and Shea asked participants to critique, create, and evaluate the use of VR classroom applications during a three-stage intervention. The researchers implemented pre- and posttest questionnaires to assess the change in attitudes toward using VR and technology when teaching. The researchers adopted a mixed-method research approach (see Creswell, 2018). C. Lee and Shea described VR as giving the users the feeling of being placed within a 3-D environment and moving around as if in a spatial reality. The users could view the environments using either a computer or an HMD or headset. C. Lee and Shea utilized Murray and Sixsmith's (1999) definition of VR as the "use of three-dimensional computer graphics technology to generate artificial environments that afford real-time interaction and exploration" (p. 316). This definition has the same components as Eden and Bezer's (2011) definition, and therefore the VR technology implemented by C. Lee and Shea meets the requirements of IVR.

Using the constructivist theory of learning as their model, the researchers gave the preservice elementary teachers the task to explore IVR and create an IVR teaching module using a three-stage learning process (C. Lee & Shea, 2020). The preservice elementary teachers researched previous work in IVR and critiqued it on several dimensions in the first stage. In the second stage, C. Lee and Shea (2020) had the preservice teachers work as teams to create an IVR project. Tondeur et al. (2017) stated that most preservice teachers will have a higher chance of using technology proficiently in their future classrooms if they have prior experience of manipulating the technology in their teacher preparation program. Finally, C. Lee and Shea designed the third stage to allow the preservice teachers to consolidate their pedagogy by assessing the advantages and disadvantages of the technology they had used. Further, having benefited from the process of peer modeling, they would be able to incorporate ideas from other participant teams into their philosophy of teaching (C. Lee & Shea, 2020).

Qualitative analysis of responses showed that preservice elementary teachers were positive about their IVR experience and had come to see IVR apps as supplementary educational tools. The majority of the teams successfully created original instructional material using IVR, increasing their self-efficacy. C. Lee and Shea (2020) reported that quantitative results varied depending on the topic of interest. When assessing self-knowledge and efficacy, the most significant changes were familiarity with the national science standards and preparation to teach science using computer-based technology. When assessing classroom feasibility, the two significant changes were preservice teachers felt significantly more confident on (a) assessment of computer-based technology activities involving student participation to learn science and (b) ability to select appropriate computer-based technology by grade level. C. Lee and Shea also noted factors the preservice elementary teachers perceived as important when using IVR apps: 73.7% remarked on the importance of the correct scientific information in all educational apps, but only 26.3% recommended apps that were interactive like a game so students could participate by immersion into the virtual environment. According to C. Lee and Shea, preservice elementary teachers reported changes in knowledge and self-efficacy: 71.1% gave positive feedback concerning their IVR learning experience and the creation of a IVR module. Preservice teachers' attitudes toward using IVR and computer-based technology in the classroom were positive: 71.1% said they would use IVR in their teaching because they could see how IVR apps are related to state and national science standards and how they could engage the learning of the students.

C. Lee and Shea (2020) implemented the three-stage learning process as a systematic way to guide preservice elementary teachers to learn about IVR and how it could be used effectively in the classroom. The authentic and inquiry-based learning experience for the preservice teachers supported Fowler's (2015) constructivist philosophy of learning by doing (C. Lee & Shea, 2020). Although they had begun the three-stage learning process with reservations, by the end, almost all preservice elementary teachers found the process of creating an IVR teaching module rewarding. Overall, the participants noted in their reflection papers and class interviews that they were excited to learn about IVR in the science methods course and use it in the classroom because it was novel and cutting edge (C. Lee & Shea, 2020).

Theelen et al. (2020) conducted a study to investigate developing preservice teachers' interpersonal knowledge with 360-degree videos in teacher education. Theelen et al. discussed how preservice teachers often struggle with creating positive teacher–student relationships through behavioral strategies, also known as interpersonal competence (Stough & Montague, 2015; Veenman, 1984). For interpersonal competence, preservice teachers must be able to notice and interpret relevant classroom events using interpersonal knowledge (van Es & Sherin, 2002). In their study, Theelen et al. defined preservice teachers' interpersonal knowledge as their knowledge of developing and sustaining healthy relationships with students and a classroom environment supporting these teacher–student relationships.

A user can watch 360-degree videos using VR headsets. Online platforms such as YouTube offer easy playback and sharing of 360-degree videos (Aguayo et al., 2017). Such 360-degree videos can be used to display real-life classroom events to provide learners sensory and imaginary experiences resembling real life (Yoh, 2001). The immersive user experience of watching 360-degree videos using VR headsets appears to be more attractive to learners (Martín-Gutierrez et al., 2016) because it disconnects them from their surroundings (Olmos-Raya et al., 2018). VR immersion provides a feeling of presence (Yoh, 2001) and embodiment (Kilteni et al., 2012), offering users a realistic and authentic situation (Martín-Gutierrez et al., 2016).

Theelen et al. (2020) combined 360-degree videos and an IVR headset with theoretical lectures. They labeled that combination as the virtual classroom. Theelen et al. utilized the virtual classroom to strengthen preservice teachers' theory-based interpersonal knowledge.

Theelen et al. (2020) assessed various aspects involving the virtual classroom. For their first research question, they were interested in the virtual classroom effect on preservice teachers' interpersonal theory-based knowledge structures by using concept maps for organizing and representing preservice teachers' knowledge structures, analyzed using social network analysis measurements of structural complexity. The researchers stated that preservice teachers showed more organized concept maps after the intervention (IVR 360-degree videos). The researchers concluded that providing preservice teachers with theoretical lectures added with observing immersive video fragments led to an increased structured concept map. According to Buitink (2009), a more structured concept map is associated with a better developed interpersonal knowledge structure. Theelen et al. reported that the preservice teachers used statistically significantly more concepts at the posttest than the pretest. Moreover, these concepts were also more relevant after the intervention when compared with the expert map. According to Theelen et al., this indicated that preservice teachers' theory-based interpersonal knowledge also developed in the desired direction after the virtual classroom.

When assessing how preservice teachers apply their theory-based interpersonal knowledge after the virtual classroom, Theelen et al. (2020) reported that preservice teachers were mainly capable of applying their theory-based interpersonal knowledge on vignettes from Quadrants 1 (directing, helpful) and 4 (imposing, confrontational). After their study, Theelen et al. concluded that the virtual classroom is a valuable method for teacher education institutes to improve preservice teachers' theory-based interpersonal knowledge. To conclude, preservice teachers' theory-based interpersonal knowledge structures, development, and application can benefit from using VR headsets combined with theoretical lectures (Theelen et al., 2020).

Although 21st-century learners have been exposed to digital devices, or have experience in video games, having a visual-spatial experience such as IVR is not common (Stepan et al., 2017). Blocking distractions around the actual physical site, users can experience a strong sense of being present in the virtual space by wearing HMDs, and they can control what and where to explore by moving their heads around in a 360-degree environment (Cummings & Bailenson, 2016; North & North, 2016). Students can learn through visualizing a physical site (IVR with 360-degree video capture) or interacting with objects (IVR with animated 3D graphics), and they can receive feedback if quizzes are embedded in the virtual setting (V. Lee et al., 2018; Pulijala et al., 2018). Concerning preservice teacher education, IVR provides multiple opportunities to improve student experiences. Schools and universities can utilize 360-degree environments that the body cannot distinguish as simulated to supplement classroom experiences (Theelen et al., 2020).

The ability to train and educate preservice teachers is in significant demand as the world continues to experience the COVID-19 pandemic. The 2020 worldwide outbreak of COVID-19 caused massive closures of school districts, businesses, and events (Centers for Disease Control and Prevention, 2021; U.S. Department of Education, 2021). Major conferences such as the Game Developers Conference (2020a, 2020b) either altogether canceled or postponed their major yearly conferences. HTC moved the VIVE Ecosystem Conference entirely into the virtual world (Engage, 2021). As school districts put more restrictive rules into place, employees have struggled to create solutions for students. With software companies such as Engage, educators can meet virtually with their students and continue instruction. IVR allows users to interact in virtual environments such as classrooms, write on virtual whiteboards, and even record the lesson for absent students or review later. More than ever, IVR and its possibilities are shifting from being a future option to a current need.

The author conducted a systematic, thorough review of multiple sources to complete a comprehensive literature review. The results support the opinion that IVR can be an effective instructional method for working with preservice teachers. However, significant gaps remain, and this study was designed to address those gaps by adding to the research regarding IVR and education.

IVR Use With University-Aged Learners

There is emerging research on the effects of IVR on student learning (Southgate et al., 2019), and IVR can improve various aspects of the learning process. IVR has several features that could be useful for education: It presents environments in 3D; it is interactive; and it can give audio, visual, and even haptic feedback. Visualizing is one of the most recognized benefits of IVR, but detractors are quick to point out that teachers can also accomplish the same with video or other 2D media. However, videos are passive learning objects, whereas IVR allows for direct interaction with the environment. Interactivity and feedback can be valuable for all subjects, as there are specific benefits of interactive learning because it promotes active learning instead of passive learning (Allcoat & von Mühlenen, 2018). The well-known visual-auditory-kinesthetic learning styles model (Barbe et al., 1979) suggests three learning styles: visual, auditory, and kinesthetic. IVR allows all three of these learning styles to be targeted in one application, as IVR headsets allow for complex visual renderings, audio, and movement tracking (Allcoat & von Mühlenen, 2018).

Even though more empirical studies are required, researchers have compared IVR to traditional learning in some areas. VR displays, such as HMDs, afford users a superior spatial awareness, compared to traditional desktop displays (Krokos et al., 2018). Krokos et al. (2018) studied memory palaces, a spatial mnemonic, were superior in the HMD condition compared to the desktop condition. In memory palaces, information is associated with spatial elements of the environment. The participants (30 men and 10 women) were shown two scenes on two display conditions (head-tracked HMD and a mouse-based interaction desktop) as well as two sets of faces (within-subject design), all treated as independent variables, with the measured accuracy of recall as the dependent variable. Krokos et al. hypothesized that a virtual memory palace experienced in an immersive head-tracked HMD (the HMD condition) would lead to a more accurate recall than on a mouse-controlled desktop display (the desktop condition). The researchers also hypothesized that participants should be more confident in their answers in the headset and make fewer mistakes or recall errors. Krokos et al. confirmed, using statistical testing, that participants were able to recall information better in the HMD condition as compared to the desktop condition, permitting them to reject the null hypothesis. The researchers also discovered that 38 of the 40 participants stated they preferred the HMD for this task. Participants stated that they felt more immersed in the scene and focused more on the task. A majority of the users (70%) reported that HMD afforded them a superior sense of spatial awareness they claimed was essential to their success (Krokos et al., 2018).

Allcoat and von Mühlenen (2018) conducted a study with 99 participants (1st-year psychology students at the University of Warwick) assigned to one of three learning conditions: traditional (textbook style), VR, and video (a passive control). The text and 3D models were the same for all conditions. The educational subject matter included plant cells and other biology topics. The researchers gave each participant a knowledge test before and after learning. Participants in the traditional and VR conditions had improved overall performance (i.e., learning, including knowledge acquisition and understanding) compared to those in the video condition. Participants in the VR condition also showed better performance for remembering than those in the traditional and the video conditions (Allcoat & von Mühlenen, 2018). The researchers conducted emotional self-ratings with each participant before and after the learning phase, which increased favorable emotions and decreased negative emotions for the VR condition. Conversely, positive emotions decreased in both traditional and video conditions. VR participants reported higher engagement than participants in the other two conditions. Allcoat and von

Mühlenen concluded, “Overall, VR displayed an improved learning experience when compared to traditional and video learning methods” (p. 1).

A case study out of Saga University in Beijing, China, was conducted by Beijing Bluefocus E-Commerce (2016); researchers investigated the impact of IVR on academic performance. Compared with traditional education, VR-based education is of distinct “advantage in theoretical knowledge teaching and practical skills training. In theoretical knowledge teaching, it boasts the ability to make abstract problems concrete and theoretical thinking well-supported” (Beijing Bluefocus E-Commerce, 2016, p. 3). The potential of IVR for practical skills training is that it helps sharpen students’ operational skills, provides an immersive learning experience, and enhances students’ sense of involvement in class, making learning more fun, secure, and more active.

The researchers aimed to show the difference between traditional teaching and VR-based teaching in students’ celestial physics learning (Beijing Bluefocus E-Commerce, 2016). The participants were high school students in Beijing, with equivalent numbers of male and female students. Their academic grades ranged from A to C. The researchers divided students into four groups based on their gender and physics test scores. One group took the test immediately after the VR-based teaching, the next group took the test 2 weeks later after the VR-based teaching, the third group (a control group) took the test immediately after the traditional teaching, and the final group (a control group) took the test 2 weeks later after the traditional teaching. The participants took an immediate test after teaching to show any differences between the two conditions (VR and non-VR) in academic performance and learning efficiency. The researchers conducted a retention test 2 weeks later to compare memory and knowledge retention.

During this study, the same teacher taught the participants about celestial physics in two ways: traditional teaching and VR-based teaching. In the traditional teaching, the teacher employed narration and a PowerPoint presentation for approximately 30 min; in VR-based teaching, the teacher utilized a VR celestial physics teaching application for approximately 30 min.

The study results showed that the VR group's score on the immediate test was 93, compared to 73 for the group receiving the traditional instruction, represented a gap of 27.4% between the two groups (Beijing Bluefocus E-Commerce, 2016). In the retention test, the VR group's average score was 90, 32.4% more than that of the traditional teaching group, 68. The researchers noted another impressive result: the Grade C students in the VR group scored, on average, 88, 15.8% higher than the average score of the Grade A students in the control group. A single study does not determine that a particular practice or teaching method is unequivocally effective but may provide a substantial justification for replication and advancement of the research. More research into the effectiveness of using IVR in the instructional process is required to determine what students might benefit the most, what content areas provide the best opportunities to be enhanced by IVR, and how teachers can adapt this technology for use in the educational setting. Some disadvantages of this design are that integrating IVR might be a laborious and costly endeavor, requiring teachers to learn an entirely new skill set. Some students might be intimidated by IVR or simply will not want to use it, and schools might not be willing to invest in another new form of technology, so it is crucial to investigate whether and how IVR can be useful for learning.

Berns et al. (2018) investigated the potential of a 360-degree video application for foreign language learning with 24 students from a beginner-level German foreign language course at the University of Cádiz. The researchers created a dating app entitled Let's Date! Berns et al. designed the app to recreate, employing various spherical recordings, a scenario (a dating agency) that provides learners with the opportunity to immerse by interacting with a virtual employee of a dating agency. A vital feature of the app was that the researchers created a chatbot to recognize the natural language learners' use when interacting with the app. The students first downloaded the app on their personal mobile devices and then introduced their data to interact with the learning environment, which the researchers stored in the database. Berns et al. designed the experience to easily monitor students' interaction and learning process, detect eventual problems with the targeted language items, and then refine the system according to students' needs. Once the students installed the app, several 360-degree video clips were displayed, allowing the learners to immerse in a virtual environment that required them to interact with an employee of a dating agency. Students were required to answer questions by voice messages, which interacted with the app via a voice-recognition feature. Depending on the student's answer, the scenario would change to fit the appropriate responses. There were various questions related to their individual characteristics (personality and character, place of living, etc.) and then several questions related to their ideal partner's characteristics. At the end of each video clip, the learner must correctly answer questions to pass and visualize the next video clips (Berns et al., 2018).

Once students had used the app, they completed an anonymous questionnaire based on the technology acceptance model. Berns et al. (2018) aimed to gather information on students' learning experience and attitude towards VR-based learning environments. The survey results showed that 23 students scored the app between useful and very useful for their language learning in general, and 20 students considered the app especially useful for learning vocabulary. Berns et al. noted that apart from considering the app helpful for vocabulary learning, 22 students agreed on its usefulness to improve comprehension skills, and the rest of the students neither confirmed nor denied its usefulness for strengthening the mentioned language aspects. One noteworthy finding that Berns et al. reported was that when the researchers asked the students about the app's potential for practicing pronunciation and oral expression, all 24 students stated that the app encouraged them to focus more accurately on both, and 21 students were strongly convinced of the app's potential for improving pronunciation.

The research conducted by Berns et al. (2018) is essential to the current study because it utilized real-world content in the IVR experience. The researchers also designed the app to be comfortable and efficient for use, which is another crucial factor considered when designing the current study experience. Research regarding teacher acceptance and use of technology supports the idea that teachers need to find the technology simple, quick, and efficient (Birch & Irvine, 2009).

The recent interest in the use of IVR in education seems to correspond with the increased affordability, accessibility, and functionality of IVR hardware and software (Bower et al., 2020). IVR can enhance immersion, improve spatial capabilities, promote empathy, increase motivation, and possibly improve learning outcomes (Schutte & Stilinovic, 2017). However, the extent to which teachers capitalize on these potentials in the future depends on their perceptions of IVR and their behavioral intentions to use it

(Bower et al., 2020). The Horizon Report for Higher Education (as cited in Alexander et al., 2019) identified IVR as an important development in technology, which researchers predicted will be adopted in the next few years due to emerging trends such as learning spaces and innovative cultures. IVR usage is also being explored in schools, with recent IVR research focusing on the effects of IVR on the learning of children (e.g., Makransky et al., 2019; Passig et al., 2016) and on the ethical and organizational considerations for the practice of using IVR in schools (Southgate et al., 2019). Researchers have studied the behavioral intention to use IVR, specifically focused on students' intention to use IVR for learning science in a higher education context (Makransky & Lilleholt, 2018). However, as IVR is a new and emerging technology for schools, the intention to use this technology among teachers and preservice teachers and the reasons for their dispositions are important to understand to optimize their classroom implementations and professional teacher learning (Bower et al., 2020).

Many benefits of IVR have emerged throughout its evolution. First, users can enhance their learning by acquiring multiple perspectives through sensory immersion, actional immersion, and symbolic emersion (Dede, 2009). Learners can be provided with first-order experiences, where they can construct their own knowledge while being in the virtual environment (Mikropoulos & Natsis, 2011). For instance, IVR enables transduction, where the learner is able to feel and experience situations that would not normally be accessible in the real world, like following whales along their migration path (Southgate, 2018). Learners also can be granted the ability to change their size and to interact with micro- and macroworlds (Mikropoulos & Natsis, 2011) or teleport instantly to new locations (Dede, 2009). In symbolic immersion, learners' psychological conditions (such as fear on a speeding rollercoaster) can increase the individual's sense of presence and hence ability to relate to the situation (Mikropoulos & Natsis, 2011). Southgate (2018) referred to IVR as "empathy machines" (p. 6). The freedom to choose their navigational path through virtual worlds also affords learners the opportunity to progress at their own pace (Pantelidis, 2009). High intrinsic student motivation to use IVR can engage students in learning and improve their academic achievement, which in turn increased their behavioral intention to use IVR (Makransky et al., 2019).

It is not uncommon for the term *immersion* to be used interchangeably with the related concept of presence (Cummings & Bailenson, 2016)—that is, a state of dissociation from reality in which people feel the subjective experience of existing in the digital environment (Slater, 2003). Barbot and Kaufman (2020) explained that engagement refers to the sense of involvement, connection with, and enjoyment of the content. Engagement builds upon a sense of presence. Consistent with an earlier review (Schuemie et al., 2001) showing how engagement with a virtual environment can influence the impact of IVR experiences across a range of outcomes, Schutte and Stilinovic (2017) concluded that "engagement was a process path connecting the virtual reality experience with empathy" (p. 711). Specifically, in an experimental study comparing IVR and non-IVR modalities, Schutte and Stilinovic showed that IVR was associated with greater engagement and a higher level of empathy towards a character featured in the media content. They further found that the association between IVR and empathy was mediated by engagement, suggesting that IVR increases characteristics such as empathy through increased engagement (Schutte & Stilinovic, 2017).

Despite promising research, there are still potential issues with the use of IVR in education. Bower and Sturman (2015) identified distraction, overuse, familiarization with interface, technical problems, and lack of support as potentially constraining effectiveness. There are gaps in the research on when and how IVR improves learning, for example, with research showing that a higher sense of presence in IVR does not necessarily improve learning outcomes (Makransky et al., 2019; Moreno & Mayer, 2002). With IVR continually becoming more prevalent in mainstream education, and with possibly many reasons that preservice teachers may or may not choose to leverage the potentials of IVR in their future classrooms, it is crucial to examine factors relating to teachers' behavioral intention to use IVR and the reasons for their perceptions (Bower et al., 2020).

Using IVR to Teach the Civil Rights Movement

The author developed an IVR lesson for this study on preservice teachers' perceptions of IVR. The author designed the Boy from Troy IVR experience to immerse users in John Lewis's crossing of the Edmund Pettus Bridge in 1965, which resulted in a clash with police, shifting public opinion and ultimately leading to the Voting Rights Act of 1965. IVR can increase the levels of empathy in the user. Many studies have highlighted empathy as an essential contributor to prosocial behavior (Baumeister et al., 2007). Through empathy, people selflessly focus on those in need (Silver, 1980), and it is defined as "sensitivity to, and understanding of, the mental states of others" (Smith, 2006, p. 3). Empathy can be activated in many ways and under different circumstances, and there is currently a lack of research to determine if IVR can activate empathy effectively. According to Paiva et al. (2005), modern psychologists distinguish two main mechanisms in empathy: (a) the mediation of empathy (facilitated via a situation and emotional expressions) and (b) the outcome of the empathic process. In situational mediation of empathy, the observer perceives that the observed person has been mistreated, and as a result, develops a feeling of anger or pain that would be experienced under the same circumstances (Kandaurova & Lee, 2019). Empathy can be mediated through emotional expressions. For example, if an observer sees a person crying, the observer can then adopt this emotional state. These two modes represent the empathetic process, which in turn results in a particular outcome (Paiva et al., 2005). Typically, the outcome is the observer experiencing the emotional state of the other, which can lead to a person's desire to help (Kandaurova & Lee, 2019).

