Internet Learning

Volume 6
Issue 1 *Spring 2017/Summer 2017*

Article 5

August 2017

Immersive Technology: Motivational Reactions from Preservice Teachers

Kevin J. Graziano
Nevada State College

Internet Learning Volume 6 Number 1 - Spring 2017/Summer 2017

Immersive Technology: Motivational Reactions from Preservice Teachers

Kevin J. Graziano, *Nevada State College*

Abstract

Within teacher education, there is limited literature on the use of contemporary immersive technologies with preservice teachers. This study describes the instructional design of an online, immersive technology module taught to undergraduate, preservice teachers (N = 27), and discusses preservice teachers' reactions to creating and interfacing with immersive technology. The online module was designed using strategies from the Attention, Relevance, Confidence and Satisfaction (ARCS) motivational design model. Data were collected using the Instructional Materials Motivation Survey. Participants thought the module contained content that was worth knowing, and was relevant to their needs and interests. Participants reported that the module impacted their interest to consider immersive technology with their own future instructional design. The results of this study shed light on new opportunities for teacher educators to become familiar with immersive technologies and suggest that such tools should be integrated into teacher preparation curricula.

Keywords: *ARCS, immersive technology, IMMS, motivation, preservice teachers, teacher preparation, virtual reality*

Introduction

The application of immersive technology is common in the areas of aviation, business, military, and medicine, but it is limited and slowly emerging in the field of teacher education (Dieker, Rodrigues, Lignugaris/Kraft, Hynes, & Hughes, 2014) and educational settings (Dawley & Dede, 2014). The 2017 Higher Education Edition of the Horizon Report discusses technology developments that have the potential to foster real changes in education, particularly in the development of progressive pedagogies and learning strategies and the arrangement and delivery of content (Adams Becker et al., 2017). The Horizon Report noted that immersive technology, such as virtual reality, has the potential to add more functionality and greater potential for learning (Adams Becker et al., 2017).

Immersive technology, defined

doi: 10.18278/il.6.1.4

herein as augmented, virtual, and 3-D reality, refers to all forms of perceptual (input to the user) and interactive (output from the user) hardware technologies that blur the line between the physical world and the simulated or digital world (Mahomedy, 2015). Immersive technology simulates a subjective impression that allows users to participate in a comprehensive, realistic, participatory experience (Dede, 2009b). Immersive technology often contains a variety of features such as 3-D display and audio effects not possible in the real world to enhance users' engagement and learning within an experiential simulation (Dawley & Dede, 2014). When high levels of engagement occur with technology, the user believes he or she is in the environment physically and cognitively (Dede, 2009b).

Libraries today on university and college campuses are expanding their information and technology resources to include cutting-edge tools such as virtual reality equipment and 3-D printers. Immersive technology has also been identified as an important technology development that could support innovation and change in K-12 classrooms (Adams Becker et al., 2017).

In 2015, schools in Australia, Brazil, New Zealand, the United Kingdom, and the United States began collaborating with Google to beta-test Expeditions. Expeditions are collections of virtual reality content and supporting materials that can be used alongside an existing curriculum (Google Expeditions, 2017). Google Expeditions enable teachers to bring students on virtual trips to museums, historical monuments, and outer space. The beta Expeditions program enabled one million students in 11 countries to participate in virtual field trips. It is predicted that virtual reality will be widely adopted by schools within 2–3 years. It is also estimated that by 2025, the market for virtual reality content on Smartphone devices will reach $5.4 billion, virtual and augmented reality entertainment revenue will reach $3.2 billion, and the education sector will attract 15 million users (Adams Becker et al., 2017).

Despite the proliferation of modern immersive technology, typical classrooms seldom leverage immersive technology for teaching and learning (Dunleavy, Dede, & Mitchell, 2009). If K-12 teachers should be more skilled at using approaches that encourage their students to engage with academic content, an obvious place to begin and experience new ways of teaching and learning, such as using immersive technology, is in teacher preparation programs (Hoban, Loughran, & Nielson, 2011).

Due to the lack of immersive technology usability in teacher education (Dieker et al., 2013), the impetus for this study was wanting to know if a module on immersive technology would capture preservice teachers' attention and interest and appear important enough to integrate into teacher preparation program curricula. This study describes the instructional design of an online, immersive technology module taught to undergraduate, preservice teachers, and discusses preservice teachers' reactions to creating and interfacing with immersive technology.

Reactions from preservice teachers were measured using the Instructional Materials Motivation Survey (IMMS) (Keller, 2010). Technologies used to measure preservice teachers' reactions to the immersive technology module included augmented and virtual reality apps, social media such as Twitter and Pinterest, and 3-D lesson building software. The research question that guided this study was *what are the motivational reactions from undergraduate preservice teachers to enhanced, online, immersive technology instructional materials*? Preservice teachers in this study refer to undergraduate students enrolled in a teacher preparation program.

