AUGMENTED REALITY AND VIRTUAL REALITY IN PRESERVICE TEACHER PREPARATION: A SYSTEMATIC REVIEW OF EMPIRICAL LITERATURE

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ABSTRACT

The field of education is facing critical shortages in qualified teachers. Preservice students are limited in field experience by their teacher preparation location and proximity to diverse populations. Many colleges and university tasked with teacher preparation are seeking post-pandemic solutions to teacher preparation which potentially involve virtual experiences. This study investigates literature (N=158) related to the use of virtual reality and augmented reality in teacher preparation. This literature review seeks to examine 10 years of empirical work as a foundation for current and future teacher preparation practice.

KEYWORDS

Virtual Reality, Augmented Reality, Mixed Reality, Teacher Preparation, Preservice Teacher

1. INTRODUCTION

The field of education is at a pivotal point. Many of the traditional practices are failing to adequately prepare new teachers. Teacher shortages abound and teacher retention is a very serious issue. Murphy et al., (2018) reported that to address these issues approximately 75 colleges and universities across the United States started using mixed reality teaching environments to prepare student teachers. Post-pandemic, have there been more or less colleges who adopted augmented, virtual or mixed reality experiences in their educational process? How have researchers informed or provided direction for extended reality in teacher preparation? How is augmented, virtual or mixed reality technology used to enhance fieldwork and opportunities for practice teaching, which are essential components of the teacher preparation process.

Preservice students are limited in field experience by their teacher preparation location. Smith and Klumper (2018) note opportunities for time in the field are often limited in location and situation. New teacher preparation practices are needed. Thus, this study investigates the use of extended reality with preservice teacher candidates. It provides a review of literature consisting of 10 years of empirical work as a foundation for current and future teacher preparation practice.

2. TEACHER PREPARATION AND EXTENDED REALITY

During the Covid-19 pandemic, many teacher preparation programs had to utilize virtual field experiences in lieu of being in the schools. During the pandemic, most learning was shifted to online modalities. Many institutions used online videos for observation and case studies. Vu and Fisher (2021) examined the academic performance of pre-service teachers in virtual (observation only) field experiences and found no difference in the results compared to students the previous semester in regular face-to-face field experiences. This result supported previous work where Chisenhall (2016) examined preservice teacher efficacy and also found no difference between face-to-face and virtual observations. As a result of pandemic restrictions, Geiger and Dawson (2020) also compared virtual to face-to-face field experiences and noted that a key to success in both was professional development related to field experience. The common thread was observation-based fieldwork

for preservice students whether in-person or virtual. The Covid-19 pandemic realities necessitated technological innovations, thus creating the opportunity for increased acceptance of virtual innovations.

Teacher preparation virtual innovations may include concepts and combinations of virtual reality (VR), augmented reality (AR), or mixed reality (MR). While these share similarities there are distinct differences (Figure 1). First, "reality as a construct that each of us makes based on what we perceive from our senses, whether what we perceive comes from the digital or the physical world" (Tremosa, 2023). Many technologies as Tremosa describes, have the ability to alter what we perceive as real and in essence extend reality, thus they fall under an umbrella term *extended reality* which includes AR, VR, and MR and fall on a continuum between the physical world and virtual environment. "Virtual reality, according to Okan (2019, p. 41) is "a three-dimensional simulation model that brings users to a different environment with computer-generated graphics, video and audio, and enables communication with the media." VR is often characterized as immersive simulations of a different environment. Augmented reality is a combination of the real world and virtual world, defined by Karacan, et al. (2022, p. 139), as a "new generation technology that shows video, picture and animated 3D objects over real-life scenes." "Mixed reality (MR) is a technology that allows not only the superposition of digital elements into the real-world environment but also their interaction" (Tremosa, 2023). While VR, AR, and MR have been in existence for decades, they have not been seriously considered for education teacher preparation until recently. Some other fields utilizing extended reality include the automotive industry, healthcare, retail, tourism, real estate, architecture, interior design, gambling, entertainment, education institutions for recruitment purposes, art and design, fitness, conferences and meetings, social, law enforcement, recreation, and journalism (https://virtualspeech.com/blog/vr-applications).