Lastly, as adduced by Basil et al. (2006), responsibility "may stem from causing something to occur or from failing to avoid the onset of some occurrence" (p. 3). For example, a realization that personal car use contributes to climate change may cause a person to feel responsible to switch to public transit. This form of responsibility is interconnected to social responsibility, where one thinks outside of one's inner circle of friends, family, community, and nation to help others in need (Pancer & Pratt, 1999). Furthermore, when individuals obtain an accurate empathic perspective about others' conditions and needs, they are more apt to feel social responsibility and become socially involved (Segal, 2011).

Preservice teachers should be open to differences in opinion concerning race and ethnicity by being continual learners and examining their own attitudes toward others (Brewley-Kennedy, 2005; Cochran-Smith & Villegas, 2015). The literature has suggested preservice teachers, especially White preservice teachers, are resistant to conversations about race (DiAngelo & Sensoy, 2014; Matias, 2016). Teacher education faculty recognize the need to prioritize preparing preservice teachers to work with an increasingly diverse K-12 student population (Anderson & Stillman, 2013; Bennett, 2012; Larson, 2016; Sleeter, 2001). In 2018, there were over 26.6 million students of color among the 50.7 million students in U.S. public schools (National Center for Education Statistics, 2019). Even as teacher education programs strive to recruit, retain, and prepare preservice teachers who better reflect the diversity within P-12 schools (American Association of Colleges for Teacher Education, 2020), teacher education programs must prioritize training all preservice teachers to consider their positionality concerning race and ethnicity and how their background experiences affect their interactions with students (Anderson & Stillman, 2013; Council of Chief State School Officers, 2013; DiAngelo & Sensoy, 2014; Matias, 2016; Picower, 2009). In particular, "with the likelihood of the teaching force remaining overwhelmingly White, examining and interrupting the Whiteness of teaching remains one of the most vital tasks for those concerned with improving educational opportunities and outcomes for students of color" (Picower, 2009, p. 213).

In 2014, Teaching Tolerance released a detailed report regarding how the Civil Rights Movement is taught in America. Authors of the report looked not just at *whether* states require instruction in the civil rights movement, but also at *how* educators in states teach movement history, including how they frame discussions of progress and opposition to change (Teaching Tolerance, 2014). To accomplish this, they considered state content standards and frameworks and the resources states offer to their teachers.

These resources included curricula, lesson plans, resource banks, and original historical documents. The Teaching Tolerance (2014) report stated,

> The United States has no national content standards for history. In recent years, states have joined with the National Governors Association Center for Best Practices and the Council of Chief State School Officers to develop and promote the adoption of Common Core State Standards (CCSS) in English/language arts and math. These standards have now been adopted in 45 states, the District of Columbia, Guam, American Samoa and the U.S. Virgin Islands. The new College, Career, and Civic Life (C3) Framework for Social Studies State Standards mirrors and supplements the Common Core. This framework, like the Common Core, is not about what students should learn but about how they should learn. (p. 13)

Since there is no national set of core content standards for history, the only way to measure the nature of shared expectations about student knowledge of the Civil Rights Movement is to look at state standards and resources. These documents have substantial practical and symbolic value (Teaching Tolerance, 2014). A significant finding of the 2014 report was that fewer than half of U.S. states include in their major curriculum documents any information on Jim Crow laws, which, for a century, divided citizens by color according to the paradoxical formula of “separate but equal.” Teaching Tolerance (2014) explained why this is so significant by posing questions to educators such as these:

> If students do not understand these laws, or how they impacted the course of history, how will they ever be able to grasp the century of delay following emancipation that Dr. King pivoted from in the spontaneous “Dream” section of his iconic speech at the March on Washington in 1963? Or what the lawyers in *Brown* were up against? Or why the Civil Rights Act of 1964 and Voting Rights Act of 1965 were and remain necessary manifestations of the 14th Amendment’s guarantee of “equal protection of the laws”? (p. 7)

Significant findings of the Teaching Tolerance (2014) report were 20 states with minimal coverage of civil rights, with raw scores from 0% to 19%, receiving grades of F. This included five states—Alaska, Iowa, Maine, Oregon, and Wyoming—that neither covered nor supported teaching about the Civil Rights Movement. Fourteen states earned grades of D for raw scores between 20% and 39%. Six states—Arkansas, the District of Columbia, Kansas, Mississippi, Tennessee, and West Virginia—earned C for raw scores between 40% and 59%. Eight states—Alabama, California, Florida, Maryland, New York, North Carolina, Oklahoma, and Virginia—earned grades of B for raw scores between 60% and 79% (Teaching Tolerance, 2014). Based on the comprehensive research supporting the need for new and focused learning experiences involving the Civil Rights Movement, the author created the IVR experience to address those needs specifically. The next chapter details the methodology for this study to address that need and help fill the research gap in effectiveness of IVR with preservice teachers.

CHAPTER 3

METHODOLOGY

This inquiry was designed to expand upon the literature on IVR technology in education and preservice teacher use of technology. The purpose of this study was to investigate the impact of IVR technology on preservice teachers through an experience focused on the American Civil Rights Movement, specifically on knowledge attainment, lesson planning effectiveness, and motivation for future use in their instructional practice. The Boy From Troy was an IVR learning experience created to improve instructional strategies among preservice teachers preparing to teach P-12. Specifically, this study addressed the effects of an IVR experience, focused on the American Civil Rights Movement, on instructional planning of elementary preservice teachers in a diverse metropolitan university. The study was guided by the following research questions:

1. Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience?
2. To what extent does the instructional method affect the learning outcomes of preservice teachers?
3. To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction?

Research Design

The research used a convergent parallel mixed-methods design, as described by Creswell and Creswell (2018). The researcher collected quantitative and qualitative data during the same phase of the research process and then merged the data analysis results into an overall interpretation. The researcherer randomly assigned all participants to either the control group (2D experience) or the experimental group (IVR experience).

Mixed methods research is “research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry” (Tashakkori & Creswell, 2008, p. 4). Purposes (or rationales) for researchers to engage in mixed methods research in education have evolved. Mixed methods research is not merely adding databases into a study; it demands a well-articulated rationale for the need for qualitative and quantitative data so that readers can grasp the intent and advantages of multiple sources of data (Tashakkori & Creswell, 2008). This study used an adaptation of the Student-Teacher Observation Tool (STOT), combined with student notebooks, to gather participants’ views. The author theorized that illustrating the successful application of a convergent parallel mixed-method model design in creating an IVR experience for educator use and addressing challenges made in the process would contribute to researchers’ understanding of educational IVR content creation.

The participants completed a pretest before partaking in the civil rights education experience (2D or IVR), and directly following the experience, the participants completed the posttest. The researcher used this test to determine content knowledge acquisition. Content knowledge was used to answer Research Question 2. The IVR (experimental) group completed a survey about various aspects of their experience, including ease of use, presence, and overall impressions. Results were used to answer Research Question 3. After the participants completed their assigned experience, the professor gave them a lesson plan creation assignment. The participants had in-class and out of class time to complete their assignments. Once the predetermined amount of time was concluded, the researcher collected all the required information and documents. Data were used to answer Research Question 1.

Participants

After obtaining human subject research approvals from the university, the researcher recruited individuals to participate in the study. The researcher recruited participants from the sample population of 45 students enrolled in EDTP 322, Social Studies Methods; the final sample was 21. Students enrolled in this course are typically undergraduates and seeking teacher certification. All students enrolled in the course had the opportunity to volunteer for participation in the study. The participants were enrolled in the teacher preparation program. The professor includes permission to participate in studies in the syllabus. Study-specific Institutional Review Board approved consent procedures were conducted per the policies of the University of Louisville's Institutional Review Board and required of all participants. Participants were assured confidentiality, and no names or personally identifying information are reported in the study.

Setting

The researcher conducted all sessions on the university's campus, in a classroom in the College of Education building, during the regularly scheduled class time. The experimental group completed their IVR experience in the adjoining classroom.

The IVR Intervention

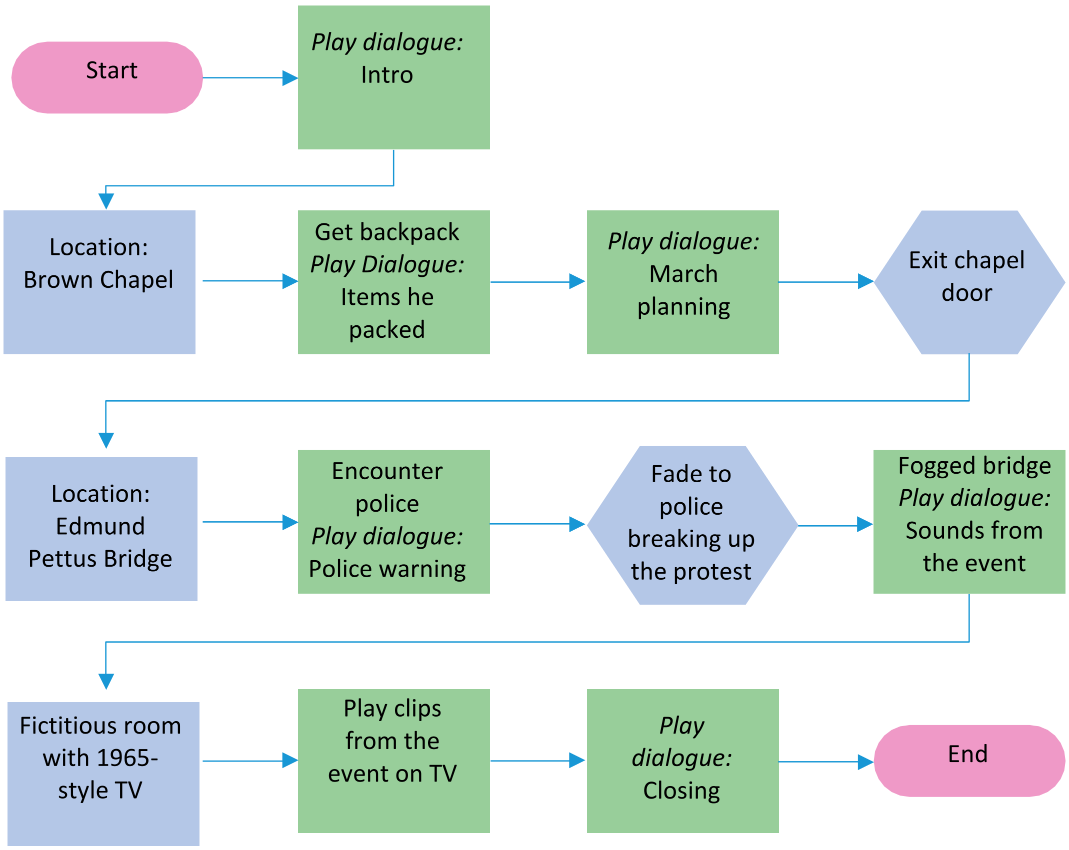
The author created the Boy From Troy IVR experience based on findings from the Teaching Tolerance (2014) report and data from other researchers (Bardiyer, 2007;

Leont’yev, 2009; Nagovitsyn et al., 2018) indicating the importance of preservice education on the Civil Rights Movement. The researcher’s goal was to create an IVR experience that could serve as a tool for preservice teachers to use in their future classrooms to have conversations about race. Preservice teachers, especially White preservice teachers, are resistant to conversations about race (DiAngelo & Sensoy, 2014; Matias, 2016). The diverse student population and lack of culturally responsive pedagogy were factors in the researcher choosing the IVR experience topic.

The researcher created the learning experience based on the events of Representative John Lewis’s life and the “Bloody Sunday” March on the Edmund Pettus Bridge in 1965. The experience is entitled The Boy From Troy, and Figure 3 illustrates the steps of the experience.

Figure 3

Steps in the Immersive Virtual Reality Experience, the Boy From Troy



John Robert Lewis was born near Troy, Alabama, in 1940 ("John Lewis Biography," 2021). He worked alongside his sharecropper parents, chafing against segregation and disappointed by the ruling of *Brown v. Board of Education* in 1954. He was inspired by Dr. Martin Luther King Jr. and the 1955–1956 Montgomery bus boycott. In 1957 Lewis moved from Alabama to Nashville, Tennessee, to attend the American Baptist Theological Seminary, where he organized nonviolent protests and sit-ins at segregated diners. Despite being arrested for such demonstrations, he participated in the Freedom Rides of 1961. After the Civil Rights Act of 1964, voting was still difficult for

African Americans in the South, so Lewis and Hosea Williams marched from Selma to Montgomery, Alabama, on Mary 7, 1965, crossing the Edmund Pettus Bridge. State troopers attached the marchers, and Lewis suffered a fractured skull. The images of the violent attack of Bloody Sunday, as the day became known, galvanized support for the Voting Rights Act of 1965 ("John Lewis Biography," 2021).

The IVR experience starts the user off in Troy, Alabama, at the representative John Lewis boyhood farm. The user joins John as the young boy practices sermons by preaching to his chickens, something he did quite often, according to his interview in the documentary, *John Lewis: Good Trouble* (Porter, 2020). Next, the user joins John as he travels to meet Dr. Martin Luther King Jr. in Montgomery, Alabama, and the user learns how John was nicknamed "the boy from Troy."

In his 2015 memoir, *Walking with the Wind: A Memoir of the Movement*, John discussed one of the various tasks, literacy tests, that African Americans were subjected to when they attempted to vote. In the IVR experience, the user walks into a voting location and attempts to vote. The user is shown a bar of soap with a random number of bubbles and then asked to identify how many bubbles there are. No matter what they answer, it is deemed incorrect, and the user is denied the right to vote.

According to Kandaurova and Lee (2019), conventional ways of introducing global issues, be it through raw imagery and visuals, do not often provide users with a rich experience of the social issue. Such methods are effective at delivering facts; however, they may be perceived as disengaging. Compared to a static image, IVR can deliver multiple communication cues that people can rely on while interpreting the communicated message. Due to its immersive nature, IVR increases realism and presence by allowing the user to become a part of the environment (Yasakethu et al., 2008). In addition to verbal, IVR increases paraverbal communication cues, such as voice volume and inflection, as well as real-time nonverbal indications such as body posture, facial mimics, gestures, and attitudes (Fabri et al., 1999). These immediate communication cues facilitate interaction in a simulated virtual realm and assist in one's decision-making process. The goal of including the soap bubble literacy test is to authentically engage the user in the task and elicit an emotional response. The poll worker speaks in a loud, demeaning tone with a physically imposing presence to intimidate the user.

All of the combined components create a sense of presence and are a critical aspect IVR provides that a flat, 2D image cannot. Bailey et al. (2014) stated that an important concept used to investigate virtual experiences is presence. Generally, presence is a subjective experience that is a psychological measure of being in the virtual environment (Ahn & Bailenson, 2011; Bailenson & Yee, 2007; Nowak & Biocca, 2003). Presence is sometimes considered a measure of a media experience's success, with higher levels of presence deemed as more successful (Meehan et al., 2002; Nowak & Biocca, 2003). This author adds to the research regarding the effect of actual presence in IVR through the Boy From Troy.

After the user has been denied the right to vote, they travel to the Brown Chapel in Selma, Alabama. Here, they are joined by Representative John Lewis in an avatar form. He explains to them that they will most likely be arrested, and therefore they will need to load their backpack with a few essentials before they start the march across the Edmund Pettus Bridge. The user then loads a toothbrush, toothpaste, an apple, an orange, and three books into their backpack, the very same way John did as he explained in his interview for *John Lewis: Good Trouble* (Porter, 2020).

The interactive component of this specific part of the experience is a crucial area of interest for the researcher. Proponents of the technology dimension have argued that interactivity is an affordance of technology (Steuer, 1992). Steuer (1992) defined interactivity as “the extent to which users can participate in modifying the form and content of a mediated environment in real-time” (p. 84). According to Bailenson et al. (2008), this active modification of the content is particularly salient in virtual worlds that function via the cycle of tracking (i.e., using sensing equipment to measure movements and behavior) and rendering (i.e., displaying a digital representation of the world to reflect the user’s representation). In other words, using media such as the internet, it is possible to have applications respond in a tailored manner to the way a user hits keys and moves the mouse. However, using IVR, it is possible to have applications respond to tracking data on a much more sensitive basis—to the way a user moves, walks, gestures, and gazes (Bailenson et al., 2008). Consequently, IVR is a medium that affords more interactivity than other media due to the richness of the potential behavioral tracking (Lanier, 2001). The researcher investigated the importance of interactivity through this experience to see what effects physically loading the backpack and joining Representative Lewis on the march had on student learning and intention of future IVR use.

The IVR experience’s final stage takes the user through the Bloody Sunday March across the Edmund Pettus Bridge. The experience exposes the user to the same violent conditions that John and his companions experienced. Tear gas explodes around them, they hear the screams and pleas for help from other protestors, and they see the police on their horses galloping directly at them. The Boy From Troy concludes with videos from current events such as the George Floyd and Breonna Taylor protests while actor Morgan Freeman reads John Lewis's (2020) final essay, which he requested be published in the *New York Times* on the day of his funeral: "Together, You Can Redeem the Soul of Our Nation."

Study Procedures and Timeline

The week before the researcher conducts the study, two or three teacher tutors with over 2 years of experience using IVR in their instructional practice conducted an in-class lecture. This lecture was held during their regular class time and allowed the participants to understand and explore the uses of VR during a 1-hour lecture, followed by a 1-hour tutorial with screenings. The lecture covered basic concepts relating to IVR, including the reality–virtuality continuum (Milgram et al., 1995), examples of devices available (types of HMDs), uses of VR in education (e.g., My New Home by Oculus, 2017), research findings with relation to use of IVR in education, and possibilities relating to students as designers of IVR (using Engage). The researcher designed the lecture content to provide a balanced view of IVR that presents both the potentials and constraints of using the technology for learning. The researcher trained the teacher tutors before the lecture to ensure they understood the content. The researcher wanted to ensure she presented an objective view of IVR so that the preservice teachers had an accurate awareness of the issues at stake. The researcher was interested in both positive and negative preservice teacher views.

Following the lecture, participants spent 20–30 min in one session participating in the HTC VIVE tutorial experience. HTC (2021), the creators of VIVE Focus Plus, which uses an HMD, designed the experience to allow users to become comfortable with the hand controllers and use them in the virtual space. The experience allowed participants to pick up objects, interact with the environment, and become proficient with hand controls. Completing the tutorial was an essential step of the process because to participate in the study, users had to interact efficiently with the virtual environment. If, after the first session, they could not perform the essential tasks of picking up an object, for example, the researcher gave them another 20- to 30-min training session. The researcher utilized a checklist to document when each participant completed a task. Appendix D contains the checklist. If a participant failed to complete all necessary actions on the checklist after the second training session, the researcher assigned them to the 2D group (and reported as such, i.e., enrolled and then assigned 2D due to screen failure).

Before starting the tutorial, the researcher administered the SSQ (Kennedy et al., 1993). Kennedy et al. (1993) developed the SSQ after identifying deficiencies in the Pensacola Motion Sickness Questionnaire. Despite being developed and validated in 1993, no other questionnaire has been developed to measure actual simulator sickness. Kennedy et al. explained,

> Simulator sickness (SS) in high-fidelity visual simulators is a byproduct of modem simulation technology. Although it involves symptoms similar to those of motion-in-duced sickness (MS), SS tends to be less severe, to be of lower incidence, and to originate from elements of visual display and visuo-vestibular interaction atypical of conditions that induce MS. (p. 203)

The concept of simulator sickness is continuously mistaken for motion sickness, and while there are similarities, it is critically important that educators are aware of the differences. The researcher followed the implementation protocols set by Kennedy et al. (1993) and gave the SSQ before participants performed any IVR activities and then immediately after. The researcher assigned any participants who failed the SSQ to the 2D (control) group. The SSQ is presented in Appendix E. The week following the tutorial, the researcher conducted the second session of the study. The second session started with a brief review (5–10 min) of IVR, conducted by the class lead instructor. Before separating the participants into their assigned groups, the lead instructor administered the content quiz. Once the participants completed the quiz, the instructor separated the participants into their randomly assigned groups (control vs. experimental, or IVR). The IVR group traveled to a separate classroom, and the experienced IVR teacher tutors introduced the IVR experience, the Boy From Troy. Simultaneously, the 2D group stayed in the original classroom, and the lead instructor introduced the 2D Boy From Troy experience.

Once the participants completed the experience, the IVR teacher tutors allowed the participants to complete the IVR survey voluntarily. The IVR teacher tutors were not part of the research team, and the survey could be completed anonymously, hence reducing the risk of perceived coercion and responder bias. Once the participants completed the surveys, they returned to the original class location and were reunited with the lead professor and the 2D group.