Literature Review

While recent attention has focused on new opportunities of immersive technology, the affordances of educational integration of virtual reality have been explored for decades, dating back to its general inception of integration by Ivan Sutherland in the 1960s (Dede, 2009a). Immersive environments shape users' learning styles, strengths, and preferences (Dunleavy et al., 2009). Immersive interfaces can aid in designing educational experiences that build on students' digital fluency to promote engagement, motivation, learning, and transfer from classroom to real-world settings (Dede, 2009b). The more an immersive experience is based on design strategies that combine actional, symbolic, and sensory factors, the greater the participant's suspension of disbelief that she or he is *inside* a digitally enhanced setting (Dede, 2009b).

Salzman, Dede, Loftin, and Chen (1999) discuss educational environments with virtual reality and conceptual learning and write,

> If properly designed, 3-D, multisensory virtual worlds might be able to aid users in comprehending abstract information by enabling them to rely on their biologically innate ability to make sense of physical space and perceptual phenomena ... By engaging users in learning activities, immersion may make important concepts and relationships more salient and memorable, helping users to build more accurate mental models. Also, inside a head-mounted display, the user's attention is focused on the virtual environment without the distractions presented in many other types of educational environments. (p. 294)

In the past several years, the utility of various elements of immersive technology in education has been discussed, from broad overviews of applications (Wu, Lee, Chang, & Liang, 2013) and overviews in teacher education (Aldosemani & Shepherd, 2014; Gregory & Masters, 2012) to specific cases such as environmental field trips (Dunleavy et al., 2009) and the use of Second Life in higher education (Warburton, 2009). Second Life is the most mature and popular multi-user virtual world platform used in education. Researchers have also investigated the affordances and constraints of augmented reality in mathematics and geometry education (Kaufmann, Schmalstieg, & Wagner, 2000), immersive virtual technology as a basic research tool in psychology (Loomis, Blascovich, & Beall, 1999), and immersive virtual reality to learn science (Bailenson et al., 2008; Dede, & Barab, 2009; Ketelhut, Nelson, Clarke, & Dede, 2010).

Empirical research on immersive technology has produced positive results. In a systematic review of literature on immersive virtual worlds in K-12 and higher education settings, Hew and Cheung (2010) examined literature on the usage of virtual worlds by students and teachers, the research methods used to study immersive virtual worlds, and the research topics conducted on virtual worlds in teaching and learning. Hew and Cheung found that virtual worlds were utilized for communication spaces, simulation of space (spatial), and experimental spaces. Most studies, 14 out of 15, were descriptive in nature and conducted in polytechnic and university settings. Research topics conducted on virtual worlds included participants' affective domain, learning outcomes, and social interaction. Hew and Cheung reported that students like using virtual worlds because they enjoy the ability to move around freely in a 3-D space, to meet new people, and to experience virtual field trips and simulated experiences.

Literature reviewed by Hew and Cheung (2010) also suggested that the use of avatars in virtual worlds could help foster social interaction among participants. For example, Bailey and Moar (2001) found avatars were the main means for elementary students in the United Kingdom to initiate contact and conversation with others. Students spent ample time searching for other people, and looked forward to meeting students from other schools. Peterson (2006) reported that the use of avatars by students of English as a foreign language in Japan contributed to a sense of being there within virtual world environments. The use of avatars enhanced interaction more than other chat environments.

The use of virtual reality created an interesting dynamic in Castenada and Pacampara's (2016) exploratory study on the use of virtual reality with seven teachers from six schools across the United States. Teachers and students learned alongside each other and collaboratively worked in groups to create and interact with content. Teachers used technology challenges as teachable moments and the students were enthusiastic about finding solutions to the challenges. A major finding of the study highlighted that more content is needed in order to make virtual reality a truly useful mechanism for learning in the non-tech classrooms.

Despite positive outcomes and benefits of immersive technology, Schrader (2008) warns educators that the highly dynamic and changing nature of immersive environments necessitates changes to existing instructional design strategies. Schrader writes, "teachers must accept less direct control over the instructional conditions and shift their focus and attention to the rules and constraints governing the immersive environments" (p. 469). Schrader argues this establishes a need for educators to fully understand the realities of contemporary educational contexts and emerging instructional roles.

The most recent research on immersive technologies in teacher education delves into the educational affordances and use cases with large-scale tools. One of the more well-known cases is the TLE TeachLivE™ lab, a virtual reality simulator that provides preservice teachers and in-service teachers opportunities to experience simulations of classroom experiences (Dieker, Rodriguez, Lignugaris/Kraft, Hynes, & Hughes, 2014; Dieker, Hynes, Hughes, & Smith, 2008; Myers, Starrett, Stewart, & Hansen-Thomas, 2016). The TLE Lab allows participants to learn teaching skills and craft their practice without real students present during the learning process (Dieker et al., 2014). "Unlike practice instruction in real classrooms, teachers can reenter the environment to fix errors with avatars and ensure student success" (Dieker et al., 2014, p. 30). Dieker et al. hypothesize that these processes should transfer to real classrooms when instructing real students. With more than 30 universities in the United States using the TLE TeachLivE™ lab to train preservice teachers, "the use of simulated environments is part of the evolution in teacher education being realized through emerging technologies" (Dieker et al., 2014, p.21).