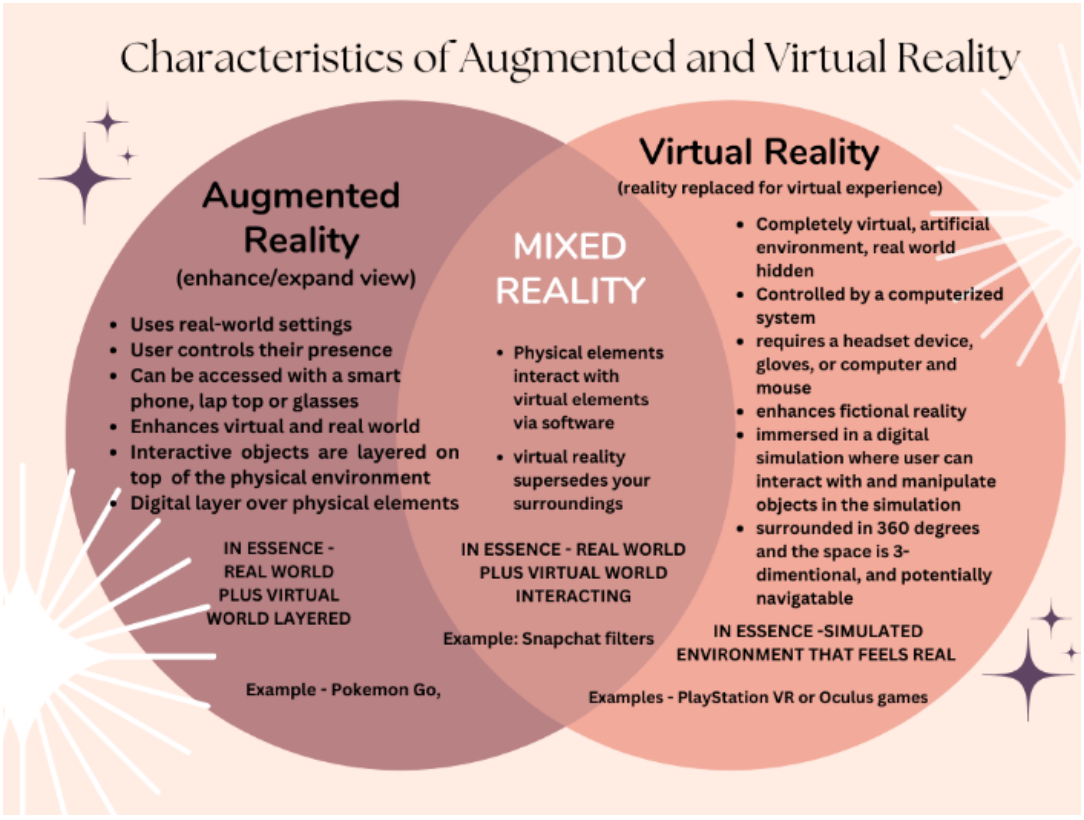

Figure 1. Characteristics of Augmented and Virtual Reality

Hechter and Vermette (2013) note some barriers exist in integrating technology into pre-service teacher training, such as inadequate access to technology, the amount of time and training needed to use these tools, as well as budget restraints. However, by integrating technology into the teacher preparation process could provide many creative and innovative solutions which address the issues facing teacher education today. While many other fields of study and commerce are immersed in the utilization of extended reality, teacher preparation is just beginning to realize its potential. On the forefront of this teaching methodology, Accardo

and colleagues (2017) utilized simulations in an experimental manner and found teacher candidates who trained using the simulations experienced increased ability with parental collaboration and reflective instructional decision making. Sorohan and Thomas (2016) explored using game-style simulations with non-traditional preservice teachers. They found these students had an increased ability to combat logistical and curricular challenges often faced by non-traditional preservice students. Other researchers found improved self-appraisal in pre-service teachers after observing a simulated classroom environment (Hopper et al., 2013). Schott and Marshall 2018) contend virtual reality is situated in experiential education, which is actually the centralized concept of teacher preparation, where preservice learners obtain guidance through experience which scaffolds them from novice to expert practioner.

2.1 Significance of the Project

Real world experiences can be recreated in a virtual extended reality setting which is useful for both low cost and realistic experiences. This approach is useful especially in laboratory and field experiences. Rather than just reading about something, virtual or augmented reality can give students the feeling of actually being in the classroom. This innovative approach to fieldwork is applicable for students in teacher preparation, both in undergraduate and graduate, in-person and online programs. However, there is limited current research on the use of mixed reality specifically for teacher preparation, or the impact on the preservice teacher's self-efficacy (TSE) related to extended reality fieldwork.