Once both groups were back in the original classroom, the lead professor administered the content quiz (posttest). After the participants completed their content quiz, the lead professor gave them the lesson plan assignment. He allowed them time to meet in their PLC to discuss various instructional methods. Astuto et al. (1993) described a professional community of learners in which the teachers in a school and its administrators continuously seek and share learning and then act on what they learn. These actions aim to enhance the teachers’ and administrators’ effectiveness as professionals so that students benefit. The arrangement also has been called a community of continuous inquiry and improvement. The students were allowed to discuss their PLC experience because this is a natural part of their lesson planning process (Little, 2002). Little (2002) reported that research has steadily converged on claims that the PLC is an important contributor to instructional improvement and school reform. Seashore Louis et al. (1995) found that in schools with a genuine sense of community, an increased sense of work efficacy led to increased classroom motivation and work satisfaction and greater collective responsibility for student learning. The lead professor gave in-class time to PLC and completion of the lesson plan assignment. Preservice teachers received their assignment from the professor to create a lesson plan, which they used to teach part of the Civil Rights Movement. The researcher reviewed the digital notebooks approximately 2–3 weeks after the VR phase of the study concluded. The researcher waited to collect the notebooks until the participants completed all required assignments in the notebook related to the Civil Rights Movement. Table 3 illustrates the study timeline.

Table 3

Study Intervention Timeline

Session	Description

First session	• In-class lecture
	  ○ 1 hour lecture to cover basic concepts relating to immersive virtual reality (IVR)
	  ○ ½ hour tutorial
	  ○ Prior to starting the tutorial, all participants were screened with the Simulator Sickness Questionnaire (SSQ)
	• 20–30 min virtual reality (VR) session
	  ○ HTC VIVE tutorial experience
	  ○ Once they have completed the tutorial and practice, they were screened again (SSQ)

Optional session	For those who, after the first session, were not able to perform the basic tasks of picking up an object, for example
	• Repeat 20–30 min VR session
	  ○ HTC VIVE tutorial experience
	• Completion Checklist
	  ○ If a participant failed to complete all required actions on the checklist after the second training session, they were assigned to the two-dimensional (2D) group (and reported as such, i.e., enrolled and then assigned 2D due to screen failure)
	  ○ A participant who failed the SSQ was assigned to the 2D (control) group

Second session	• Whole group
	  ○ 5–10 min review of equipment
	  ○ 10 min content quiz
	• Breakout groups
	  ○ IVR group (proceeded to new classroom): 20–30 min VR experience
	  ○ Control group (stayed in same room): 20–30 min VR experience
	• Whole group
	  ○ 10 min content quiz
	  ○ Professor gave lesson plan assignment
	  ○ 60 min professional learning community
	  ○ 60 min work on lesson plan assignment

The lead researcher trained all scoring participants on the lesson plan scoring guide before their participation, as described in detail in the Data Analysis section. Reviewers scored the lesson plans using the Preservice Teacher Lesson Plan Rubric. The lesson plans were scored by two school-based teachers who had previous experience working with preservice teachers, two principals, and two college-level professors who had at least 3 years of experience working with preservice students. Two weeks after the participants completed their learning experience (IVR or 2D) and had time to complete their lesson plan assignments and their required digital notebooks assignments, the researcher collected the notebooks for qualitative screening.

Data Collection Instruments

Preservice Teacher Lesson Plan Rubric

The researcher used the Preservice Teacher Lesson Plan Rubric. Various researchers indicated that lesson plans are of great importance in the teacher providing an effective learning environment (Clark & Dunn 1991; A. P. Johnson, 2000; Rusznyak & Walton, 2011). Brittin (2005) stated that teachers must set up a learning environment in which students can learn effectively, and this involves planning materials, strategies, and timing. A lesson plan is a document that shows what will happen in a particular timeframe (Whitton et al., 2004). It involves goals, knowledge, sequencing and activity procedure, implementation, and assessment (Jacobs et al., 2008). Lesson planning connects the curriculum and textbooks' requirements with what is presented in the classroom (O. Lee et al., 2013). Thus, preparing a lesson plan helps preservice teachers to organize their activities, construct their goals, and get feedback from their supervisors (Kagan & Tippins, 1992).

Accordingly, planning is one of the crucial skills that preservice teachers should gain during their training. The process of writing lesson plans at the beginning of one's teaching career can be time consuming (Arnett-Hartwick & Cannon, 2019); however, the development of sequenced lessons that result in effective learning must be organized and articulate, not done haphazardly. Designing a lesson through a written document can help a teacher see the pattern, flow, and implications of a lesson and how it will help all students, particularly when considering the needs of special education students or English language learners (Arnett-Hartwick & Cannon, 2019). Teacher preparation programs and associated faculty, much like P-12 public school counterparts, are also held accountable for student performance. For instance, in some states, colleges of education and the professoriate who teach preservice methods courses are accountable for their graduates' performance for up to 2 years after graduation and certification from their teacher preparation programs (Goldston et al., 2012).

A rubric is a set of rules or standards to evaluate performance consistently (Nitko & Brookhart, 2011). Rubrics include two main defining aspects: criteria and performance-level descriptions (Brookhart, 2013) that need to be included in the process. Criteria for rubrics should be appropriate, definable, observable, distinct from one another, complete, and able to support descriptions along a continuum of quality. General steps in a top-down approach to developing a rubric are to create (or adapt from an existing source) a conceptual framework of criteria to be assessed, write a general scoring rubric using the dimensions and performance levels, use the rubric to assess, and adapt the rubric as needed for final use (Nitko & Brookhart, 2011). The researcher has chosen the STOT developed by the North Dakota Association of Colleges for Teacher Education (NDACTE, 2017, 2019) because it has gone through that process, including validity and reliability testing, and is based on national standards. Over 30 institutions of higher education currently use the STOT in their teacher educator programs.

The STOT was originally developed by the NDACTE (2017), and the researcher revised it to focus on lesson plan design and assessing the quality of lesson plans. According to their website (http://ndacte.org), as of January 2021 the NDACTE included 13 colleges and universities that provide leadership on issues related to professional education, with a primary focus on teacher education. NDACTE goals are to promote effective public policy regarding professional education, improve professional education programs at member institutions, and enhance the professional effectiveness of members.

Construct validation of the STOT was implemented via exploratory factor analysis using data collected from a sample of 139 respondents who completed all 34 assessment items during the fall of 2016 (NDACTE, 2017). The respondents were cooperating teachers evaluating preservice teachers from seven North Dakota institutions (NDACTE, 2017). The STOT instrument includes four constructs: the learner and learning (including student diversity), content knowledge, instructional practice, and professional responsibility. This assessment is based on the 10 national standards of effective practice for teachers, developed by the Council of Chief State School Officers (2013) Interstate Teacher Assessment and Support Consortium (InTASC). According to the Council of Chief State School Officers (2016), the consortium includes

> state education agencies and national educational organizations dedicated to the reform of the preparation, licensing, and on-going professional development of teachers. ... Its work is guided by one basic premise: An effective teacher must be able to integrate content knowledge with the specific strengths and needs of students to assure that *all* students learn and perform at high levels. (para. 1)

The researchers followed the InTASC standards because the Council for the Accreditation of Educator Preparation requires them. Council for the Accreditation of Educator Preparation (2013) Standard 1.1 states, “Candidates demonstrate an understanding of the 10 InTASC standards at the appropriate progression level(s) in the following categories: the learner and learning; content; instructional practice; and professional responsibility" (p. 1). Table 4 illustrates in detail the 10 InTASC standards (Council of Chief State School Officers, 2013).

Table 4

Interstate Teacher Assessment and Support Consortium Standards for Teacher Practice

General area	Standard	Description
The learner and learning	1. Learner development	Teacher understands how learners develop, recognizing that patterns of learning and development vary individually across cognitive, linguistic, social, emotional, and physical areas, and designs and implements developmentally appropriate and challenging learning experiences.
	2. Learning differences	Teacher uses understanding of individual differences and diversity to ensure inclusive learning environments enabling each learner to meet high standards.
	3. Learning environment	Teacher creates environments to support individual and collaborative learning and to encourage positive social interaction, active engagement in learning, and self-motivation.
Content knowledge	4. Content knowledge	Teacher understands the central concepts, tools of inquiry, and structures of the content area and creates learning experiences making the discipline accessible and meaningful for learners to assure mastery.
	5. Application of content	Teacher understands how to connect concepts and use differing perspectives to engage learners in critical thinking, creativity, and collaborative problem solving related to authentic local and global issues.
Instructional practice	6. Assessment	Teacher understands and uses multiple methods of assessment to engage learners in their own growth, to monitor learner progress, and to guide teacher and learner decision-making.
	7. Planning for instruction	Teacher plans instruction that supports every student in meeting rigorous learning goals by drawing upon knowledge of content areas, curriculum, cross-disciplinary skills, and pedagogy, as well as knowledge of learners and the community context.
	8. Instructional strategies	Teacher uses a variety of instructional strategies to encourage learners to develop deep understanding of content and their connections, and to build skills to apply knowledge in meaningful ways.
Professional responsibility	9. Professional learning and ethical practice	Teacher engages in ongoing professional learning and uses evidence to continually evaluate practice, particularly the effects of teacher choices and actions on others (learners, families, other professionals, and the community), and adapts practice to meet the needs of each learner.
	10. Leadership and collaboration	Teacher seeks appropriate leadership roles and opportunities to take responsibility for student learning; to collaborate with learners, families, colleagues, other school professionals, and community members to ensure learner growth; and to advance the profession.

Note. Source: *InTASC Model Core Teaching Standards and Learning Progressions for Teachers 1.0,* by Council of Chief State School Officers, 2013, https://ccsso.org/sites/default/files/2017-12/2013_INTASC_Learning_Progressions_for_Teachers.pdf

Researchers for the NDACTE (2017) developed the STOT over 2 years. During that time, researchers first collected observation tools from 12 North Dakota institutions of higher education, and a panel of expert volunteers reviewed the tools and began Draft 1. After consulting with various education experts and conducting multiple revisions, after Draft 12, they conducted Pilot Test 1 with cooperating teachers. Next, they performed statistical analysis for validation and edited the tool again using the results. They used Draft 18 for Pilot Test 2, and more statistical testing was conducted with 11 of 12 North Dakota universities and colleges participating. They submitted the final draft (Draft 20) for full use in the upcoming academic year. The NDACTE (2019) also created interrater reliability training modules that are available as a resource on their website. These modules provide extra training to evaluators who will be using the tool to help ensure reliability. The NDACTE divided the modules by grade groups, and an expert panel for early childhood, elementary, and secondary education rated the pieces of training. Finally, NDACTE (2017) performed statistical testing to confirm the validity of the STOT.

The STOT is divided by standards, and key indicators are defined. For each standard, varying numbers of indicators are defined to show what the rater is looking for in the lesson plan. The rater assesses the lesson plan according to a 7-point system. Underdeveloped earns a score of 1 point, proficient earns a score of 5 points, and distinguished earns a score of 7 points. The rater also can award scores of 2, 4, or 6 to allow for a partial meeting of the indicator. The author adapted the STOT to be used solely for assessing lesson plans. The author made minor adjustments to the wording in the assessment tool. For example, one indicator for Standard 1 on the STOT is "supports student learning through developmentally appropriate instruction," and a score of 1 is to be assessed if the teacher candidate "implements instruction that exceeds or does not match a developmentally appropriate level for the students." The modification for this study is that instead of "implementing" instruction, the teacher candidate will "plan instruction." Since the focus of the research question was whether the IVR learning experience affected the competency level of preservice teacher's lesson planning compared to a 2D learning experience, the author picked the standards directly related to lesson planning and the need for culturally relevant pedagogy (see Nagovitsyn et al., 2018).

The rubric includes one item each from STOT Standards 1, 2, 3, 4, 5, and 8. The final, seventh standard is a technology-specific standard adopted from the Technology Integration Assessment Rubric, a performance-based evaluation of TPACK rubric created by Hofer et al. (2011). Researchers have used TPACK as a framework to explore multiple ways to understand and assess teachers' knowledge for technology integration (Hofer et al., 2011). Hofer et al. created and validated a reliable instrument to assess the TPACK evident in teachers' written lesson plans. They also developed a TPACK-based observation rubric that testing has shown to be robust. Seven TPACK experts confirmed the rubric's construct and face validity.

Based on previous research regarding preservice teachers technology integration, specifically related to lesson planning technology-specific standards (Mishra & Koehler, 2006; Venkatesh et al., 2003; Wang et al., 2018), the author chose to include two items from the Hofer et al. (2011) rubric. The first item assesses technological pedagogical knowledge through instructional strategies and technologies (using technology in teaching and learning). The second item assesses technological content through technology selection (compatibility with curriculum goals and instructional strategies). These two items combine to create Standard 7 on the lesson plan assessment rubric. Appendix C contains the full rubric. Once all participants completed their lesson plans, their names and identifying information were removed. They were assigned a number and then scored.

Content Test

In the present study, the author aimed to test the effects of a fully featured and interactive IVR experience by comparing participant learning when engaging in IVR activities and a 2D simulation. The author used a pre- and posttest model to measure participant learning. The pre- and posttests consisted of 10 questions each, drawn from existing assessments of student understanding of the Civil Rights Movement (Keirn & Luhr, 2012; Ragland, 2007; Wintz, 2009). Appendix F contains the content test.

Survey of IVR

The author used the survey developed by Bower et al. (2020) for their study investigating reasons associated with preservice teacher intention to use IVR in education. In their study, Bower et al. used the UTAUT2 to quantitatively gauge preservice teacher perceptions of IVR along each of the dimensions, as well as a frame for structuring qualitative investigations as to the reasons for those perceptions. Bower et al. stated they chose this model for multiple reasons; first, each of the model's dimensions was relevant to teachers' IVR use. For instance, performance expectancy—or belief that IVR will assist in the future performance of teachers—had been validated in research demonstrating improved student problem-solving performance and analogical thinking in geometry (Hwang & Hu, 2013; Passig, 2015) and creative problem solving (Wang et al., 2018). However, IVR may lead to a higher cognitive load with more distractions, resulting in poorer performance (Makransky et al., 2019; Southgate et al., 2019).

The author used a survey based directly on the UTAUT2 instrument (Venkatesh et al., 2012), with some adjustments to wording to account for the specific technology (IVR) and context (education) being investigated. The survey is a 7-point Likert-type scale (1 = *strongly agree* to 7 = *strongly disagree*) that measures the seven dimensions of the UTAUT2 model: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Behavioral Intention. The author removed questions on the eighth dimension, Habit, as students did not have repeated sessions with the IVR. Survey Questions 1–19 were from the UTAUT2 instrument, using a 7-point Likert-type scale, as noted above. Question 20 asked about how natural the interactions with the virtual world seemed on a 5-point scale (1 = *very natural* to 5 = *very unnatural*). Questions 21–22 asked about how engaging the training was, on a 5-point scale (1 = *very engaging* to 5 = *very unengaging*). Questions 23–27 asked about various aspects of becoming comfortable with navigating the virtual world. Questions 28–30 asked about emotional reactions to the experience, such as “I felt fear when the police approached me” and were scored on a 5-point scale (1 = *strongly agree* to 5 = *strongly disagree*). Overall, lower scores represented greater response and greater likelihood to use VR in the classroom. Respondents’ ages were gathered as well. Appendix G contains the full survey.

Digital Notebooks

The researcher reviewed the qualitative aspects of preservice teachers' work. According to Merriam and Tisdell (2016), rather than determining cause and effect, predicting, or describing some attribute distribution, researchers might be interested in uncovering the meaning of a phenomenon for those involved. As qualitative researchers are interested in understanding how people interpret their experiences and what meaning they attribute to their experience (Merriam & Tisdell, 2016), reviewing the participants' digital notebooks provided the author the ability to assess the various effects of the experience besides knowledge acquisition.

The participants in this study were required to keep a digital interactive notebook throughout the semester. The professor, in 2020, explained the digital interactive notebook as follows:

> During this course, you will be maintaining a detailed, electronic interactive notebook that includes all Notebook Items (class activities), class notes, handouts, taught lesson plans, etc. Purpose and teaching procedures for the activities should also be documented. The notebook will be a modified version of the model described by the History Alive curriculum. The purpose of the notebook is not only to document the social studies activities in class, but also to be a resource to you in your teaching. A reflection component embedded in most face-to-face classes will provide an opportunity to think about the social studies activities and integrate the research from course readings. The notebook is due at the end of the last class. Several electronic versions will be shown in class as potential models for your own notebook.

The researcher analyzed the participant's digital notebooks for any themes related to the Boy From Troy IVR experience and any other technology themes.

Reviewing the digital notebooks of participants allowed the researcher to gain valuable insight into the participants' minds. When reviewing the notebooks, the researcher was not investigating any specific data component; instead, she was mining the documents for detailed descriptions of people's activities, behaviors, and emotions regarding the Boy From Troy experience (Patton, 2015).

Data Analysis

The particular data collection process used by the researcher qualifies as convergent parallel strategy due to the concurrent collection of both the qualitative and quantitative data during the same phase of the research process. Data were analyzed separately and then mixed for interpretation (Creswell & Creswell, 2018). Data analyses are described by research question.

Research Question 1

Research Question 1 was the following: Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience? The data for Research Question 1 were collected via the scores on the Preservice Teacher Lesson Plan Rubric. The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variable for Research Question 1 was the score received by the preservice teachers on the Preservice Teacher Lesson Plan Rubric.

As 21 participants agreed to be in the study, 21 lesson plans were collected. Student names were removed from the lesson plans, which were numbered and randomly divided. Next, blind scoring was conducted by the researcher and trained scorers. The scores were recorded in Excel spreadsheet files. In total, six evaluators rated the lessons, assuming about seven lesson plans per evaluator. (If 10 or fewer lesson plans were evaluated, the researcher would have been the sole scorer). One evaluator was the researcher, two were school-based teachers with at least 2 years of experience working with preservice teachers. Two were principals with at least 2 years of experience having preservice teachers in their school building, and two were university level professors with a minimum of 5 years of experience teaching preservice teachers.

The researcher conducted all training with the selected raters using a detailed training process. The main focus of the training was calibration of the scoring by the evaluators. To establish the calibration, the researcher selected three anchor lessons with agreed-upon ratings and discussed these in great detail with the trainees to ensure scoring calibration of the application of the instrument. The members of the scoring team individually scored the training lesson plans, and then shared and discussed their ratings with the rest of the rating team. The calibration goal of the training was to score two consecutive lessons no more than one level apart on each component from the score set by the researchers. The lesson plans were randomly distributed among the raters. Due to the potential for lack of face-to-face contact, the ratings were recorded on spreadsheets and shared with the researcher upon scoring completion. The scores were averaged if the raters did not agree upon a score. An independent-samples *t* test was used to determine if there was a significant difference in the mean scores on the Preservice Teacher Lesson Plan Rubric of the IVR group and the 2D group. Results of the analysis were used to answer Research Question 1.

Research Question 2

Research Question 2 was the following: To what extent does the instructional method affect the learning outcomes of preservice teachers? The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variable for Research Question 2 was the score on a content test. The researcher collected pre- and posttest scores on the content test. Those scores were analyzed using a two-way mixed-design analysis of variance (ANOVA) to determine any statistically significant differences in scores by groups, particularly change in score from pre- to posttest.

Research Question 3

Research Question 3 was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The researcher focused on one dependent variable for Research Question 3: the intention of the preservice teachers to use IVR in their future instructional practice. The researcher used two types of data and data analysis to answer Research Question 3: (a) a survey administered to the IVR group and (b) qualitative data collected from participants' digital notebooks.

To analyze the survey, the researcher utilized independent *t* tests. The survey items were either rating scores or multiple choice. As described earlier, the survey included 19 items based on the UTAUT2 instrument (Venkatesh et al., 2012). Survey Questions 1–19 were from the UTAUT2 instrument, using a 7-point Likert-type scale (1 = *strongly agree* to 7 = *strongly disagree*). Question 20 asked about how natural the interactions with the virtual world seemed on a 5-point scale (1 = *very natural* to 5 = *very unnatural*). Questions 21–22 asked about how engaging the training was, on a 5-point scale (1 = *very engaging* to 5 = *very unengaging*). Questions 23–27 asked about various aspects of becoming comfortable with navigating the virtual world. Questions 28–30 asked about emotional reactions to the experience, such as "I felt fear when the police approached me" and were scored on a 5-point scale (1 = *strongly agree* to 5 = *strongly* *disagree*). Lower scores indicated greater response and greater likelihood of using IVR in future instruction. A separate analysis occurred of Survey Items 20–30to determine engagement and empathy with the Boy From Troy experience, which might influence future use of IVR.

The researcher analyzed the participant's digital notebooks for any themes related to the Boy from Troy IVR experience and any other technology themes. The researcher adopted the grounded theory approach when analyzing the lesson plans and digital notebooks. In 1967, Glaser and Strauss established systematic and scientific guides in qualitative methods called grounded theory in contrast to quantitative methods (Dunne, 2011). According to Glaser and Strauss (1967), grounded theory is a research method influenced by symbolic interactionism for developing a theory that conceptualizes the specific social concepts, patterns, and structures through the process of constant comparative methods. Researchers using grounded theory are interested in knowledge or reality founded on empirical data (B. Johnson & Christensen, 2012).