While some reviews of literature on this topic have been completed in the past 10 years, none of these specifically address the body of research about AR and VR for teacher preparation over the past decade. For example, Ade-Ojo and colleagues (2021) completed a systematic scoping review of textual narrative involving mixed reality simulation in pre-service teacher training. Their work however, was focused upon just 13 articles. They suggest mixed reality could specifically increase confidence, self-efficacy, classroom management skills and communication. Another systematic literature review for using immersive virtual reality technology in teacher education by Billingsley, Smith, and Smith (2019), examined eight studies. They maintain immersive VR technologies can enrich and enhance learning in teacher preparation. This project is significant in that it documents where the field of education began inroads into the use of VR, AR, or MR, and thus serves to set the stage for advancing the implementation of extended reality in teacher preparation.

Teacher preparation involves an experiential journey in which steps are taken to develop a person from a novice to expert teacher. Kolb's (1984) stages of learning exemplify the journey: concrete experience, reflective observation, abstract conceptualization, active experimentation. The preservice teacher begins with exposure to classrooms and educational situations where they have opportunity to have concrete experiences in which they assimilate information about education. Reflection follows that experience along with conceptualization of themselves in the educator role. Lastly, they have active experimentation in which they practice and hone their educator skills. With continued practice, confidence and self-efficacy develops.

While this study examines the scope of work related to extended reality in teacher preparation, it also includes research about the impact AR, VR or MR could have upon teacher self-efficacy. The social cognitive concept of teacher self-efficacy (TSE) proposed by Albert Bandura (1977) is a key element in a teacher candidate's success, especially related to instructional and managerial tasks. As Bandura (1994) explains, "self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave." As a teacher gains experience, they often gain confidence in educational decision making. This builds teacher self-efficacy. A teacher with strong self-efficacy believes they can impact, manage and motivate their students, all of which are building blocks for student achievement. This research project also seeks to understand if teacher self-efficacy can be increased with the utilization of AR, VR, or MR embedded in the preservice teacher preparation process.

2.2 Research Questions

The following research questions provided a framework for the study and a guide for disseminating the results. These questions provide a means to review past teacher preparation VR, AR and MR practices and project to future uses.

1. What are notable observations from the past 10 years (2013-2023) of empirical study involving the use of extended reality in teacher preparation?
2. Does the use of augmented reality, virtual reality, or mixed reality in teacher preparation impact preservice teacher's self- efficacy?
3. How might augmented reality, virtual reality and mixed reality be utilized in a teacher preparation programs for both instructional practice, classroom management and professional reflection?

3. METHOD

This study investigates the use of mixed reality with preservice teacher candidates. A systematic literature review (Baker, 2016) was conducted of the literature related to both virtual reality and augmented reality in teacher preparation. The goal of the review was to assess the scope of empirical work related to mixed reality and teacher preparation and any connections to teacher self-efficacy.

The following academic journal databases were searched: Academic Search Complete, APA Psycinfo, ERIC, and Teacher Reference Center. Search fields codes included *pre-service teachers*, or *preservice teachers*, or *teacher candidates* and *virtual reality*. A second search was also completed utilizing *pre-service teachers*, or *preservice teachers*, or *teacher candidates* and *augmented reality*. The original yield resulted in 369 articles related to virtual reality and 189 related to augmented reality, with a total of 558 articles published between 2013 and 2023. Each of these search results were analyzed via their abstract and then if needed, the actual paper was retrieved. Inclusion criteria required that the study be empirical (a study systematically collected data which included subject, methodology and results) and written or translated in English. While many of these studies noted teaching practices involving extended reality, they were excluded if not directly involving pre-service teachers or teacher preparation. After duplicates and articles not directly about teacher preparation were removed, 158 empirical studies (N=158) remained (see Figure 2).

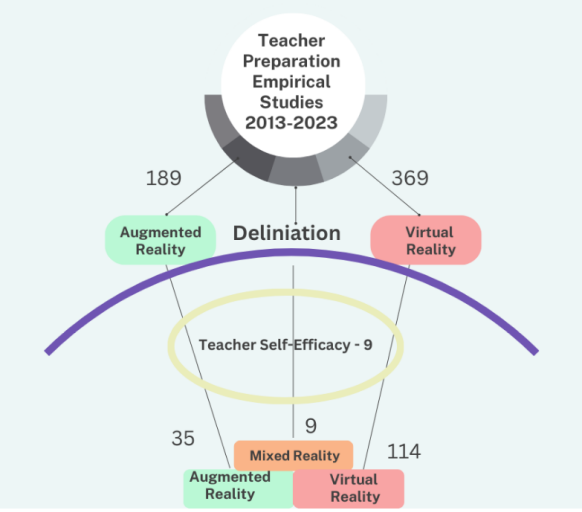

Figure 2. Systematic review of teacher preparation studies and resulting yield.