To analyze the qualitative data, the researcher first uploaded all data from the digital notebooks to an online platform to securely store all data in one location. Then, the researcher went through each line and assigned codes. The research used in vivo and descriptive coding. In vivo coding is to write the exact word or phrase from the participant's notebook, reflecting the voice of the participant and describing their perspectives authentically. Saldaña (2015) stated, "In vivo codes use the direct language of participants as codes rather than researcher-generated words and phrases" (p. 149). Descriptive coding refers to assigning codes by describing and summarizing the data in a word or phrase (Saldaña, 2015). After that, the researcher grouped the codes that had similar meaning using pattern coding and put them in one category. Data then were generalized into themes to address Research Question 3.

To address confirmability, and ensure the validity of all data collected, the researcher described and clarified the step-by-step process of analyzing the data. She also utilized an expert in the field of qualitative research to perform an audit to confirm the outcomes of the study. The expert audit included examination of the analysis of the collected data, confirmation of the work conducted by the researcher, and review for any potential researcher bias.

Resources for the Learning Experience

The researcher created the learning experience based on the events in Representative John Lewis's life and the Bloody Sunday march on the Edmund Pettus Bridge in 1965. The experience is entitled the Boy From Troy, and the researcher designed the experience for IVR and non-IVR platforms.

2D (Control)

The author used the Engage (engagevr.io) software to create and run the Boy from Troy IVR experience. The author chose this software for multiple reasons (as explained in detail below), but the primary reason she chose this software was the cross-platform feature. Users of the IVR experience created in Engage can view it on an HMD or 2D screen. The control group participated in the same experience but did not have an HMD and instead watched it on a 2D monitor.

IVR (Experimental)

Media effects scholars have demonstrated that the body responds to digital media technology (e.g., computers, televisions, IVR) as if it were real (Reeves, 1989; Reeves &

Nass, 1996) and that the mind has not evolved to respond to it any differently from the physical world (Reeves, 1989). This is especially important to consider when working with children under the age of 18. For example, Sharar et al. (2007), using an HMD, found children of 6–18 years of age reported higher levels of presence and seeming realness of a virtual environment than adults 19–65. According to Bailey and Bailenson (2017), if young children experience IVR as more real than adults, they may be more likely to be influenced by the content in both positive (e.g., prosocial education) and negative ways (e.g., increased materialism).

Unlike other educational technology (tablets, desktop PCs), IVR should always be a 100% voluntary experience for a child under 18. According to Bailey and Bailenson (2017), children may have strong reactions to IVR because they are still developing the skill of experiencing fully immersive technologies.

> IVR is a system that blocks out the physical world, providing rich sensory fidelity wherein the user feels and responds to the virtual world as if it were real. However, little is known about how IVR relates to child development. The little research examining young children and IVR suggests that they may have experiences unique to their age range. (Bailey & Bailenson, 2017, p. 194)

Experts have not concluded on an agreed-upon age for when IVR is deemed safe for the developing brain, and the potential for physical side effects such as nausea, dizziness, or headaches, the use of IVR in education must be voluntary. There are instances in education when students do not have the choice to opt out of using technology. According to the Jefferson County Public Schools (2020) website, they currently use the Measures of Academic Progress test as a form of assessment. Jefferson County Public Schools defines the Measures of Academic Progress as a computerized adaptive assessment program that provides educators with the information they need to improve teaching and learning. The school district requires all students to take the test, and there is no paper option available for any reason.

Educators should always give students the option to participate in activities involving IVR and require parental permission. Even if a student opts out of an IVR activity, educators need to ensure that they will still be involved in the activity. Educators can accomplish this by casting the IVR experience from the HMD to a 2D device such as a computer screen or television. Casting allows users to wirelessly share multimedia, including high-resolution pictures and high-definition video content between Wi-Fi devices (Wi-Fi Alliance, n.d.), and ensure the student participates in the activity.

Hardware

Focus Plus HMD. The researcher developed the IVR experience targeting the HTC VIVE Focus Plus as the deployment device based on the listed requirements. According to HTC (2021), the VIVE Focus Plus is $799 (educational volume price) per unit and make it a more affordable and widely used option. Key components of the Focus Plus are explained in detail below, and these features are what lead to the decision to deploy the IVR experience on the Focus Plus HMD. Table 5 lists the required equipment.

Table 5

Required Equipment for Development and Use of the Immersive Virtual Reality Experience

Equipment	Brand, model	Application
Head-mounted displays (HMDs) and interaction tracking system	HTC VIVE Focus Plus	Displaying virtual reality (VR) contents Tracking interaction
High performance workstation (personal computer)	Video card: NVIDIA GeForce GTX 970, AMD Radeon R9 290, or above	Rendering VR contents
HMD audio	HTC VIVE	Dual-OLED displays with a combined resolution of 2880 x 1600 pixels and 615 pixels per inch provide graphics with super rich colors and contrast. Hi-res certified headphones are integrated with 3D spatial sound for true-to-life immersive audio
Base stations	HTC VIVE and SteamVR	Motion tracking of HMD
Controller	HTC VIVE	Interaction with the virtual world, outside of eye-tracking (launching the app)
Television	Sony	Used to show 2D experience
Software	Unity	3D game objects created in Unity software
	Engage	Main software used for creation

According to HTC (2021), the Focus Plus utilizes inside-out tracking with 2880 x 1600 combined resolution, which allow users to see text, textures, and graphics in stunning clarity with resolution at 615 pixels per inch. The Focus Plus delivers deep blacks and vivid colors throughout the 110-degree field of view, ensuring a fully immersive experience. The Focus Plus is designed for optimal comfort in regard to weight, balance, and hygiene. The system accommodates 95% of users with a comfortable, ergonomic design. Weight distribution is optimized to avoid fatigue. Interpupillary distance is the distance between the centers of the eyes (HTC, 2021), and the Focus Plus suits almost all vision types with an adjustable interpupillary distance and is eyeglass compatible. The Focus Plus is durable, easy to wear and remove, with easy-to-clean synthetic materials for high-use environments.

The Focus Plus has an added feature which make it an optimal choice for this study called Screencasting and recording. The VR experience can be cast onto TV, PC, or tablet using Miracast for a similar 2D experience (Wi-Fi Alliance, n.d.). Miracast gives users the ability to see what trainees are viewing in VR on a TV, PC, or tablet. Instructors get real-time feedback that allows them to provide guidance. Training sessions can also be recorded and shared (Wi-Fi Alliance, n.d.).

Controllers. Chirp SonicTrack controllers offer six degrees of freedom with ultrasonic and inertial measurement unit fusion tracking (HTC, 2021). The controllers feature a button trackpad, trigger, grip button, menu button, and VIVE button, powered by two AAA batteries (for up to 4 hours of active use), according to HTC (2021).

Software

Unity 3D. As for any typical VR, a game engine is needed for the software development process. The researcher utilized the Unity Version 2019.4.14f1 game engine for the 3D model development to ease the porting process for different future platforms (Unity, 2019). Unity 3D is a software that helps the developer to create virtual scenes. It supports three programming languages, which are Boo, C#, and JavaScript. The Unity website also has tutorials and online chat, where all of the users can communicate and help each other. Furthermore, a free version is available, which reduces the cost of building a virtual application (Al Awadhi et al., 2017).

Engage. Teacher integration of new technologies is highly influenced by their beliefs (Tondeur, 2020; Tondeur et al., 2017). whereas external or first-order barriers such as access to resources, training, and support inevitably hinder the technology integration practices of teachers, it is the internal or second-order barriers such as teacher confidence, the perceived value of technology, and perceptions about how students learn that pose the greatest challenge to successful adoption (Ertmer et al., 2012). The researcher considered all of these beliefs when choosing the software used to create the IVR experience. Engage is an education and corporate training platform in VR. Per their website, Engage (2021)

> empowers educators and companies to host meetings, presentations, classes, and events with people across the world. Using the platform, virtual reality training and experiences can be created in minutes. The tools are very easy to use and require no technical expertise. You can choose to host your virtual reality sessions live, or record and save them for others to experience later. A wide variety of effective and immersive virtual experiences can be created with an extensive library of virtual objects, effects, and virtual locations available on the platform.

The ease of use and minimal learning time associated with Engage, combined with the ability to take 3D models created in Unity 3D, supported the decision to create the IVR experience using the Engage software.

CHAPTER 4

RESULTS

The purpose of this study was to investigate the impact of IVR technology on preservice teachers through an experience focused on the American Civil Rights Movement, specifically on knowledge attainment, lesson planning effectiveness, and motivation for future use in their instructional practice. The study was designed to determine the effects of the Boy From Troy, an IVR learning experience, on improving instructional strategies among preservice teachers preparing to teach P-12, particularly any effects the IVR experience had on preservice teachers' lesson planning. The chapter presents the results of this investigation of the influence of IVR on the instructional strategies of preservice teachers preparing to teach P-12. The specific focus was comparing results between two groups of preservice teachers. One group of preservice teachers experienced a lesson via an HMD, in a fully immersive manner (experimental group), whereas the second group of preservice teachers experienced it via a computer screen (control group). The researcher then conducted testing to determine what influence the mode of viewing the experience had on preservice teachers' lesson planning, content knowledge, and beliefs towards IVR technology. Underpinning the investigation's conceptual framework was the convergent parallel mixed-methods design, as described by Creswell and Creswell (2018).

Research Question 1 was the following: Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience? The data for Research Question 1 were collected via the scores on the Preservice Teacher Lesson Plan Rubric. The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variable for Research Question 1 was the score received by the preservice teachers on the Preservice Teacher Lesson Plan Rubric. An independent-samples *t* test was used to determine if there was a significant difference in the mean scores on the Preservice Teacher Lesson Plan Rubric of the IVR group and the 2D group. Results of the analysis were used to answer Research Question 1.

Research Question 2 was the following: To what extent does the instructional method affect the learning outcomes of preservice teachers? The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variables for Research Question 2 were the score on a content test before viewing the experience (pretest) and the score on a content test after viewing the experience (posttest). The scores were analyzed using a mixed-design ANOVA to determine any statistically significant differences in scores by groups, particularly change in score from pre- to posttest.

Research Question 3 was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The researcher focused on one dependent variable for Research Question 3: the intention of the preservice teachers to use IVR in their future instructional practice. The researcher used two types of data and data analysis to answer Research Question 3: (a) a survey administered to the IVR group and (b) qualitative data collected from participants' digital notebooks. To analyze the survey, the researcher utilized independent *t* tests. The survey items were rating scores. The researcher qualitatively analyzed the participants' digital notebooks for themes related to the Boy From Troy IVR experience and any other technology themes. According to Merriam and Tisdell (2016), rather than determining cause and effect, predicting, or describing some attribute distribution, researchers might be interested in uncovering the meaning of a phenomenon for those involved. As qualitative researchers are interested in understanding how people interpret their experiences and what meaning they attribute to their experience (Merriam & Tisdell, 2016), reviewing the participants' digital notebooks provided the researcher the ability to assess the various effects of the experience besides knowledge acquisition.

Based on the literature review, the researchers' experience as a teacher, and the researcher's work with IVR technologies, the following hypotheses or outcomes were anticipated:

1. The lesson plan scores for the IVR group would be on average higher than for the 2D group.
2. The participants in the IVR group would include more technology into their lesson plans by using a wider range of technology options.
3. The IVR group would show a higher improvement in scores from the pre- to posttest on the content quiz.
4. The participants would have had limited exposure to IVR and its related technologies.
5. The participants would enjoy the IVR experience, but it might be too new of a technology to make a significant impact on their intention for future use.

Participants

The study participants were a sample of preservice teachers from the population of 30 students enrolled in EDTP 322, Social Studies Methods; the final sample was 21. There were two sessions of EDTP 322, one on Monday and the other on Wednesday. There were 17 total students in the Monday session, and 10 of those students agreed to be in the study, two refused to participate, and five gave no response. The Wednesday session had 13 total students, and of those students, 12 agreed to participate and one refused. If a student refused or gave no response, their data were not collected.

Students enrolled in this course are undergraduates and seeking initial teacher certification. All students enrolled in the course had the opportunity to volunteer for participation in the study and were enrolled in the teacher preparation program of a medium-sized, southeastern U.S. university. The professor included permission to participate in studies in the syllabus. Study-specific consent procedures approved by the Institutional Review Board were followed per the policies of the University of Louisville Institutional Review Board and required of all participants. Participants were assured confidentiality, and no names or personally identifying information are reported in the study. Participation in the study required student completion of the course, completion of the pre- and posttests, successful completion of the IVR skills checklist, successful completion of the SSQ, as well as the submission of the UTAUT2 survey. In addition, students were required to be of legal age (18) and sign a consent form to signify their willingness to allow the results of their tests and survey data to be analyzed.

Participants of both groups combined (*N* = 21) were mostly female (19 out of 21, or 90.5%), in their junior year (76.2%), 20–21 years old (90.5%), and White (81%). Table 6 reports the participating preservice teachers' characteristics.

Table 6

Characteristics of Participants

Characteristic	Experimental group (*n* = 12)		Control group (*n* = 9)	
	n	%	*n*	%
Age				
20	6	50.0	3	33.3
21	4	33.3	6	66.7
22	1	8.3	0	0.0
23	1	8.3	0	0.0
Year in college				
Junior	8	66.7	8	88.9
Senior	4	33.3	1	11.1
Race				
White	10	83.3	7	77.8
Black	2	16.7	1	11.1
Black & White	0	0.0	1	11.1
Gender				
Female	11	91.7	8	88.9
Male	1	8.3	1	11.1

Research Question 1

Research Question 1 was the following: Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience? The data for Research Question 1 were collected via the scores on the Preservice Teacher Lesson Plan Rubric. The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variable for Research Question 1 was the score received by the preservice teachers on the Preservice Teacher Lesson Plan Rubric. An independent-samples *t* test was used to determine if there was a significant difference in the mean scores on the Preservice Teacher Lesson Plan Rubric of the IVR group and the 2D group.

To begin, box plots were used to examine the assumptions of the independent *t* test for lesson plan scores. Specifically, no outliers were identified in the data, as assessed by inspection of a boxplot for values greater than 1.5 box-lengths from the edge of the box.

Next, the researcher implemented the Shapiro-Wilk test to determine if data were normally distributed. The Shapiro-Wilk test is recommended with small sample sizes (< 50 participants). Engagement scores for each level of gender were normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). To check for the equality of variances, the researcher used the Levene test for equality of variances. Homogeneity of variances was found for lesson plan scores for the 2D and 3D groups (control and treatment), as assessed by Levene's test for equality of variances ($p = .879$). All the assumptions for the independent *t* test were met.

There were 9 participants in the 2D control group and 12 participants in the 3D experimental group. Scores on the Preservice Teacher Lesson Plan Rubric could range from 8–56. The lesson plan scores were higher in the 3D experimental group (M = 35.44, SD = 4.61) than in the 2D control group (M = 35.33, SD = 4.56). After inspection of the statistical output, the researcher determined there was not a statistically significant difference in mean lesson plan score between the 2D and 3D groups, $t(21) = -.055$, $p = .957$. Therefore, no statistically significant difference between means ($p < .05$) was reported, and thus the IVR learning experience did not affect the competency level of preservice teachers' lesson planning when compared to a 2D learning experience.

Research Question 2

Research Question 2 was the following: To what extent does the instructional method affect the learning outcomes of preservice teachers? The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variables for Research Question 2 were the total score on the pretest and posttest measuring content knowledge about the Civil Rights Movement, compared between control and experimental groups. Those scores were analyzed using a mixed-design ANOVA to determine any statistically significant differences in scores by groups, particularly change in score from pre- to posttest. The posttest was the same as the pretest, but with questions in a different order.

Descriptive Statistics

An initial analysis was completed using the raw scores for each group. The raw score was based on a percentage of questions answered correctly, based out of a total possible score of 100. The average overall mean score on the pretest was 42.86, with a standard deviation of 15.86. The average overall mean score for the posttest was 80.95, with a standard deviation of 15.46. Table 7 reports descriptive statistics by group.

Table 7

Descriptive Statistics for Mean Scores on Content Test

Test	Experimental group (*n* = 12)	Control group (*n* = 9)
Pretest	35.83	52.22
Posttest	82.50	78.89
Change in score	46.67	26.67

The mixed-design ANOVA compares the mean differences between groups that have been split on two independent variables (Field, 2009). The primary purpose of a mixed ANOVA is to understand if there is an interaction between the two independent variables on the dependent variable. To run a two-way mixed ANOVA, eight assumptions need to be considered. The first three assumptions relate to statistical testing choice and were met and support the choice of a mixed ANOVA.

According to Fox (2016), an assumption of the mixed ANOVA is that there should be no significant outliers in any cell of the design. There were no outliers in the data, as assessed by inspection of a boxplot for values greater than 1.5 box-lengths from the edge of the box. There were no outliers, as assessed by examination of studentized residuals for values greater than ±3. The assumption of normality is necessary for statistical significance testing using a mixed ANOVA. However, according to Fox, the mixed ANOVA is considered robust to violations of normality. This means that some violation of this assumption can be tolerated and the test will still provide valid results.

The Shapiro-Wilk test is recommended with smaller sample sizes (< 50 participants). Test score was normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). The dependent variable should be approximately normally distributed for each cell of the design. Test score was normally distributed, as assessed by the normal Q-Q plot.

The variance of the dependent variable should be equal between the groups of the between-subjects factor. This assumption is referred to as the assumption of homogeneity of variances (Lehmann & Romano, 2005). The population variance of the residuals between the groups must be equal. This assumption is necessary for statistical significance testing in the mixed ANOVA. Although this assumption can be violated a little in studies with equal, but not small, sample sizes in each cell of the design, it is an important assumption for a mixed ANOVA, particularly when sample sizes are not equal (Maxwell & Delaney, 2004). There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance ($p > .05$). The researcher ran a Box's test of equality of covariance matrices in addition to the Levene's test and found homogeneity of covariances, as assessed by Box's test of equality of covariance matrices ($p = .380$).

ANOVA

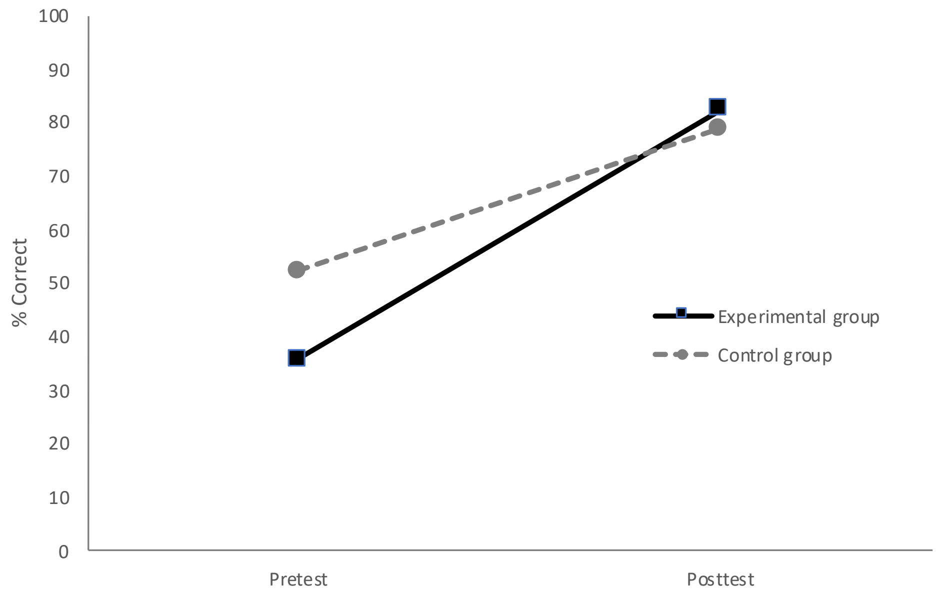
The researcher analyzed the descriptive statistics and determined a statistically significant interaction between the method of experience and pre- and posttest score on the content quiz, $F(1, 19) = 7.05$, $p < .001$, partial $\eta^2 = .271$. The within-subjects main effect showed that the sample as a whole reported a higher posttest score than pretest score. As noted earlier, the overall mean score for all participants regardless of group membership on the pretest was 42.86 (*SD* = 15.86) and 80.95 for the posttest (*SD* = 15.46).

The between-groups main effect showed that the experimental group outperformed the control group on the posttest and in terms of change in score, irrespective of repeated measures. The between-groups main effect showed a statistically significant difference in change in scores overall between the treatment and control groups, $F(1, 19) = 2.70$, $p = .005$, partial $\eta^2 = .014$. Both groups did show improvement from the pretest to posttest, but the experimental group improved significantly more than the control group, allowing the researcher to reject the null hypothesis.

The interaction effect showed that the posttest score was statistically significantly greater in the experimental group compared to the control group. Although the control group did improve in their overall mean score, they did not improve a statistically significant amount. The experimental group made a greater overall improvement in scores, and that improvement was statistically significant. The results lead the researcher to reject the null hypothesis that there would be no statistically significant difference in overall score improvement from pre- to posttest dependent upon group membership. Figure 4 graphically illustrates what scores looked like across groups on the pre- and posttest.

Figure 4

Pre- and Posttest Content Scores by Group



Research Question 3

Research Question 3 was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The researcher focused on one dependent variable for Research Question 3: the intention of the preservice teachers to use IVR in their future instructional practice. The researcher used two types of data and data analysis to answer Research Question 3: (a) a survey given to the IVR group and (b) qualitative data collected from participants' digital notebooks.