Data extracted from each of the empirical studies included the following: title, author(s), publishing source, the type of research, whether the study involved augmented reality or virtual reality, location of the study if provided, the number of participants, teacher preparation training focus, and the specific virtual tools, if noted in the study manuscript. Lastly, each study was reviewed for mention of teacher self-efficacy and whether the focus of the virtual aspect was specific to teacher preparation or content delivery.

4. RESULTS

The results of this study are detailed in response to the research questions.

4.1 What are Notable Observations from the Past 10 Years (2013- 2023) of Empirical Study Involving Extended Reality in Teacher Preparation?

The majority of studies focused upon virtual reality in teacher preparation, representing 72%, while augmented reality related studies were 22% and studies noted as mixed reality were 6% of the total studies. The sources publishing empirical work on AR and VR in teacher preparation are globally representative. Countries in addition to the United States represented in the study of AR and VR in teacher preparation included the following: Turkey (N=18), and between one and five articles each from Thailand, Spain, Slovakia, Russia, Portugal, Netherlands, Malaysia, Denmark, Colombia, China, Bulgaria, and Australia.

The publishing sources included a total of 93 academic journals, with the following having the highest distribution: Computers & Education (N=11), British Journal of Educational Technology (N=10), Education and Information Technologies (N=5), Journal of Computer Assisted Learning (N=4), Journal of Educational Technology Systems, (N=4), 5 more journals with each having a (N=3), and 19 journals each having a (N=2). The remainder of journals were only represented one time. Notably, the sources publishing were not primarily education oriented, rather technological in nature.

The type of research methodology most utilized was quantitative (N=65), followed by qualitative (N=60) and mixed methods (N=32). Forty-two per cent of quantitative studies were comprised of experimental studies while 25% were correlation and 20% were descriptive comparative. Additionally, the number of participants in the studies ranged from (N=1), usually case studies, to (N=1,920). The mean number of participants/subjects was (N=90), the mode was tied at 85 and 5, and the median was 46. Eighty per cent of the studies had fewer than 100 participants.

Much of the most recent data accessed for this study mentioned the pandemic or Covid. Ninety-nine of the original articles prior to delineation had the word "Covid" within them. Not all of the articles which mentioned Covid were utilized for this study, but it was notable that Covid impacted the field of education, and was a catalyst to the development of technological innovations that can be employed regardless of the particular educational setting.

4.2 Does the Use of Augmented Reality, Virtual Reality, or Mixed Reality in Teacher Preparation Impact Preservice Teacher's Self-Efficacy?

With practice comes increased proficiency and confidence. The essence of building teacher self-efficacy (TSE) is honing the educator craft, including effective instruction, management, assessment, and overall facilitating learning. The virtual world provides opportunity for practice in the realm of teacher preparation.

A total of (N=12) studies included teacher self-efficacy as part of the focus. Each of these studies also focused solely on the preparation of the teacher and not on content delivery. Other themes associated with self-efficacy were classroom management, inclusion, communication, reflection, immersive experiences and engagement of learners.

4.3 How Might Augmented Reality, Virtual Reality, and Mixed Reality be Utilized in a Teacher Preparation Program for Both Instructional Practice, Classroom Management and Professional Reflection?

4.3.1. Instructional Practice and Reflection

Instructional practice is necessary for teacher preparation. Typically, field experiences are rooted within the preparation program where preservice teachers gain opportunity to practice. These experiences will vary from program to program and may or may not include virtual learning. Quintana and colleagues (2017) found the use of virtual learning environments improved teaching and learning. In such environments, instructional

practice can occur without the fear or anxiety of mistakes impacting students negatively.

Upon review of the use of extended reality for instructional purposes, it was noted the focus for these studies tended to veer in one of two directions, either the use of AV, VR, or MR for pedagogical purposes (N=112) or to determine attitudes, opinions or preferences related to AV, VR, and MR in teacher preparation (N=35). Two exceptions to this focus trend were literature reviews and validation or evaluation of AV/VR programs, equipment or software (N=4). Most often attitudes, opinions or preferences were parsed from preservice teacher reflections.