The participants invited to take part in the survey were 12 preservice teachers who were randomly assigned to the IVR 3D experimental group. Out of the total possible number of participants eligible to take part in the survey, 100% (12 participants) elected to take the survey.

The UTAUT2 model (Venkatesh et al., 2003) was used to frame the survey. According to Bower et al. (2020), the UTAUT2 is one of the most established and robust frameworks for investigating technology perceptions. Subsequent qualitative analysis of participant digital notebooks was used to provide a complete understanding of reasons for preservice teacher perceptions and behavioral intention to use IVR in education. As described earlier, the survey included 19 items based on the UTAUT2 instrument (Venkatesh et al., 2012) and using a 7-point Likert scale (1 = *strongly agree* to 7 = *strongly disagree*) and 11 items using a 5-point Likert scale.

UTAUT2 Portion of Survey

The first part of the survey included 19 items rated on a 7-point Likert-type scale (1 = *strongly agree* to 7 = *strongly disagree*) that measured seven dimensions of the UTAUT2 model: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Behavioral Intention. The researcher conducted an item analysis of the survey instrument to determine how items were functioning. The researcher then created the raw score based on summing items together. A questionnaire was employed to measure different, underlying constructs. The reliability coefficient for the instrument of measurement was calculated via Cronbach's alpha. Cronbach's alpha is a common measure of internal consistency (a measure of reliability) and is used to examine the interrelationship among a set of scale items. Results are shown in Table 8. Six of the seven constructs had Cronbach's alpha values above 0.70; hence, the results indicated good internal consistency of items in the measurement scale. Thus, the results of the confirmatory factor analysis confirmed that the factors in the survey model provided an acceptable means of describing preservice teacher perceptions of IVR use in education. The one construct that did not meet the .70 threshold was Hedonic Motivation, which had a Cronbach's alpha of .66. The two items for that factor could be too similar: "VR is enjoyable" and "VR is very entertaining."

Table 8

Cronbach's Alphas for Item Sets of Survey

Factor	Survey items	Cronbach's alpha
Performance Expectancy	1–3	.723
Effort Expectancy	4–6	.796
Social Influence	7–9	.900
Facilitating Conditions	10–13	.738
Hedonic Motivation	14–15	.660
Price Value	16–17	.775
Behavioral Intentions	18–19	.821

Table 9 presents the descriptive statistics. Lowest scores—indicating greatest agreement—were for "Using IVR is very entertaining," "Using VR is enjoyable," "I intend to continue using VR in the future," "Using VR is helpful for accomplishing things more quickly in teaching," "Learning how to use VR is easy for me," and "It is easy for me to become skillful at using VR." Lowest levels of agreement, measuring about neutral, were for having resources for IVR and sources for help. By factor, Hedonic Motivation (M = 1.34) showed the lowest scores (agreement), followed by Performance Expectancy (M = 1.97), Behavioral Intention (M = 2.05), and then Effort Expectancy (M = 2.31).

Table 9

Descriptive Statistics, Survey Questions 1–19

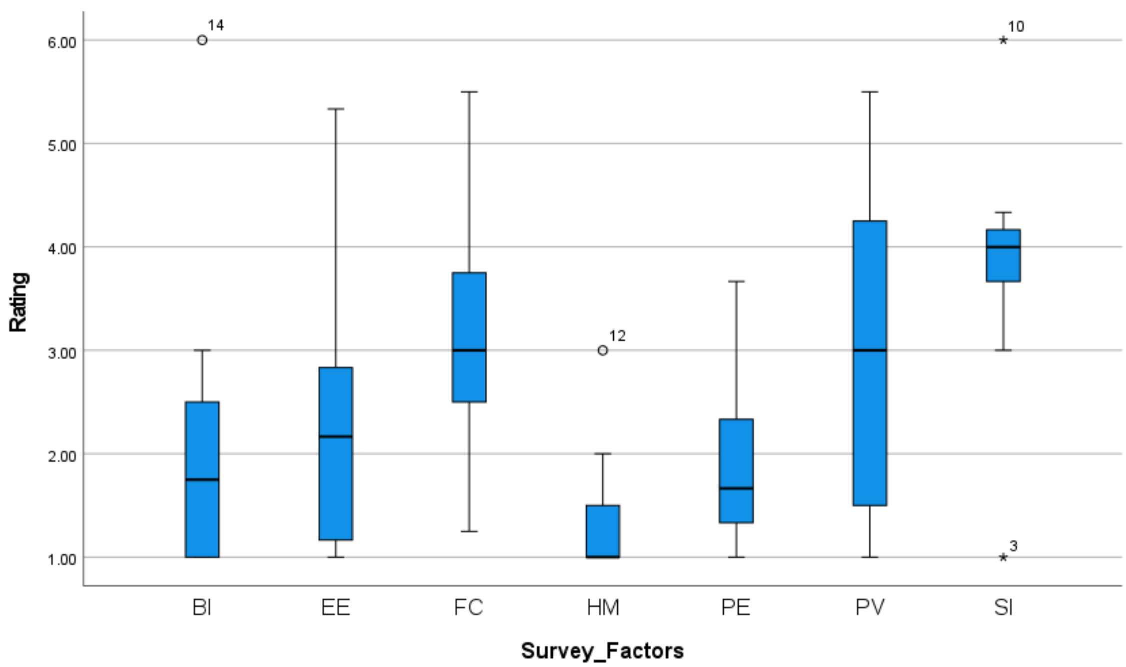
Question	Min.	Max.	Mean	*SD*
Performance Expectancy			1.97	0.90
1. I think VR is useful for teaching in schools	1	5	2.17	1.58
2. Using VR is helpful for accomplishing things more quickly in teaching	1	3	1.75	0.75
3. Using VR helps increase my teaching productivity	1	3	2.00	0.95
Effort Expectancy			2.31	1.25
4. Learning how to use VR is easy for me	1	5	1.92	1.24
5. My interaction with VR technology is clear and understandable	1	6	3.08	1.78
6. It is easy for me to become skillful at using VR	1	5	1.92	1.38
Social Influence			3.83	1.13
7. People who are important to me think that I should use VR	1	6	3.75	1.29
8. People who influence my behavior think that I should use VR	1	7	3.92	1.31
9. People whose opinions that I value suggest that I use VR	1	5	3.83	1.12
Facilitating Conditions			3.17	1.26
10. I have the resources necessary to use VR	1	6	3.92	1.98
11. I have the knowledge necessary to use VR	1	6	2.17	1.70
12. VR is compatible with other technologies I use	1	4	2.50	1.09
13. I can get help from others when I have difficulties using VR	1	6	4.08	1.83
Hedonic Motivation			1.33	0.62
14. Using VR is enjoyable	1	3	1.42	0.79
15. Using VR is very entertaining	1	3	1.25	0.62
Price Value			3.00	1.59
16. VR is reasonably priced	1	6	3.42	1.98
17. VR is a good value for the money	1	5	2.50	1.51
Behavioral Intention			2.04	1.44
18. I intend to continue using VR in the future	1	6	1.67	1.44
19. I will always try to use VR in my teaching	1	6	2.42	1.68

Note. *N* = 12. Score based on a scale of 1 = *strongly agree* to 7 = *strongly disagree*.

Figure 5 shows the graphical representation of the distributions of the seven factor constructs in box plot form. There were outliners towards the lower end of the scales for Behavioral Intentions, Hedonic Motivation, and Social Influence; however, one respondent was an outlier across all three constructs. The mean of Hedonic Motivation (enjoyment) received the highest rating of any factor, whereas the lowest rated factor was Social Influence. Social Influence had the most variation in responses, as compared to Hedonic Motivation, which had the least variation. The notebook responses shed light on reasons for the wide difference in preservice teachers' responses.

Figure 5

Box Plot of Factors Measured by Survey



Note. BI = Behavioral Intention; EE = Effort Expectancy; FC = Facilitating Conditions; HM = Hedonic Motivation; PE = Performance Expectancy; PV = Price Value; SI = Social Influence.

Hedonic Motivation

The Hedonic Motivation construct scored the lowest (best) overall with a mean score of 1.33 (*SD* = 1.58). This is the same result that Bower et al. (2020) reported when they conducted their survey. The participants scored the two items in Hedonic Motivation higher than any other items. “Using VR is enjoyable” had an overall mean score of 1.42 (*SD* = 0.8), and “Using VR is very entertaining” had an overall mean score of 1.25 (*SD* = .062), the best rated item on the survey. For teacher acceptance of IVR technology, first and most importantly they need to find it enjoyable before they will use it in their classrooms.

Performance Expectancy

The overall mean score for Performance Expectancy was 1.97 (*SD* = 1.58), which was the second highest score behind hedonic motivation. The perceived ability of the technology to be able to improve their teaching was the second most important construct for participants when deciding if they will use IVR in their instruction. According to their responses, preservice teachers rated that using VR is helpful for accomplishing things more quickly in teaching (*M* = 1.75, *SD* = 0.754). Although no participants specifically referenced time in their notebook items, they discussed elements such as VR being “super hands on and interactive, so it keeps students engaged.” The longer the teacher can keep the student engaged, the more effective the lesson. Therefore, teachers might consider highly engaged lessons as more effective, which requires less time to achieve the lesson objectives.

Behavioral Intention

The overall mean score for Behavioral Intention was 2.04 (*SD* = 1.44), and participants rated it the third most important construct. The individual items of "I intend to continue using VR in the future" (*M* = 1.67, *SD* = 1.43) and "I will always try to use VR in my teaching" (*M* = 2.42, (*SD* = 1.68) are strong support for the hypothesis that teachers will continue to use IVR in their instruction. The other constructs revealed what preservice teachers feel are most important when deciding if they will adopt IVR into their instructional practice. They want the experience to be enjoyable, and they want IVR to have a measurable positive impact on student learning.

Effort Expectancy

The overall mean score for Effort Expectancy was 2.31 (*SD* = 1.25), which made Effort Expectancy the fourth most important construct for participants. Two items were rated equally (*M* = 1.92): "Learning how to use VR is easy for me (*SD* = 1.24) and "It is easy for me to become skillful at using VR (*SD* = 1.4). If preservice teachers are going to adopt IVR into their instructional practice, the technology needs to be easy for them to learn and become proficient users.

Price Value

Price Value was rated as the fifth overall most important construct with an overall mean score of 3.00 (*SD* = 1.60). The individual item of "VR is reasonably priced" had an overall mean score of 3.42 (*SD* = 2.0), close to the neutral rating of 4 (*neither agree nor disagree*). One potential barrier to IVR adoption in the educational setting is the price. Participants did rate that VR is good value for the money (*M* = 2.5, (*SD* = 1.51).

Facilitating Conditions

The second lowest rated construct was Facilitating Conditions with an overall mean score of 3.17 (*SD* = 1.26). This was not unexpected because of the newness of the technology. Similar to the Social Influence construct, where participants did not feel that people who influence their behavior have heard of IVR, they also feel unsure about the level of support they could receive. The overall lowest scored item on the survey was "I can get help from others when I have difficulties using VR" (*M* = 4.08, representing *neither agree nor disagree, SD* = 1.83). Potential lack of support from people with the necessary knowledge to support their use of IVR is an important factor for IVR creators developing the technology. Teachers will need a strong support network that can help them navigate the problems or barriers they experience when trying to integrate VR into their instructional practice.

Social Influence

The least amount of agreement was for Social Influence, with an overall mean score of 3.83 (*SD* = 1.13) indicating nearly neutral ratings and thus the least importance. The item "People who influence my behavior think that I should use VR" was scored overall the second lowest of any item at 3.92 (*SD* = 1.31). One reason for this low rating could be that as IVR technology is new, most people have not heard about it or do not know enough to start discussing it. In a notebook, Participant 15 stated, "Virtual reality is a new piece of technology that will most likely be in the schools in the near future." People in the educational field are still learning about IVR and how it can be used, so future research might see this rating shift dramatically.

When inspecting the items and how they related to each other, the researcher noted that items functioned as they were hypothesized to do. For example, the item "Learning how to use VR is easy for me" had a -1.36 impact on "I think VR is useful for teaching in schools." This indicated that the more difficult the participant finds the technology to learn, the less valuable they think it is for teaching. This finding supports those of G. Cooper et al. (2019) when they investigated preservice teachers' self-efficacy to use VR in their pedagogy. They too discovered that the more confidence a preservice teacher had in their ability to use the technology, the higher they rated its value in their teaching practice. A Pearson correlation coefficient lower than .3 is cause for concern because it is an indication that this particular item might not be measuring the same construct (Kline, 2005). The researcher found one item below the suggested threshold of .3 for corrected item total correlation: "Using VR is helpful for accomplishing things more quickly in teaching" at $r = .148$. She removed this item and ran the factor analysis again. The resulting Cronbach's alpha slightly increased to .877. As this was not a significant difference, the researcher left the item in the analysis.

The Boy From Troy Rating Portion of the Survey

The second portion of the survey asked about how natural the interactions with the virtual world seemed, how engaging the training was, various aspects of becoming comfortable with the IVR, and emotional reactions to the experience on a 5-point scale (1 = *strongly agree* to 5 = *strongly disagree*). Overall, lower scores represented greater response and greater likelihood to use VR in the classroom. This part of the survey was specifically related to the experience created by the researcher. The first part of the survey was about IVR and the general use of it in educational practice. The 5-point scale item questions were specifically related to the Boy From Troy and the participants' perceptions about that specific IVR experience.

Although the Cronbach's alpha for these items did not meet the .70 suggested threshold, it was still relatively high at .623. The researcher has a few hypotheses on why this might be. The first is that the experience was not as interactive as she had originally intended. The initial plan, when the survey was created and received Institutional Review Board approval, was to have the participants try to vote themselves and pack their own backpack. However, due to time constraints based on the class schedules being changed because of the COVID-19 pandemic, the researcher was not able to fully integrate these interactive components into the experience. In future studies, including fully interactive components may add to the feeling of presence and emotion that the researcher was originally intending.

Descriptive statistics of preservice teacher responses to the Likert-type scale questions from the second part of the survey revealed a wide variety of ratings, with mean scores across the questions ranging from 2.33 to 3.08 (see Table 10). There was also a wide range of perceptions within items, reflected in the standard deviations that ranged from 0.67 to 1.27.

Table 10

Descriptive Statistics, Survey Questions 20–30

Question	Mean	*SD*
20. How natural did your interactions with the virtual world seem?	2.33	1.07
21. How engaging did the visual aspects of the virtual world seem?	2.58	0.90
22. How engaging did the auditory (sound) aspects of the virtual world seem?	3.08	1.17
23. How compelling was your sense of moving around inside the virtual world?	2.83	1.27
24. How quickly did you adjust to the virtual world experience?	2.58	1.08
25. How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?	2.83	0.94
26. How much did the visual display quality interfere with or distract you from performing assigned tasks or required activities?	2.92	0.67
27. How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?	2.50	1.17
28. I felt like I was a part of the march.	3.00	1.04
29. I felt fear when the police approached me.	2.67	1.16
30. I felt like I was a part of the Civil Rights Movement.	2.17	0.94

Note. *N* = 12. Score based on a scale of 1 = *strongly agree* to 5 = *strongly disagree* or, for example, 1 = *very engaging* and 5 = *very unengaging*.

When inspecting the items and how they related to each other, the researcher noted that items functioned as they were hypothesized to do. For example, the item "How much did the visual display quality interfere with or distract you from performing assigned tasks or required activities" had a .337 positive impact on the item "I felt fear when the police came towards me." This indicates that the higher the quality of the visual display and thus fewer distractions allowed the participant to focus on the experience.

When the visual quality was high, they had an emotional fear reaction to the police coming towards them, which was an original goal the researcher set for the experience.

The distributions of the 11 items were examined in box plot form. There were outliners towards the higher end for “How much did the visual display quality interfere with or distract you from performing assigned tasks or required activities?” There were also outliners towards the higher end for “How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?”

The participants rated “I felt like I was a part of the Civil Rights Movement” the best with an overall mean score of 2.17 (*SD* = 0.94). Despite the experience not having all of the original interactive components that the researcher had intended, the participants still felt a strong connection to the subject matter. The participants rated “I felt fear when the police approached me” with an overall mean score of 2.67 (*SD* = 1.16). The strong mean score for the emotional response supports some of the statements the participants made in their digital notebooks. Participant 7 stated,

> The students were able to go through an experience with VR to see all the things that John Lewis may have experienced during the time period. The students are more engaged and involved with the VR experience. They are given a new perspective on this time of fighting for social justice, and it can engage the students to be more involved and absorb more to develop a stronger understanding of John Lewis and his involvement during these times.

The participants were emotionally impacted by the experience as illustrated by their notebook responses, as well as their ratings on the survey questions.

The least positively rated item was “How engaging did the auditory (sound) aspects of the virtual world seem?” with an overall mean score of 3.08 (*SD* = 1.17). The audio clips used for the experience were quite old, some being more than 50 years old.

The researcher did use the highest quality audio available, but the sound might not have been of the quality to make more of an impact with the participants.

Qualitative Analysis

Further data to answer Research Question 3 were gathered through qualitative data in personal notebooks from participants. Personal documents refer to any “first person narrative that describes an individual's actions, experiences, and beliefs” (Bogdan & Biklen, 2011, p. 133). According to Merriam and Tisdell (2016), in “some ways documents are like observations in that documents give us a snapshot into what the author thinks is important, that is, their personal perspective, while observations allow us to see over behavior” (p. 167). The researcher reviewed the digital notebook responses from the participants to discover, in their own words, what they deemed was important.

The participants in this study were required to keep a digital interactive notebook throughout the semester. The professor, in 2020, explained the digital interactive notebook as follows:

> During this course, you will be maintaining a detailed, electronic interactive notebook that includes all Notebook Items (class activities), class notes, handouts, taught lesson plans, etc. Purpose and teaching procedures for the activities should also be documented. The notebook will be a modified version of the model described by the History Alive curriculum. The purpose of the notebook is not only to document the social studies activities in class, but also to be a resource to you in your teaching. A reflection component embedded in most face-to-face classes will provide an opportunity to think about the social studies activities and integrate the research from course readings. The notebook is due at the end of the last class. Several electronic versions will be shown in class as potential models for your own notebook.

The researcher analyzed the participant’s digital notebooks for any themes related to the Boy From Troy IVR experience and any other technology themes. Reviewing the digital notebooks of participants allowed the researcher to gain valuable insight into the participants' minds. When reviewing the notebooks, the researcher was not investigating any specific data component, but rather mining the documents for detailed descriptions of people's activities, behaviors, and emotions regarding the Boy From Troy experience (see Patton, 2015).

Positionality

The researcher had been working with IVR technology for over 6 years at the time she conducted the study. She has laid out the research supporting her hypotheses that IVR technology is beneficial to educational instruction across a wide range of variables. She is aware of this and wanted to ensure that she included all aspects of participant beliefs. When creating the coding scheme to analyze the notebook responses, she included a code for "Inappropriate." She did this so that she could highlight participants' emotional reactions, whether positive or negative. The researcher is presenting the most complete report of all results and checking herself to ensure that, as much as possible, her own emotional desires do not influence the validity of the qualitative reporting.

Codes

The researcher used seven codes to identify themes across the participants' digital notebook entries. Table 11 highlights the seven codes, their definitions, and how many times they were assigned across the analysis.

Table 11

Codes From Analysis of Participant Notebooks

Code	Description	Frequency code mentioned or assigned
Engagement	Participant specifically used the word “engage” or discussed how the technology was engaging.	29
Emotion	Participant specifically used the word “emotional” or described feeling a specific emotion, such as “happy,” “excited,” or “scared.”	22
Perspective	Participant specifically used the word “perspective” or discussed the idea of understanding a time/place/event from another person’s perspective.	22
Enjoyment	Participant specifically used the word “enjoy” or discussed what they “liked” about the technology/experience.	7
Interactive	Participant specifically used the word “interactive” or discussed the interactive components/possibilities.	4
Versatile	Participant specifically used the word “versatile” or mentioned multiple uses, availability to multiple users.	2
Inappropriate	Participant specifically used the word “inappropriate” and discussed a certain age group they felt the experience would be appropriate or inappropriate for.	1

Note. *N* = 21.

The first major theme or code that the researcher noted from the analysis of the digital notebooks was engagement. More participants noted that the engagement that IVR creates is the most important factor and the aspect of the technology that impressed them the most. A few participants even discussed how IVR is more engaging than a standard 2D video. Participant 15 explained:

> Comparing the YouTube video of the Boy From Troy and the VR experience, the two forms did not compete in the slightest. The VR experience eliminates all distractions in the classroom and has the student 100% focused on the experience.

> VR puts the student in a scene for them to experience like they were originally there. Utilizing VR allows students to be present in these historical events guiding them to feel emotions and make connections they would not necessarily feel from a textbook or a YouTube video.

Participant 15 felt that the two different forms of technology did not compare and that IVR would guide their students to feel stronger emotions and make more significant connections than a video or textbook. This theme of engagement is an important result to the researcher because engagement was not a specific word used across the survey. The survey asked about participants' views on how useful they felt IVR could be in their instructional practice, but the notebook items helped the researcher learn exactly what aspect of the technology the participants valued. This critical information will be valuable to IVR content creators who design experiences for educational uses.

Two other themes or codes were mentioned frequently throughout the participants' digital notebook entries: "emotion" and "perspective." These two themes were typically mentioned together. Participant 4 stated,

> In my classroom I would love to use VR if I have the opportunity. I think VR can be a powerful tool in helping students build empathy for social justice topics. VR is such an exciting new tool for education, I hope to use it in the future. The VR experience is a new tech that has been adopted for the classroom. VR is so fantastic for the classroom because it can be used in so many ways while keeping students entertained and engaged in the learning process.

Participant spoke about the power of IVR as a tool for educators to help students build empathy and experience emotionally difficult situations from another person's perspective. A significant amount of emotion was discussed throughout Participants 4's entry, and the focus of the entry was the ability of IVR to help expand student empathy.

This finding is directly in line with research that has shown the effectiveness of using IVR for empathy (Bower et al., 2020). According to Borba (2018), "Empathy—or the ability to understand others' feelings and needs—is also the foundation of a safe, caring, and inclusive learning climate" (p. 22). Students with high levels of empathy display more classroom engagement, higher academic achievement, and better communication skills (Jones et al., 2014). Empathy reduces aggression, boosts prosocial behaviors (Eisenberg et al., 2010), and may be the best antidote to bullying and racism (Santos et al., 2011). For teachers, finding successful strategies to help children develop empathy for others can be a stressful and difficult task. IVR provides an effective and engaging method for them to put their students directly into varying experiences, allowing them to feel the emotion of the event, and truly understand what another person's perspective.

Roswell et al. (2020) conducted a study utilizing IVR to cultivate empathy and advance conversations about racism, inequity, and climate in medicine. Their initial results suggested that using VR as a platform for discussing structural racism was most effective in heightening engagement, enhancing racial empathy, and improving communication (Roswell et al., 2020). The participants in this study repeatedly discussed the ability of IVR technology to help students understand other perspectives and develop empathy. Participants described how the engagement makes IVR a valuable asset to their instructional practice.

Conversely, Participant 19 stated, "I would not show this particular video to my students due to its gruesome nature and gun violence that may be triggering for students." This participant made a valid point. This statement was coded as "inappropriate" because the participant did not feel the IVR was right for students and did not state if they thought there was a specific age when it would be appropriate. The effectiveness of IVR to immerse a user in an experience must be respected and considered when teachers are deciding whether or not to use it in their classroom. Students will have background experiences, traumas, and emotions that they enter the classroom with, and teachers need to be aware of what topics might cause further trauma if not handled in a supportive manner.

Summary

Research Question 1 was the following: Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience? An independent-samples *t* test was used to determine if there was a significant difference in the mean scores on the Preservice Teacher Lesson Plan Rubric of the IVR group and the 2D group. The lesson plan scores were higher in the 3D experimental group (M = 35.44, SD = 4.61) than in the 2D control group (M = 35.33, SD = 4.56). However, the difference was not statistically significant, $t(21) = -.055$, $p = .957$. Therefore, the IVR learning experience did not affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience.

Research Question 2 was the following: To what extent does the instructional method affect the learning outcomes of preservice teachers? The dependent variables for Research Question 2 were the total score on the pretest and posttest measuring content knowledge about the Civil Rights Movement, compared between control and experimental groups. The between-groups main effect showed a statistically significant difference in change in scores overall between the treatment and control groups, $F(1, 19) = 2.70$, $p = .005$, partial $\eta^2 = .014$. Both groups did show improvement from the pretest to posttest, but the experimental group improved significantly more, suggesting the IVR experience increased content knowledge.

Research Question 3 was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The researcher used two types of data and data analysis to answer Research Question 3: (a) a survey given to the IVR group and (b) qualitative data collected from participants' digital notebooks. Participants reported the IVR was enjoyable and that they intended to use VR in the future. Participants also described learning to use IVR as easy. Lowest levels of agreement, measuring about neutral, were for having resources for IVR and sources for help. Participants also indicated the Boy From Troy experience evoked an emotional response. Participant notebooks revealed the Boy From Troy was perceived to be engaging, emotional, and an effective way to gain a new perspective on historical events.

CHAPTER 5

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

A review of the literature revealed that the use of IVR technologies has been increasing steadily in the K-12 educational environment. Advancements towards more user-friendly technology, increased affordability, and improved accessibility to technology allow educators to become their own IVR experience designers. Teachers have the power to create an authentic real-world experience and provide students realistic simulations that would otherwise be impossible. Although the benefits of IVR as an instructional tool for learners have been documented, the benefits to educators to understand complex pedagogical concepts on how to implement immersive technology experiences have not been fully explored. Therefore, the purpose of this study was to investigate the impact of IVR technology on preservice teachers through an experience focused on the American Civil Rights Movement, specifically on knowledge attainment, lesson planning effectiveness, and motivation for future use in their instructional practice.

In this study, two groups of preservice teachers from a medium-sized, southeastern U.S. university were taught identical learning modules on the pedagogical concept of IVR in an elementary Social Studies Methods course. The only difference between the groups was the technological method of the IVR lesson. A total of 21 preservice teachers out of 30 participated in the study for a participation rate of 70%. Preservice teachers of both groups combined (N = 21) were mostly female (19 out of 21, or 90.5%), in their junior year (76.2%), 20–21 years old (90.5%), and White (81%).

There were nine participants in the 2D control group and 12 participants in the 3D experimental group.

The following research questions were investigated:

1. Does the IVR learning experience affect the competency level of preservice teachers' lesson planning when compared to a 2D learning experience?
2. To what extent does the instructional method affect the learning outcomes of preservice teachers?
3. To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction?

To test for differences in lesson planning scores, one instrument was utilized, the Preservice Teacher Lesson Plan Rubric, which included one item each from STOT Standards 1, 2, 3, 4, 5, and 8. The final, seventh standard is a technology-specific standard adopted from the Technology Integration Assessment Rubric, a performance-based evaluation of the TPACK rubric created by Hofer et al. (2011). To test for differences in knowledge attainment, one instrument was utilized, a 10-question online multiple-choice test on various aspects of the American Civil Rights Movement. To test for differences in reasons associated with preservice teacher intention to use IVR in education, the author used a survey based directly on the UTAUT2 instrument (Venkatesh et al., 2012), with some adjustments to wording to account for the specific technology (IVR) and context (education) being investigated. The survey is a 7-point Likert-type scale (1 = *strongly agree* to 7 = *strongly disagree*) that measures the seven dimensions of the UTAUT2 model: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Behavioral

Intention. Survey Questions 1–19 were from the UTAUT2 instrument, using a 7-point Likert-type scale, as noted above. Question 20 asked about how natural the interactions with the virtual world seemed on a 5-point scale (1 = *very natural* to 5 = *very unnatural*). Questions 21–22 asked about how engaging the training was, on a 5-point scale (1 = *very engaging* to 5 = *very unengaging*). Questions 23–27 asked about various aspects of becoming comfortable with navigating the virtual world. Questions 28–30 asked about emotional reactions to the experience, such as "I felt fear when the police approached me" and were scored on a 5-point scale (1 = *strongly agree* to 5 = *strongly disagree*). The author reviewed the qualitative aspects of preservice teachers' work through their digital notebook responses, as the final method to determine the effects of the Boy From Troy, the IVR lesson, on preservice teachers' intentions on implementing IVR as an instructional method in their own future practice. The findings from this study are discussed in this chapter based on the data analysis of the instruments.

Discussion

Research Question 1

Research Question 1 was the following: Does the IVR learning experience affect the competency level of preservice teachers' lesson planning compared to a 2D learning experience? The data for Research Question 1 were collected via the scores on the Preservice Teacher Lesson Plan Rubric. The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variable for Research Question 1 was the score received by the preservice teachers on the Preservice Teacher Lesson Plan Rubric. The lesson plan scores were higher in the IVR experimental group (*M* = 35.44, *SD* =

4.61) than in the 2D control group (*M* = 35.33, *SD* = 4.56). However, results of an independent-samples *t* test revealed no statistically significant difference in mean lesson plan score between the 2D and IVR groups, $t(21) = -.055$, $p = .957$. Therefore, the IVR learning experience did not affect the competency level of preservice teachers' lesson planning when compared to a 2D learning experience.

These results could be attributed to any of the factors listed below. First, one factor that must be carefully considered when discussing all of the research questions was the COVID-19 pandemic. The pandemic interrupted life for everyone, and university students were no exception. This study took place during their first semester back to any in-person learning after being remote only for almost a year. Students were required to maintain social distancing guidelines and follow all mask mandates. This meant they were not allowed to sit at the same tables or gather in large groups, and the PLC process was not as effective as it could have been.

The mask mandate was a significant factor when looking at results of the study. Participants in the study did complain that even though they were used to the masks, they were still hot and uncomfortable. The students were required to wear the masks when using the HMD, and this was a variable that could not have been avoided. The masks did cause some fogging of the lens during the experience, which would break the presence the researcher was trying to create.

The number of participants was affected by the COVID-19 pandemic. This was the students' first semester back to any in-person learning, but at the beginning of the semester students had the option to remain remote if they chose to. The students were also allowed to decide weekly whether they wanted to attend class in person or remotely.

Three participants who had been randomly assigned to the IVR group emailed the professor the morning of class telling him they would not be at class in person that night. The researcher had to change these three participants' group membership, which resulted in the unequal number of participants in the two groups.

The researcher implemented and explained all of the extensive safety measures to the participants, but fear of equipment contamination was also a factor. The participants were required to record the number of the HMD they used for the initial training. Then, when the researcher came back and ran the study, they received the same HMD. Those HMDs were not used by anyone else during the time between the training and study, and they went through a sanitation process via a Cleanbox. According to the Cleanbox (2021) website, the proprietary engineering of UVC light in an LED provides safe hygiene and is lab tested to kill 99.999% of contagions without the use of chemicals, heat, or liquids. Despite all of these precautions, the HMD does go on the face and sits right over the nose and mouth, which are the two major areas of concern with the spread of COVID-19. When this study took place, there was no vaccine yet, and a high number of new COVID-19 cases were being reported daily in the city where the study university is located. The COVID-19 pandemic was not the only factor affecting the results of the study, but it was a significant factor whose true impact might never adequately be known.

The second factor was technical. Despite the researcher running through the IVR experience on each HMD and experiencing no problems, during the actual study unforeseen technical issues arose. The university's internet went through an unscheduled update that afternoon and changed some firewall settings. This change in setting affected the IVR experience because the firewall blocked some of the Engage software from loading properly. The researcher and lead professor were still able to get all participants through the experience; however, these delays could have been significant to the participants. The delays potentially interrupted the viewing experience, breaking that presence that is crucial to the IVR experience. The experience might have been less impactful for the participant, and therefore they might have been less motivated to plan for the technology in their own lesson plan assignment. This delay could have been frustrating for the participants to the point that they now associate IVR with a negative experience. They might feel that IVR is too difficult to implement effectively as they saw the researcher having problems with the technology.

The third factor was the short exposure. Although the participants had a previous experience where they learned about IVR technology, it was only one lesson. The impact of one lesson is not significant enough for preservice teachers to start and plan for consistent use of IVR and its related technologies. One participant stated in their notebook,

> "Virtual reality is something that I have not experienced prior to this class period, but once you put the headset on all of your focuses is on the video from all angles around you. Virtual reality makes you feel like you are in the event, in there with the characters."

Preservice teachers have been learning about digital presentation software such as Microsoft PowerPoint and Google Slides for years, and yet only one participant actually planned for student use in their lesson. PowerPoint even has the functionality now where the user can integrate moveable, functioning 3D models into their slide shows. However, at the institutional level, those skills are not being taught, resulting in the lack of use by preservice teachers.

Finally, the individual mean scores of the individual standards suggest some interesting observations. When looking at the individual standards, the lowest average score for the IVR group (4.1) was for the technology standard “Instructional Strategies & Technologies (Using technology in teaching/learning).” The three lowest scores for the 2D group were for the technology-specific standards (4.2). Out of all the different aspects of teaching being rated, the overall lowest average score was for technology integration. The preservice teachers overall scored worse on integrating technology as a whole into their lesson plans than they did anything else. This is not specific to IVR; they struggle to plan for the utilization of technology into their instructional practice. An international comparison of millennials’ performance on the Programme for International Assessment of Adult Competencies technology test ranked the United States last out of 19 participating countries (Educational Testing Service, 2015). Despite the fact that there were numerous forms of technology used and taught in this class, and a slide listing all those technologies displayed for all the students during the lesson planning, preservice teachers are still not utilizing technology in their lesson plans. The results of the lesson plan rubrics support this struggle for teachers to plan for technology.

The highest rated standard for the IVR group was “integrates culturally relevant content to build on learners’ background knowledge.” One goal of the researcher when designing the experience was for the preservice teachers to be emotionally impacted. The researcher hypothesized that if the preservice teacher is impacted enough, they will adjust how they plan for lessons to include more culturally relevant material.

The researcher hypothesized that the participants in the IVR group would include more technology into their lesson plans by using a wider range of technology options.

When reviewing all of the lesson plans, only two participants actually planned for any student use of technology. Both of those participants were in the IVR group. One participant planned for the students to make an interactive PowerPoint presentation to share their work with the rest of the class. The other participant planned for the students to use an app that allows them to record themselves responding to various questions as opposed to having to write them. The other 19 participants all planned for students to cut and paste, color in pictures (or draw), or fill in graphic organizers such as a timeline or create a poster. None of those are bad ideas or unsound instructional practices; however, the research has shown when technology use is successfully integrated into education, success rates increase. The instructional strategy of having students color a preprinted picture has been rooted in educational practice for a long time. According to Cuban (2001), teachers entering the 21st century use roughly the same tools as those who came before them.

Even when other characteristics that affect earnings are held constant, the benefits of possessing the required technical skills are critical. On average, a person at the highest technical skill level earns almost 40% more than someone at the lowest level, even if both are of the same gender, race, and education level and have roughly the same literacy and numeracy skills (Goodman et al., 2015). These results reinforce that using technology to address challenges is a defining characteristic of work in the 21st century.

Research Question 2

Research Question 2 was the following: To what extent does the instructional method affect the learning outcomes of preservice teachers? The independent variable was the viewing method: the IVR group wearing the HMD versus the control group viewing the experience on a 2D screen. The dependent variables for Research Question 2 were the total score on the pretest and posttest measuring content knowledge about the Civil Rights Movement, compared between control and experimental groups. Those scores were analyzed using a mixed-design ANOVA to determine any statistically significant differences in scores by groups, particularly change in score from pre- to posttest. The posttest was the same as the pretest, but with questions in a different order.

An initial analysis was completed using the raw scores for each group. The raw score was based on a percentage of questions answered correctly, based out of a total possible score of 100. For the experimental IVR group, the mean score on the pretest was 35.83, improving 46.67 points to 82.5 on the posttest. For the control 2D group, the mean score on the pretest was 52.22, improving 26.67 points to 78.89 on the posttest.

The researcher analyzed the descriptive statistics and determined a statistically significant interaction between the method of experience and pre- and posttest score on the content quiz. The between-groups main effect showed that the experimental group outperformed the control group on the posttest and in terms of change in score, irrespective of repeated measures. The IVR group had higher posttest scores than the 2D group, and their improvement in scores from pre to posttest was greater than the 2D group. The researcher hypothesized that the IVR group would show a higher improvement in scores from the pre- to posttest on the content quiz. This hypothesis was confirmed by the results of the mixed ANOVA. Not only did the IVR group outperform the 2D group, but their overall improvement was also greater, and both were at a statistically significant level. The researcher based her hypothesis on previously conducted research. For example, in their meta-analysis on the effectiveness of IVR using

HMDs on learning performance, Wu et al. (2020) reported that IVR using HMDs was more effective than non-immersive learning approaches. The results in the current study could be attributed to any of the factors listed below.

First, the fully immersive nature of the technology blocks out any and all external distractions. The user is completely surrounded by the experience, with nothing else to focus on, other than what the HMD is displaying. The well-known visual-auditory-kinesthetic learning-styles model (Barbe et al., 1979) suggested three learning styles: visual, auditory, and kinesthetic. IVR allows all three of these learning styles to be targeted in one application, as IVR headsets allow for complex visual renderings, audio, and movement tracking (Allcoat & von Mühlenen, 2018). The researcher observed participants in the 2D group accessing their cell phones, removing objects from their backpacks, looking around the classroom, and other various behaviors during the viewing of the experience. These behaviors could have distracted them from the information of the Boy From Troy. The IVR group did not have this option and therefore were focused for the entire time the Boy From Troy was playing.

Second, six participants from the 2D control group were remote for the study. They did not consume the experience in the typical classroom environment, and instead were in an alternative location. They might have been at their home; they could have been at a community location such as a coffee shop or library. All of these locations contain a wide range of variables that could affect the learning experience. Remote students could have experienced excess noise, another program simultaneously on a separate television, or an interruption in internet service. If the participant experienced any technical issues on their own, they would have the added stress of having to fix the problem themselves. All of these factors could have interrupted the experience or distracted the participants enough that it affected their overall acquisition of the content.

Third, IVR displays, such as HMDs, afford users a superior spatial awareness, compared to traditional desktop displays (Krokos et al., 2018). Krokos et al. (2018) concluded memory palaces, a spatial mnemonic, were superior in the HMD condition compared to the desktop condition. In certain aspects of the Boy From Troy experience, spatial awareness was critical. When the participant was on the bridge with all of the other marchers, spatial components were key. The other marching avatars had to be correctly spaced so that the user would feel that they were part of a group. The bridge was "over" the water so that when the participant looked over the railing, they felt like they were high above the ground. When the police on horseback charged at the participant, the horses were larger than the participant and moved quickly to create that sense of fear. These concepts of spatial awareness cannot be accomplished on a 2D flat screen.

Fourth, engagement is an element of IVR. Allcoat and von Mühlenen (2018) conducted a study with 99 participants (1st-year psychology students at the University of Warwick) assigned to one of three learning conditions: traditional (textbook style), VR, and video (a passive control). The researchers gave each participant a knowledge test before and after learning. The researchers conducted emotional self-ratings with each participant before and after the learning phase, which increased favorable emotions and decreased negative emotions for the VR condition. Conversely, positive emotions decreased in both traditional and video conditions. VR participants reported higher engagement than participants in the other two conditions.

With the Boy From Troy, the researcher chose a topic with significant emotional components. As discussed in the previous sections, the discussion on race in America is of critical importance but can be challenging for teachers, especially new teachers. One goal the researcher had was to create an experience that would elicit an emotional reaction. The researcher wanted the preservice teachers to begin considering how to discuss hard topics once they enter the actual teaching environment. It is not uncommon for the term *immersion* to be used interchangeably with the related concept of presence (Cummings & Bailenson, 2016)—that is, a state of dissociation from reality in which people feel the subjective experience of existing in the digital environment (Slater, 2003). Barbot and Kaufman (2020) explained that engagement refers to the sense of involvement, connection with, and enjoyment of the content. Engagement builds upon a sense of presence. Consistent with an earlier review (Schuemie et al., 2001) showing how engagement with a virtual environment can influence the impact of IVR experiences across a range of outcomes, Schutte and Stilinovic (2017) concluded that "engagement was a process path connecting the virtual reality experience with empathy" (p. 711). Specifically, in an experimental study comparing IVR and non-IVR modalities, Schutte and Stilinovic showed that IVR was associated with greater engagement and a higher level of empathy towards a character featured in the media content. They further found that the association between IVR and empathy was mediated by engagement, suggesting that IVR increases characteristics such as empathy through increased engagement (Schutte & Stilinovic, 2017). Whereas the 2D group could still have an emotional reaction to the content, the emotion was more significant with the IVR group. The more emotionally invested the participants were, the greater authentic engagement with the content matter, resulting in higher retention and scores on the content test.

A statistic that the researcher thought was important to note was that the 2D control group had a significantly larger pretest score (M = 52.22) compared to the IVR experimental group (M = 35.83). One factor that could have had an impact on the difference in these scores was that the 2D control group reported that out of the 9 participants, 8 (89%) had taken a university course in American history. The IVR experimental group reported that out of the 12 participants, only 3 (25%) had taken a course in American history. The participants who had taken a course in American history should have a larger base of knowledge to start with.

Research Question 3

Research Question 3 was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The researcher focused on one dependent variable for Research Question 3: the intention of the preservice teachers to use IVR in their future instructional practice. The researcher used two types of data and data analysis to answer Research Question 3: (a) a survey given to the IVR group and (b) qualitative data collected from participants' digital notebooks.

The UTAUT2 model (Venkatesh et al., 2003) was used to frame the survey. The first part of the survey included 19 items rated on a 7-point Likert-type scale (1 = *strongly agree* to 7 = *strongly disagree*) that measured seven dimensions of the UTAUT2 model: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, and Behavioral Intention. The results of the investigation utilizing the survey produced several noteworthy findings regarding the extent of the use of IVR in training to influence preservice teachers' intention for use of IVR in their P-12 instruction. Table 9 (see Chapter 4) presented the descriptive statistics.

Lowest scores—indicating greatest agreement—were for "Using IVR is very entertaining," "Using VR is enjoyable," "I intend to continue using VR in the future," "Using VR is helpful for accomplishing things more quickly in teaching," "Learning how to use VR is easy for me," and "It is easy for me to become skillful at using VR." Lowest levels of agreement, measuring about neutral, were for having resources for IVR and sources for help. By factor, Hedonic Motivation (*M* = 1.34) showed the lowest scores (agreement), followed by Performance Expectancy (*M* = 1.97), Behavioral Intention (*M* = 2.05), and then Effort Expectancy (*M* = 2.31). The reasons for this motivation can be discussed more thoroughly through the lens of each construct.