When considering the evolving cognitive patterns of each generation, it would behoove educational leaders to adjust and adapt instruction accordingly. Dyak, et al. (2022) contend their research findings conclude that modern education should orient teachers and students to new ways of preparation and practice in education. Many of the articles in this review are seeking to gauge and understand the receptiveness of preservice candidates to either being taught via mixed reality or utilizing it as an instructional tool. This receptiveness is crucial, as Theelen and colleagues (2020) note, an inherent digital society gap is developing between verbal and visual cultures with youth increasingly interacting with the virtual environment.

4.3.2 Classroom Management and Reflection

Multiple studies in this review claim classroom management as a key area of focus. Through virtual scenarios, students are able to practice and reflect upon their management decisions. Such VR technology opportunities and challenges are highlighted by Graeske and colleagues (2021). They emphasize results in which students' motivation and problem-solving skills increased, which naturally involves reflection. They also emphasize that such technology use is most effective when it functions in accordance with the curriculum established by the educational institution. Mixed reality can be particularly useful to enhance learning opportunities. Additionally, the manner in which mixed reality is currently being used involves a great deal of reflection following practice, thus increasing the opportunity to improve preservice teachers' TSE.

5. DISCUSSION

The field of education is not adequately focusing on innovation involving technology; seemingly the majority of the empirical research seems to be scattered among journals with either an educational technology or purely technological focus. Over the past decade there has not been a flagship journal producing reports heralding the importance of AR and VR in teacher preparation. Globally researchers have dabbled in the topic of in extended realities, the highest concentration of research found in the United States and Turkey. As is evidenced by the paucity of articles published globally in the past ten years which focus on using AR and VR for teacher preparation, it is clear AR and VR have barely been studied or utilized for teacher preparation purposes.

Virtual reality related teacher preparation represented 70% of the research reviewed in this study. There is cause to conclude that teaching practitioners might be unaware of the potential of extended realities to be a significant tool in motivating and enhancing instruction by providing vivid illustration of places, procedures and concepts through video, picture, and animated 3D objects over real-life scenes (Karacan, et al., 2022).

There is a healthy mix of types of methodology utilized in these studies related to AR and VR in teacher preparation (20% mixed methods, 59% qualitative, and 41% quantitative). There is a need for increased, purposeful, robust research in regard to the use of extended reality to enhance teacher education. Additionally, these studies understandably will likely have participants with relatively small (N) as that would be reflective of classroom sizes and yearly collegiate cohorts. This was evident with 80% of studies represented in this review over the past 10 years with a (N) less than 100.

As noted previously, preservice teachers have historically expressed a need for increased training in classroom management. This study barely touches the surface of possibilities in that direction with only 9 studies having classroom management as a focus. Two studies use 360 video in teacher prep to facilitate management by increased awareness of behaviors (Gandolfi, et al. 2021; Kosko,2022). Another study discusses the use of immersive VR and transferring that experience into future classroom management.

6. CONCLUSION

Lastly, we cannot ignore the impact of the Covid-19 pandemic upon the field of education and related research, especially as it relates to technological innovation. The repercussions from that historical event will continue to influence and impact educational decisions moving forward. Many of the studies directly referred to the pandemic, and were emphasizing the need for increased online instruction pedagogical prowess.

The limitations of this study include a delay in research as a result of the Covid-19 pandemic. However, that situation also served to open doors to new considerations for teacher preparation. Caution must be taken that VR and AR are employed with care in educational settings and within the bounds of the educational objectives for that particular learning experience. Another potential limitation may be that terms for teacher preparation may vary globally and potentially may not have captured in the search terms. Additionally, there are some studies which could potentially have been included but were not because they were not in English.

There is significantly more work to be done on the innovative use of AR and VR in teacher preparation as reinforced by Ade-Ojo and colleagues (2021), who completed a focused review on mixed reality and simulation in teacher preparation. They plea for further work on mixed reality in education preparation and note the field of education is comparatively behind other fields such as medicine and aviation in both innovation and research on use of mixed reality. Billingsley and colleagues (2019) note that research in this area is lacking and call for increased attention to this topic. This current study adds to the findings of previous literature reviews which clearly articulated the need for further study on innovation utilizing VR and AR in teacher preparation. While this study adds to the current knowledge base regarding AR and VR in teacher preparation by providing a critical examination of the current methodology and research trends, and it also exposes the need for significant future research.

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