Hedonic Motivation

The Hedonic Motivation construct scored the lowest (best) overall with a mean score of 1.33 (*SD* = 1.58). "Using VR is enjoyable" had an overall mean score of 1.42 (*SD* = 0.8), and "Using VR is very entertaining" had an overall mean score of 1.25 (*SD* = .062), the best rated item on the survey. For teacher acceptance of IVR technology, first and most importantly they need to find it enjoyable before they will use it in their classrooms. The researcher hypothesized that the participants would enjoy the IVR experience, but it might be too new of a technology to make a significant impact on their intention for future use. The results of the survey support the hypothesis that the participants would enjoy the experience. Participants readily expressed that using IVR was stimulating, with numerous comments such as "virtual reality is such a cool experience for students. . . . Through VR students are able to learn about social studies content in a way that makes them feel like they're actually there." Participants were quick to relate the fun of IVR to children's interests: "This activity grabs student's attention to the fullest extent, giving them a way to be immersed in the history. It forces them to be aware of what is happening around them in a fun and engaging way." The participants not only enjoyed the experience themselves but also were motivated by the expectation that their students would enjoy it. The fun of IVR was, therefore, seen as useful for teaching children. Yet not a single participant planned to incorporate this technology or any other technology in their instruction. There is still a disconnect with preservice teachers learning new technologies and actively planning to use them in their instruction and more research is needed to try and discover what those specific barriers are, and how to remove them.

Performance Expectancy

The overall mean score for Performance Expectancy was 1.97 (*SD* = 1.58), which was the second highest score behind hedonic motivation. The perceived ability of the technology to be able to improve their teaching was the second most important construct for participants when deciding if they will use IVR in their instruction. According to their responses, preservice teachers particularly rated that using VR is helpful for accomplishing things more quickly in teaching (*M* = 1.75, *SD* = 0.754). According to Lawless and Pellegrino (2007), although "technology can make it quicker or easier to teach the same things in routine ways," it also makes it possible to "adopt new and arguably better approaches to instruction and/or change the content or context of learning, instruction, and assessment" (p. 581). The survey results indicated preservice teachers want their instructional technology to expedite the learning process and feel IVR can help support that.

Behavioral Intention

The overall mean score for Behavioral Intention was 2.04 (*SD* = 1.44), and participants rated it the third most important construct. The individual items of “I intend to continue using VR in the future” (*M* = 1.67, *SD* = 1.43) and “I will always try to use VR in my teaching” (*M* = 2.42, (*SD* = 1.68) are strong support for the hypothesis that teachers will continue to use IVR in their instruction. Some of the preservice teachers were enthusiastic about using IVR in their future teaching, with comments such as “I am definitely going to plan on using a virtual reality experience in my classroom when possible!” Some of the participants’ intention to use IVR was rooted in their view of it as a future trend. One stated, “With the new upcoming technology, I would hope that this would be available to me at some point in my teaching journey in the future.” Other participants saw IVR as another approach and even compared it to 2D videos. One explained,

> Having this experience in the classroom made me realize just how much virtual reality can impact what a student learns. It was interesting to watch the video in both 2D and virtual reality because I was able to visualize how I took a lot more information away from virtual reality because it felt like I was really there.

Some preservice teachers indicated that they would only use IVR selectively. One stated, “This would be an activity done with much older students due to the extremely harsh nature that won't be suitable for young kids.” One participant indicated being more likely to use IVR as content became more available. One participant explained,

> Virtual reality is a new piece of technology that will most likely be in the schools in the near future. Virtual reality is a phenomenal resource for the classroom that

> is not yet utilized consistently. Comparing the YouTube video of the Boy From Troy and the VR experience, the two forms did not compete in the slightest.

Effort Expectancy

The overall mean score for Effort Expectancy was 2.31 (*SD* = 1.25), which made Effort Expectancy the fourth most important construct for participants. Two items were rated equally (*M* = 1.92): "Learning how to use VR is easy for me (*SD* = 1.24) and "It is easy for me to become skillful at using VR (*SD* = 1.4). Research regarding teacher acceptance and use of technology has supported the idea that teachers need to find the technology simple, quick, and efficient (Birch & Irvine, 2009). To use technology to facilitate student learning, teachers need additional knowledge and skills of the technology. Lawless and Pellegrino (2007) asserted, "Technological literacy has fast become one of the basic skills of teaching" (p. 580). Despite multiple participants stating that they would love to use IVR in their future classrooms, no one specifically discussed IVR being challenging to implement or requiring significant effort. One participant mentioned, "To implement this in my classroom I will need access to some VR headsets, but if I were lucky enough to have access to them, I would use them." The participants rated Effort Expectancy only the fourth highest construct and did not mention any challenges to being able to implement this technology in their instructional practice. These results combined support the hypothesis that preservice teachers will want to use IVR in their classrooms.

Price Value

Price Value was rated as the fifth overall most important construct with an overall mean score of 3.00 (*SD* = 1.60). The individual item of "VR is reasonably priced" had an overall mean score of 3.42 (*SD* = 2.0), close to the neutral rating of 4 (*neither agree nor* *disagree*). One potential barrier to IVR adoption in the educational setting is the price. However, participants did rate that VR is good value for the money (*M* = 2.5, *SD* = 1.51). One participant stated, “The great thing about this is how versatile they are and how they can be used for any grade level content areas and age!” Participants were taught about the two levels of IVR (standalone and wired) during the training session prior to the Boy From Troy experience. During this session, the varying prices of IVR and its related components were discussed. An interesting observation was that only one participant discussed price or any cost aspects associated with implementing IVR, stating, “I believe this will be the new version of fieldtrips if my school can afford it.” Also, the participants rated it the third lowest of all the constructs, showed that for these participants, price was not a barrier for them when considering the future use of IVR.

Facilitating Conditions

The second lowest rated construct was Facilitating Conditions with an overall mean score of 3.17 (*SD* = 1.26). Participants felt unsure about the level of support they could receive. The overall lowest scored item on the survey was “I can get help from others when I have difficulties using VR” (*M* = 4.08, representing *neither agree nor disagree, SD* = 1.83).

In a survey of 764 teachers, Wozney et al. (2006) found that one of the two greatest predictors of teachers’ technology use was their confidence that they could achieve instructional goals using technology. The participants expressed varying levels of excitement at the possibility of using IVR in their classrooms. One participant stated, “Being able to have my students experience the video from a virtual reality viewpoint, will allow them the chance to gain more insight in details of what the video is actually about." Another participant said,

> I never thought that VR could be a positive impact in the classroom because I always associate it with gaming and just another more advanced way to be in front of a screen. HOWEVER, I came to really really like a VR and I got to see all the benefits it has on the classroom in students. It is a great resource that should start being implemented in schools everywhere.

Despite technical difficulties during one of the sessions, the participants expressed their desire and confidence to embrace IVR in their instructional practice.

Social Influence

The least amount of agreement was for Social Influence, with an overall mean score of 3.83 (*SD* = 1.13) indicating nearly neutral ratings and thus the least importance. The item "People who influence my behavior think that I should use VR" was scored overall the second lowest of any item at 3.92 (*SD* = 1.31). One reason for this low rating could be that as IVR technology is new, most people have not heard about it or do not know enough to start discussing it. Almost all of the participants mentioned that it was either their first time using IVR or that they did not understand how it could be used educationally. One participant, as noted, through VR was for gaming. Another stated, "For teachers, this is an important experience and learning opportunity." In a major address on reforming teacher preparation at Teacher's College, Columbia University, former U.S. Secretary of Education Arne Duncan (2009) said, "University-based teacher preparation programs need revolutionary change, not evolutionary tinkering" (para. 3). For IVR to be integrated into the educational field, important stakeholders need not only to be aware of the newest technology and the research supporting the benefits of the technology but also to be prepared to make significant changes to the curriculum for preservice teachers.

The researcher originally intended to create an aspect of the experience where the participants would go to a voting location in the early 1950s and attempt to vote. The participant would be handed a bar of soap or even told to sing the National Anthem, like Mrs. Jones (a character from the experience) was forced to do. However, the researcher lost about 3 weeks of work time when the local school district announced the plan to have students and teachers return to the campus for in-person learning. This announcement forced the lead professor to change his syllabus, and so the researcher had to adapt the experience. Despite this, the participants rated "I felt like I was a part of the Civil Rights Movement" the best, with an overall mean score of 2.17 (*SD* = 0.94). The participants rated "I felt fear when the police approached me" with an overall mean score of 2.67 (*SD* = 1.16). The strong mean score for the emotional response supports some of the statements the participants made in their digital notebooks. One participant stated, "Utilizing VR allows students to be present in these historical events, guiding them to feel emotions and make connections they would not necessarily feel from a textbook or a YouTube video." The participants were emotionally impacted by the experience as illustrated by their notebook responses, as well as their ratings on the survey questions.

The least positively rated item was "How engaging did the auditory (sound) aspects of the virtual world seem?" with an overall mean score of 3.08 (*SD* = 1.17). The audio clips used for the experience were quite old, some being more than 50 years old. The researcher did use the highest quality audio available, but the sound might not have been of the quality to make more of an impact with the participants. Seeing the results about the participants opinion about the audio, the researcher would consider having the participants wear headphones, especially if there is a significant amount of old audio.

Conclusions

In review, the first research question asked whether the IVR learning experience affected the competency level of preservice teachers' lesson planning when compared to a 2D learning experience. Although no statistically significant difference was found on the overall average score between the IVR group and the 2D group, there were some interesting observations. When reviewing the individual mean scores of the individual standards, the highest rated standard for the IVR group was "integrates culturally relevant content to build on learners' background knowledge." The researcher designed the experience to have an emotional impact on the participants to encourage more culturally relevant discussions. The lowest average score for the IVR group (4.1) was for the technology standard "Instructional Strategies & Technologies (Using technology in teaching/learning)." The three lowest scores for the 2D group were for the technology-specific standards (4.2). Out of all the different aspects of teaching being rated, the overall lowest average score was for technology integration. The preservice teachers overall scored worse on integrating technology as a whole into their lesson plans than they did anything else. These results support the body of research involving the lack of instructional technology education for preservice teachers.

The second research question was to what extent the instructional method affected the learning outcomes of preservice teachers. The results of the study illustrated the justification for more research into utilizing IVR technology with preservice teachers for content acquisition. The IVR group improved and outscored the 2D group significantly.

This provides a basis for continuing to use IVR across varying contents to see if it is an effective mode for instructing preservice teachers.

The third research question was the following: To what extent does the use of IVR in training influence preservice teachers' intention for use of IVR in their P-12 instruction? The survey revealed that the construct rated the best was Hedonic Motivation (enjoyment); if preservice teachers enjoyed the experience, they are more likely to use it. The construct scored the lowest was Social Influence. Whether because they do not know about the technology, or any other reasons, participants were not influenced by people to use IVR technology.

The research into IVR is still in its infancy. More research will be needed on how IVR affects technology integration by preservice teachers and subsequently the engagement of student learning. This study was built upon previously conducted research and adds to the body of literature regarding IVR in the educational field.

Limitations and Recommendations for Future Research

The results of this study, while promising, highlight the need for more intense research into the impact of IVR on preservice teacher education, both as it impacts participants as current students (knowledge acquisition) and as future teachers (implementation into practice). Additional studies could investigate whether the results of this study provide direct evidence that the immersive technology was directly responsible for the outcomes, excluding other variables identified. As previously stated, the COVID-19 pandemic significantly affected the entire study.

The first limitation that the researcher acknowledges is the small sample size. According to the National Center for Education Statistics (2021), about 76% of public school teachers were female in 2017–2018, with a lower percentage of male teachers at the elementary school level (11%) than at the secondary school level (36%). In this study, 91% of the participants were female, and only 9% were male. The researcher acknowledges the difference in these rates, and in future research will try to recruit more male participants. Also, according to the National Center for Education Statistics (2021), in 2017–2018, about 79% of public school teachers were White, 9% were Hispanic, 7% were Black, 2% were Asian, 2% were of two or more races, and 1% were American Indian/Alaska Native; additionally, those who were Pacific Islander made up less than 1% of public school teachers. In this study, 80% of the participants were White, which is consistent with the national average, and even though 14% were Black, that percentage can be misleading due to the small sample size. Originally the researcher wanted 40–50 participants or to possibly conduct the study across two semesters, but when the pandemic shut everything down, she was forced to adjust.

The second limitation was the lack of all the interactive components in the IVR experience. Although there was still some interactivity (walking across the bridge), there was not the amount that the researcher intended. One of the major components and arguments made by the researcher for the use of IVR was the ability to take the user from a passive observer to an active participant. To be an active participant in the virtual environment, interactive components are needed. Future research could investigate whether adding the component where the participant attempts to vote affects the results in any way.

Future research could expand the research to investigate transition into the classroom. One of the major reasons the researcher chose the topic of civil rights is not only because it is timely due to what is currently happening around the United States, but also because her hope is that teachers will do this experience first. Once the teacher has completed the experience, they will discuss varying components of it, and then their students will do the experience. This will lead to meaningful conversations on race and other challenging topics. As previously mentioned, through an informal questionnaire, the author learned that out of 29 currently enrolled college juniors, only 4 could identify who Representative John Lewis was, and only 3 had heard of the Bloody Sunday march on the Edmund Pettus Bridge. This is of significant concern since a number of the students had taken a college-level American History course. The researcher saw this experience as a way to expand and effect curriculum change at the university level and below. Conducting either a longer study or follow-up investigation to see if any of the preservice teachers implemented this experience into their classrooms would be of extreme interest.

The results of study illustrated the justification for more research into utilizing IVR technology with preservice teachers for content acquisition. The IVR group improved and outscored the 2D group significantly. This provides a basis for continuing to use IVR across varying contents to see if it is an effective mode to instruct preservice teachers.

The research into IVR is still in its infancy. More research will be needed on how IVR affects technology integration by preservice teachers and subsequently the engagement of student learning. This study was built upon previously conducted research and adds to the body of literature regarding IVR in the educational field.

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APPENDIX A

INCLUSION AND EXCLUSION CRITERIA FOR STUDIES REVIEWED

Billingsley et al.[a]	This study	Justification
	Inclusion criteria	
Written in English and published in peer-reviewed journals	Written in English; did not have to be in peer-reviewed journal	To address publication bias, gray literature was searched (WWC, V 4.0)
IVR used in some way to further learning experiences for teacher educators or to teach specialized skills (e.g., discrete trial training).	Yes	I utilized Eden and Bezer's (2011)[b] definition, but both definitions have the same requirements (HMD)
Study must be an empirical study with independent and dependent variables that would have increased potential for generalizability or replicability.	Yes	Same
Participants were either undergraduate students enrolled in teacher preparation courses or in-service teachers taking graduate or continuing education courses.	If the study had current practicing participants combined with preservice teachers, it was included, but if it was solely current teachers, it was excluded.	The participants of my study are PST's only.
	Exclusion criteria	
Excluded if studies were conceptual or descriptive (e.g., discussed future plans for, or the potential for the use of VR in teacher education).	Yes	This exclusion criterion was selected because this was an investigation into experiments already conducted that offered results by which to guide future implementation.

Billingsley et al.[a]	This study	Justification
If they utilized any other form of virtual technology (e.g., desktop VR, epistemic or simulation games, video-web communication, or virtual guest speaker) other than immersive VR in which to prepare teachers so that appropriate comparisons can be made of IVR experiments.	Yes	Same
If they described or measured learning experiences where technology was used in online teaching, or in supplementary ways, such as presentation formats, learning modules, podcasts, blogs, course wikis, online portfolios, and forum discussions.	Yes	Same
If IVR in teacher education programs was used for any purpose other than coursework or field experiences explicitly intended to prepare future teachers.	No. Studies that involved preservice teachers using IVR for content acquisition were included.	Student attitudes toward learning will be assessed in this study, this impact should be considered as researchers aim to develop ways to recruit more STEM majors or to promote knowledge retention (Madden et al., 2019)[c]
If the study involved teaching pre-service educators how to use VR technology to teach their own future students.	No. Studies that examined intention for future use were included.	This agrees with the findings of Miranda and Russell (2012)[d] that the teachers' beliefs in the benefits of technology and its use in teaching are key to the integration of technology in the classroom.

Note. HMD = head-mounted display; VR = virtual reality; IVR = immersive virtual reality; STEM = science, technology, engineering, and math.

[a] "A Systematic Literature Review of Using Immersive Virtual Reality Technology in Teacher Education," by G. Billingsley, S. Smith, S. Smith, and J. Meritt, 2019, *Journal of Interactive Learning Research, 30*(1), 65–90.

[b] "Three-Dimensions Vs. Two-Dimensions Intervention Programs: The Effect on the Mediation Level and Behavioural Aspects of Children With Intellectual Disability," by S. Eden and M. Bezer, 2011, *European Journal of Special Needs Education, 26*(3), 315–337.

[c] *Virtual Reality as a Teaching Tool for Moon Phases and Beyond* [Paper presentation], by J. H. Madden, A. S. Won, J. Schuldt, B. Kim, S. Pandita, Y. Sun, T. Stone, and N. Holmes, 2018, August 1–2, Physics Education Research Conference, Washington, DC, United States.

[d] "Understanding Factors Associated With Teacher-Directed Student Use of Technology in Elementary Classrooms: A Structural Equation Modeling Approach," by H. P. Miranda and M. Russell, 2012, *British Journal of Educational Technology, 43*(4), 652–666.

APPENDIX B

INCLUDED STUDIES

Authors, year	Country	Design[a]	*N*	Independent variable	Dependent variables	Participants	Results
Bower, DeWitt, & Lai, 2020	Australia	MM S I	65	Tutorial and use of CoSpaces immersive virtual reality (IVR) creation platform	Intention to use IVR in future teaching Effort expectancy Social influence Facilitating conditions Hedonic motivation Price value Habit Behavioral intention	66% female, 32% male 62% primary, 38% secondary education Completed avg. 45 practicum days	Effort expectancy: Some teachers identified IVR was easy to use, previous experience was an advantage, and reliability of tech increased effort. Social influence: Varied, peers and general educational pop. Using IVR was positive, but supervisor's negative opinion was negative influence. Facilitating conditions: Significantly dependent on the school. Hedonic motivation: Preservice teachers rated hedonic motivation, or enjoyment of using IVR, higher than any other factor. IVR was stimulating, exciting, new and visual. Price value: Varied widely depending on specific form. Habit: Generally, did not feel that IVR was a habit because it was not integrated into their lifestyle. Behavioral intention: Mixed, some excited to use, some thinking traditional would be more effective.

Authors, year	Country	Design[a]	*N*	Independent variable	Dependent variables	Participants	Results
G. Cooper, Park, Nasr, Thong, & Johnson, 2019	Australia	CS	41	Virtual reality (VR)	Preservice teacher use of VR Self-efficacy to use in pedagogy Perceptions of VR as a learning and teaching tool Concerns about VR	31 female, 10 male In a 4-year Bachelor of Education degree program: 4 in Year 1 12 in Year 2 4 in Year 3 21 in Year 4	Preservice teacher use of VR: 36% (*n* = 12) reported use of VR, 64% (*n* = 21) never used VR. Of the 12 who said yes, 11 used mobile, and only 1 used desktop VR. Self-efficacy to use it in pedagogy: Significant difference between average amount of self-efficacy to teach using VR compared to using other digital technologies. Perceptions of VR as a learning and teaching tool: 32 of 33 participants said they would use VR, mostly because they felt it would be engaging. Preservice teachers' concerns about VR: 12 expressed concerns about their self-efficacy, as typified in the following response: "My fear would be that I am inexperienced in using virtual reality, and I think it would be hard to manage/control in a classroom"
Lamb & Etopio, 2020	Finland	MM	54	Real-life classroom VR classroom	Measures of cognitive dynamics: Autonomic nervous system measures, heart rate variability, & eye tracking Paper measures: Student Teacher Assessment Record rubric	41 female, 13 male Mean age of the preservice science teachers = 25.8 years	Autonomic nervous system measures: Responses provided further evidence of the similarity of physiological response between VR and real-life conditions. Measures of heart rate variability: Consistent across conditions Eye tracking: VR conditions promote the same levels of attentional dynamics as real-life activities. Student Teacher Assessment Record: Rubric rating same for each group—developing—across areas of assessment. Consensus among participants that VR activities in comparison with classroom activities are similar enough to be considered realistic and comparable with real life

Authors, year	Country	Design[a]	*N*	Independent variable	Dependent variables	Participants	Results
C. Lee & Shea, 2020	USA	MM WIS PPT INT	38	3-stage intervention	Quantitative: Self-knowledge and efficacy Classroom feasibility Qualitative: Factors preservice teachers perceived as important when using VR apps Changes in knowledge and self-efficacy Attitudes toward the use of VR/computer-based technology in the classroom	30 female, 8 male 11 seniors 27 juniors with little classroom teaching experience	Quantitative Self-knowledge and efficacy: most significant changes were familiarity with national science standards & feeling prepared to teach science using computer-based technology. Classroom feasibility: Significantly more confident on assessment of computer-based technology activities involving student participation to learn science) & selection of appropriate computer-based technology by grade level. Qualitative Factors perceived as important when using VR apps: 73.7% remarked on the importance of the correct scientific information in all educational apps, but only 26.3% recommended apps that were interactive like a game, so that students could participate by immersion in the virtual environment. Changes in knowledge and self-efficacy: 71.1% gave positive feedback concerning their VR learning experience and the creation of a VR module. Attitudes toward the use of VR/computer-based technology in the classroom: 71.1% said they would use VR in their teaching because they could see how VR apps are related to state and national science standards and how they could engage the learning of the students.

Authors, year	Country	Design[a]	*N*	Independent variable	Dependent variables	Participants	Results
Theelen, van den Beemt, & den Brok, 2020	Nether-lands	MM PPT I	114	Virtual classroom (VC)	Effect of VC on preservice teachers' theory based interpersonal knowledge structures Effect of VC on preservice teachers' theory based interpersonal knowledge development How preservice teachers apply their theory-based interpersonal knowledge after the VC	81 female, 33 male In Year 1 of teacher education program, being prepared for secondary education in 8 domains (history, geography, economy, Dutch, German or English language, mathematics, and physics). 27 had little teaching experience (1–2 months); 87 had no teaching experience.	Effect of VC on theory-based interpersonal knowledge structures: PSTs showed more organized concept maps after the intervention Effect of VC on theory-based interpersonal knowledge development: Used statistically significantly more concepts at posttest. Moreover, these concepts were more relevant after the intervention, when compared with the expert map. How preservice teachers apply their theory-based interpersonal knowledge after the VC: Mainly capable in applying knowledge on vignettes from Quadrants 1 (directing, helpful) and 4 (imposing, confrontational).

Note. Studies: "Reasons Associated With Preservice Teachers' Intention to Use Immersive Virtual Reality in Education," by M. Bower, D. DeWitt, and W. M. J. Lai, 2020, *British Journal of Educational Technology, 51*(6), 2214–223; "Using Virtual Reality in the Classroom: Preservice Teachers' Perceptions of its Use as a Teaching and Learning Tool," by G. Cooper, H. Park, Z. Nasr, L. P. Thong, and R. Johnson, 2019, *Educational Media International*, *56*(1), 1–13; "Virtual Reality: A Tool for Preservice Science Teachers to Put Theory Into Practice," by R. Lamb & E. A. Etopio, 2020, *Journal of Science Education and Technology, 29*, 573–585; "Exploring the Use of Virtual Reality by Pre-Service Elementary Teachers for Teaching Science in the Elementary Classroom," by C. K. Lee and M. Shea, 2020, *Journal of Research on Technology in Education, 52*(2), 163–177; "Developing Preservice Teachers' Interpersonal Knowledge With 360-Degree Videos in Teacher Education," by H. Theelen, A. van den Beemt, and P. den Brok, 2020, *Teaching and Teacher Education, 89,* Article 102992.

[a] CS = case study; I = interview; INT = intervention; MM = mixed methods; PPT = pre- and posttest; S = survey; WIS = within subjects.

APPENDIX C

PRESERVICE TEACHER LESSON PLAN RUBRIC

This assessment is based on the 10 national standards of effective practice for new teachers (InTASC). Standards 1-3 address *The Learner and Learning*. Standards 4- 5 address *Content Knowledge*. Standard 8 address *Instructional Practice*.

Standard 10 is a technology specific standard adopted from the Technology Integration Assessment Rubric (TIA-a performance-based evaluation of TPACK rubric created by Harris et al. 2010.

Under the Family Educational Rights and Privacy Act (FERPA) of 1974, the teacher candidate has the right of inspection and review of this document.

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 in the rating box next to each standard, which describes the teacher candidate as a pre-professional. **An overall average rating will be calculated by the university for each standard.* Thank you for your time and commitment to the profession.

Adapted from the rubric created by the North Dakota Association of Colleges for Teacher Education #20-06292017

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.

Standard #1: Learner Development. The teacher understands how children learn and develop, recognizing that patterns of learning and development vary individually within and across the cognitive, linguistic, social, emotional, and physical areas, and designs and implements developmentally appropriate and challenging learning experiences.

InTASC Standard 1:
Accounts for differences in students' prior knowledge

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Does not account for differences in students' prior knowledge	With assistance, partial success at rating of 3	Addresses students' prior knowledge as a class, but individual differences are not considered	In addition to rating 3 performance, partial success at rating of 5	Accounts for individual differences in students' prior knowledge and readiness for learning	In addition to rating 5 performance, partial success at rating of 7	Accesses student readiness for learning and plans expansions based on individual students' prior knowledge	

Comments:

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.
Standard #2: Learning Differences. The teacher uses understanding of individual differences and diverse communities to ensure inclusive learning environments that allow each learner to meet high standards.

InTASC Standard 2:
Uses knowledge of students' socioeconomic, cultural and ethnic differences to meet learning needs

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Demonstrates minimal knowledge about learners' backgrounds and how to meet their learning needs	With assistance, partial success at rating of 3	Demonstrates a basic knowledge about learners' backgrounds and how to meet their learning needs	In addition to rating 3 performance, partial success at rating of 5	Demonstrates thorough knowledge that learners are individuals with differences in their backgrounds as well as their approaches to learning and performance	In addition to rating 5 performance, partial success at rating of 7	Anticipates individual learning needs by proactively planning differentiated instruction using knowledge of learners' socioeconomic, cultural, and ethnic backgrounds	

Comments:

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.
Standard #3: Learning Environment: The teacher works with learners to create environments that support individual and collaborative learning and that encourage positive social interaction, active engagement in learning, and self-motivation.

InTASC Standard 3:
Guides learners in using technologies in
appropriate, safe, and effective ways when applicable

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Rarely plans how to guide learners in using technology appropriately, safely, and effectively	With assistance, partial success at rating of 3	Plans basic guides on how to direct learners in using technology appropriately, safely, and effectively	In addition to rating 3 performance, partial success at rating of 5	Plans detailed guides to direct learners in using technology appropriately, safely, and effectively	In addition to rating 5 performance, partial success at rating of 7	Plans for interactive technologies as a resource to support student learning; anticipates how information may be misused and develops guidelines for learners to use technology appropriately, safely, and effectively	

Comments:

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.
Standard #4: Content Knowledge. The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and creates learning experiences that make these aspects of the discipline accessible and meaningful for learners to assure mastery of the content.

InTASC Standard 4:

Integrates culturally relevant content to build on learners' background knowledge

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Demonstrates minimal knowledge of learners' cultural backgrounds and experiences, and there is no plan to design learning experiences that build on learners' cultural backgrounds	With assistance, partial success at rating of 3	Demonstrates basic knowledge or ability to design learning experiences that integrate culturally relevant content to build on learners' cultural backgrounds and experiences	In addition to rating 3 performance, partial success at rating of 5	Designs learning experiences that integrate culturally relevant content to build on learners' cultural backgrounds and experiences	In addition to rating 5 performance, partial success at rating of 7	Flexibly designs learning experiences that integrate culturally relevant content to build on learners' cultural backgrounds and experiences	

Comments:

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.
Standard #5: Application of Content. The teacher understands how to connect concepts and use differing perspectives to engage learners in critical/creative thinking and collaborative problem solving related to authentic local and global issues.
InTASC Standard 5: Designs activities where students engage with subject matter from a variety of perspectives

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Designs activities related to subject matter but does so from a singular perspective and discipline	With assistance, partial success at rating of 3	Designs activities for learners to engage with subject matter, from a variety of perspectives, but no inter-disciplinary connections are developed	In addition to rating 3 performance, partial success at rating of 5	Designs activities for learners to engage with subject matter from a variety of perspectives and to develop inter-disciplinary connections	In addition to rating 5 performance, partial success at rating of 7	Embeds interdisciplinary connections and multiple perspectives into activities, allowing learners to independently relate these connections to key concepts and themes	

Comments:

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.							
Standard #6: Instructional Strategies. The teacher understands and plans a variety of instructional strategies to encourage learners to develop deep understanding of content areas and their connections, and to build skills to apply knowledge in meaningful ways.							
InTASC Standard 8: Varies instructional strategies to engage learners							
Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Utilizes only one instructional approach	With assistance, partial success at rating of 3	uses a variety of instructional approaches, but approaches are not matched to learner needs, interests, and goals	In addition to rating 3 performance, partial success at rating of 5	Plan varying roles between instructor, facilitator, guide, and audience; considers learners' needs, interests, and goals in determining instructional strategies to engage learners	In addition to rating 5 performance, partial success at rating of 7	Integrates a variety of instructional approaches for all members of the classroom; considers learners' needs, interests, and goals in determining instructional strategies to engage students as both learners and teachers	
Comments:							

Directions: For each of the items below, place a rating of 1, 2, 3, 4, 5, 6, or 7 to describe the teacher candidate as a preprofessional. *An overall average rating will be calculated by the university for each standard. Thank you for your time and commitment to the profession.

Standard 7: Instructional Strategies & Technologies

Technology Integration Assessment Rubric Standard:
Instructional Strategies & Technologies

Underdeveloped (1)	**(2)**	**Emerging (3)**	**(4)**	**Proficient (5)**	**(6)**	**Distinguished (7)**	**Rating**
Instructional Strategies & Technologies (using technology in teaching/learning)							
Technology use does not support instructional strategies	With assistance, partial success at rating of 3	Technology use minimally supports instructional strategies	In addition to rating 3 performance, partial success at rating of 5	Technology use supports instructional strategies	In addition to rating 5 performance, partial success at rating of 7	Technology use optimally supports instructional strategies	
Technology Selection (compatibility with curriculum goals & instructional strategies)							
Technology selections are inappropriate, given curriculum goals and instructional strategies	With assistance, partial success at rating of 3	Technology selections are marginally appropriate, given curriculum goals and instructional strategies	In addition to rating 3 performance, partial success at rating of 5	Technology selections are appropriate, but not exemplary, given curriculum goals and instructional strategies	In addition to rating 5 performance, partial success at rating of 7	Technology selections are exemplary, given curriculum goals and instructional strategies	

Comments:

APPENDIX D

VR CHECKLIST

	Controller			
	Left hand	Right hand		Dominant hand
Fit				
Hold				
Grip button				
Trigger button				
Touchpad				
IPD adjust				
Volume				
Point				
Grab objects				
Connect objects				

Notes:

Date:

User:

Complete	yes	no

APPENDIX E

THE SSQ

APPENDIX F

CONTENT TEST

Civil Rights Movement

Please answer the following questions

1. How did the Civil Rights Act of 1964 fight racial discrimination in hiring practices?

   Mark only one oval.

   - It established the Equal Employment Opportunity Commission to enforce anti-discrimination statutes.
   - It established the American Civil Liberties Union (ACLU) to defend individuals who came forward with a discrimination claim.
   - It required companies to hire at least one employee whose job was to recruit and establish a diverse workforce.
   - The Civil Rights Act of 1964 did not address racial discrimination in hiring practices.

2. Poll taxes, literacy tests, and other barriers to black enfranchisement were made illegal with the passage of

   Mark only one oval.

   - The Civil Rights Act of 1964
   - The 13th Amendment.
   - Jim Crow Laws
   - The Voting Rights Act of 1965.

3. Where is the Edmund Pettus Bridge located?

   Mark only one oval.

   - Jackson, Mississippi
   - Selma, Alabama
   - Montgomery, Alabama
   - Pettus, Georgia

4. What tragic event seemed to provide the spark for African American Civil Rights leaders to plan the famous "March to Selma?"

Mark only one oval.

- The shooting of Governor George Wallace by a lone gunman, Arthur Bremmer in Montgomery, Alabama.
- The Assassination of President John F. Kennedy.
- The unjustifiable shooting of Jimmie Lee Jackson by Alabama State Trooper, James Bonner took place on February 18, 1965.
- On August 28, 1963, members of Klu Klux Klan disrupted Martin Luther King's speech at the Lincoln Memorial.

5. John Lewis helped lead the march that took place on the day people now refer to as_________________

Mark only one oval.

- Bloody Sunday
- Selma Day
- March on Washington
- Civil Rights Day

6. What legislation was passed as a result of the Bloody Sunday march?

Mark only one oval.

- The National Voter Registration Act of 1993
- The Civil Rights Act of 1960
- The 14th Amendment
- The Voting Rights Act of 1965

7. What committee was John Lewis the chairman of?

Mark only one oval.

- The Student Nonviolent Coordinating Committee
- The National Association for the Advancement of Colored People (NAACP)
- The Black Panthers
- Boycott Brigade

8. Why did the protestors choose Selma as the site for their protest?

Mark only one oval.

- It was an example of what they thought cities should aspire to be.
- They expected very little resistance.
- The police chief was known to be aggressively opposed to civil rights.
- It was a random choice.

9. Who was Jim Clark?

Mark only one oval.

- The Sheriff of Dallas County, Alabama, in 1965.
- The congressman from Alabama who first drafted the Jim Crow laws.
- One of Dr. Martin Luther King Jr's confidants.
- The leader of the Ku Klux Klan in 1965.

10. Who was president of the United States when Bloody Sunday took place?

Mark only one oval.

- Abraham Lincoln
- John F. Kennedy
- Woodrow Wilson
- Lyndon B. Johnson

APPENDIX G

SURVEY ON THE BOY FROM TROY

The Boy From Troy

Start of Block: IVR

There are no correct or incorrect answers on this survey.
Please respond to each statement or question as honestly and accurately as you can.
Your answers will be kept strictly confidential.

The term *virtual reality* has been used to refer to many different experiences. For the purposes of this survey, Virtual Reality is defined as "the ability to immerse yourself in a virtual world with the use of head-mounted display (HMD) and hand-held controllers, and interactions with the virtual world happen in real time."

Key Word Definitions
Head-Mounted Display (HMD): Sometimes referred to as "goggles," the HMD is the device you physically put on your head.
Real Time: When you physically perform an action, such as picking up an orange using the hand-held controller, there is no delay when that action happens in the virtual environment.
Hand-Held Controller: The device that is physically held in your hand and used to interact with the virtual environment.
Virtual World: A simulated or prerecorded environment created by a computer (this definition is for the purposes of this study only).

Please indicate the degree to which you agree or disagree with the following statements.

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
1. I think VR is useful for teaching in schools.	○	○	○	○	○	○	○
2. Using VR is helpful for accomplishing things more quickly in teaching.	○	○	○	○	○	○	○
3. Using VR helps increase my teaching productivity.	○	○	○	○	○	○	○
4. Learning how to use VR is easy for me	○	○	○	○	○	○	○
5. My interaction with VR technology is clear and understandable	○	○	○	○	○	○	○
6. It is easy for me to become skillful at using VR	○	○	○	○	○	○	○
7. People who are important to me think that I should use VR	○	○	○	○	○	○	○
8. People who influence my behavior think that I should use VR	○	○	○	○	○	○	○

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
9. People whose opinions that I value suggest that I use VR	○	○	○	○	○	○	○
10. I have the resources necessary to use VR	○	○	○	○	○	○	○
11. I have the knowledge necessary to use VR	○	○	○	○	○	○	○
12. VR is compatible with other technologies I use	○	○	○	○	○	○	○
13. I can get help from others when I have difficulties using VR	○	○	○	○	○	○	○
14. Using VR is enjoyable	○	○	○	○	○	○	○
15. Using VR is very entertaining	○	○	○	○	○	○	○
16. VR is reasonably priced	○	○	○	○	○	○	○
17. VR is a good value for the money	○	○	○	○	○	○	○
18. I intend to continue using	○	○	○	○	○	○	○

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
VR in the future							
19. I will always try to use VR in my teaching	○	○	○	○	○	○	○

End of Block: IVR

Start of Block: Reflection/UX questions

20. How natural did your interactions with the virtual world seem?

21. How engaging did the visual aspects of the world seem in the Boy From Troy?

○ Very engaging (1)

○ Somewhat engaging (2)

○ Neither engaging nor unengaging (3)

○ Somewhat unengaging (4)

○ Very unengaging (5)

22. How engaging did the auditory (sound) aspects seem?

- Very engaging (1)
- Somewhat engaging (2)
- Neither engaging nor unengaging (3)
- Somewhat unengaging (4)
- Very unengaging (5)

23. How compelling was your sense of moving around inside the virtual world?

- Very compelling (1)
- Somewhat compelling (2)
- Neither compelling nor uncompelling (3)
- Somewhat uncompelling (4)
- Very uncompelling (5)

24. How quickly did you adjust to the virtual world experience?

- Very quickly (1)
- Somewhat quickly (2)
- Neither quickly nor slowly (3)
- Somewhat slowly (4)
- Very slowly (5)

25. How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?

- ◯ Very proficient (1)
- ◯ Somewhat proficient (2)
- ◯ Neither proficient nor not proficient (3)
- ◯ Somewhat not proficent (4)
- ◯ Not at all proficient (5)

26. How much did the visual display quality interfere with or distract you from performing assigned tasks or required activities?

- ◯ Not at all distracting/interfering (1)
- ◯ Somewhat not distracting (2)
- ◯ Neither distracting nor not distracting (3)
- ◯ Somewhat distracting/interfering (4)
- ◯ Very distracting/interfering (5)

27. How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?

- ○ Very well (1)
- ○ Somewhat well (2)
- ○ Neither well nor poorly (3)
- ○ Somewhat poorly (4)
- ○ Very poorly (5)

To what extent do you agree with the following statement:

28. I felt like I was a part of the march.

- ○ Strongly agree (1)
- ○ Agree (2)
- ○ Neither disagree nor agree (3)
- ○ Disagree (4)
- ○ Strongly disagree (5)

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29. I felt fear when the police approached me.

- ◯ Strongly Agree (1)
- ◯ Agree (2)
- ◯ Neither disagree nor agree (3)
- ◯ Disagree (4)
- ◯ Strongly disagree (5)

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30. I felt like I was a part of the Civil Rights Movement.

- ◯ Strongly agree (1)
- ◯ Agree (2)
- ◯ Neither disagree nor agree (3)
- ◯ Disagree (4)
- ◯ Strongly disagree (5)

End of Block: Reflection/UX questions

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31. My age is...

- ○ under 18 (1)
- ○ 18–24 (2)
- ○ 25–34 (3)
- ○ 35–44 (4)
- ○ 45 + (5)

CURRICULUM VITA

NAME: Shannon Putman

ADDRESS: 3229 Allison Way,

Louisville, Kentucky 40220

DOB: Syracuse, New York. December 7, 1981

Education and Degrees

Med Special Education with a concentration in Learning and Behavior Disorders, University of Louisville

BS-Criminology minor Psychology, University of Tampa

National Board Certification Special Education, NBCT

Teaching Areas

Graduate Research Assistant, University of Louisville 2018-Present

Teacher in Residence, Cochran Elementary 2016-2018

Learning and Behavior Disorder Resource Teacher, Cochran Elementary 2014-2016

Multi-Modal Communication Classroom Teacher, Cochran Elementary 2006-2014

Multi-Modal Communication Classroom Instructional Assistant, Cochran Elementary 2005-2006

Courses Taught (University of Louisville):

EDTP 330-96, Building Learning Communities (Fall 2017)

Publications:

Putman, S. & Id-Deen, L. (2019, February). "I Can S*ee* it!": Math Understanding Through Virtual Reality.*Educational Leadership*

Id-Deen, L., Jasnoff, G. **Putman, S.,** & Foster, T. (under review). Navigating Synergic Boundaries: The Journey of a Mathematics Teacher Educator in an Urban Elementary School-Partnership. In Norton-Meier, L., & Overstreet, M. (Eds.), *Clinical Partnerships in Urban Elementary Settings: An Honest Celebration of the Messy Realities of Doing this Work*.

Putman, **S.** (2013, February). Hacking the Classroom to Encourage Student Independence. *THE Journal, Transforming Education Through Technology*. Retrieved from https://thejournal.com/articles/2013/02/13/hacking-the-classroom-to-encourage-student-independence.aspx

Presentations:

2018

Going Virtual: Using Technology To Educate The Masses! National Association for Professional Development National Conference, Jacksonville, FL, March 2018.

2017

Destroy the Box and Join an Educational Revolution. National Association for Professional Development National Conference, Washington D.C, March 2017.

2016

Destroy the Box and Open Your Minds to the Latest Technology. Council for Exceptional Children Kentucky Conference, Louisville, KY, November 2016.

2012-2013

Louisville Writing Project (LWP) Summer Technology Institute Director. Louisville, KY, July 2012 & July 2013.

2011

Destroy the Box! How Technology Can Enhance Student Writing- Louisville Writing Project (LWP) summer technology institute. Louisville, KY, June 2011.

2010-2013

Destroy the Box! How Technology Can Enhance Student Writing- Louisville Writing Project (LWP) winter conference. Louisville, KY, November.

Professional Organizations:

TASH-member 2017-present

American Society for Engineering Education (ASEE)-member 2017-present

Association for Behavioral Analysis International (ABAI)-member 2017-present

National Association for Professional Development Schools (NAPDS)-member….. 2016-present

Kentucky Society for Technology in Education (KYSTE)-member 2016-present

Council for Exceptional Children-National and Kentucky member 2015-present

Golden Key National Honor Society-member 2012

Honors and Awards:

Microsoft Innovative Educator-one of only 100 teachers nationally chosen to attend competition at Microsoft Headquarters and labeled "One of the 100 best teachers using technology in education." 2012.

Microsoft Expert Teacher Lecturer-chosen to lead monthly blog and discussion for Microsoft in Education website. 2012

Breaking Barriers Spotlight Award-elementary special education teacher of the year award. 2011.