Gregory and Masters' (2012) findings using Second Life with preservice teachers who performed role plays in a real-life physical setting and within the virtual world of Second Life also revealed that real-world role-plays can be simulated in a virtual world. Preservice teachers found the real-life and virtual world-based versions of the role-playing activity interesting and engaging. Students put the same amount of effort into the real-life workshops as the Second Life workshops; however, students found carrying out the activity in real-life more appealing and worthwhile than doing so in Second Life.

Gregory et al. (2011) explored the assessment of virtual professional experiences (VirtualPREX) with preservice teachers who role-played professional experiences in a virtual world. VirtualPREX was designed and implemented to provide preservice teachers with experiences that reflect the complex, diverse, multifaceted nature of a teacher's role in the classroom. Although preservice teachers found the role-play activity interesting and entertaining, and commented on the value of virtually role-playing a teacher or student, 31% of preservice teachers ($N = 71$) found the activity confusing and only 40% found the activity useful.

Immersive Technology and Motivation

Research indicates that the use of immersive technology results in increased student motivation. Student and teachers report high engagement as a result of using handhelds, adopting roles, negotiating meaning within active, inquiry-based compelling narratives, solving authentic problems, and physically exercising (Dunleavy & Dede, 2014). Motivation was also a key finding from Freina and Ott's (2015) review of the literature on immersive virtual reality technology in education. Freina and Ott reviewed 93 published articles between 2013 and 2015, and concluded that immersive technology increases the learner's involvement and motivation while widening the range of learning styles supported. The main motivation for virtual reality use is that it gives the opportunity to live and experiment those situations that cannot be accessed physically.

Theories about motivation from social psychology describe various reasons why participants might become highly engaged in immersive simulations and might be motivated to frequently seek out this experience (Bartle, 2003). Students are motivated by the realistic scenes, dynamic presence, and high interaction supported by immersive technology (Lee, Wong, & Fung, 2010). In immersive simulations, motivational factors that encourage a willing suspension of disbelief include empowering the participant in an experience to initiate actions that have novel, intriguing consequences, invoking powerful semantic associations and cultural archetypes via the content of an experience, and sensory immersion through extensive visual and auditory stimuli (Dawley & Dede, 2014).

Mahadzir and Phung (2013) studied augmented reality pop-up books to motivate and support students in English language learning. They developed a pop-up book that incorporated Keller's (2010) Attention, Relevance, Confidence, and Satisfaction (ARCS) motivation model, observed primary school students using the pop-up book for a year, and conducted semi-structured interview at the end of application. Mahadzir and Phung revealed that the augmented reality pop-up book contributed to "perceptual arousal, inquiry arousal, variability, goal orientation, motive matching, familiarity, learning requirements, success opportunities, personal control, intrinsic reinforcement, extrinsic rewards, and equity" (p. 34). In addition, the study found that augmented reality increased students' performance by providing a more inspiring environment for students.

Solak and Cakir's (2015) descriptive research study also investigated students' performance using immersive technology. They examined the motivational levels of 130 undergraduate students in a language classroom that utilized augmented reality. Findings revealed that augmented technology had a positive impact on increasing learners' motivation towards vocabulary learning in a language classroom. Solak and Cakir also found no statistically significant difference between genders towards motivation, and high achievers had a high level of motivation in terms of confidence and satisfaction towards the use of augmented reality in the language classroom.

Data on immersive technology

has also demonstrated an increase in engagement and motivation of students who had previously been disengaged and disinterested in school. Through interviews and observations, Dunleavy, Dede, and Mitchell (2008) documented how teachers and students describe and comprehend ways in which participating in an augmented reality simulation aids or hinders teaching and learning. Teachers reported a positive difference in the behavior and engagement of students during their use of augmented reality as compared to their normal classroom behavior. Students and teachers reported that the most motivating and/or engaging factors of using augmented reality were using the handhelds and GPS to learn; collecting data outside; and distributed knowledge, positive interdependence, and roles.

Results from research studies using the virtual reality simulator TLE TeachLivE™ Lab in the fields of counseling, secondary science students, teacher preparation in algebra, and special education also reveal that participants were motivated to use immersive technology and felt confident in studying content while using the simulator (Andreasen & Haciomeroglu, 2009; Bousfield, Dieker, Hughes, & Hynes, 2016; Dieker, Grillo, & Ramlakan, 2011; Dieker et al., 2014; Gonzalez, 2011; Straub, Dieker, Hynes, & Hughes, n.d.; Vince-Garland, Vasquez, & Pearl, 2012). In fact, Vince-Garland et al. (2012) reported that graduate students in special education improved, on average, their performance with discrete-trials teaching, an evidence-based practice used in educational programs for children with autism spectrum disorders, from a mean accuracy of 37% to 87 after receiving coaching in the TLE TeachLivE™ virtual classroom setting.

Other forms of immersive technology such as gamification and role-play-based augmented reality have enhanced users' motivation and a sense of authenticity (Rosenbaum, Klopfer, & Perry, 2007). Gee (2003) argues that gamification can promote problem-solving, goal-related behavior, engagement, and motivation. Aspects of gamification that promote intrinsic motivation include intrapersonal factors such as challenge, control, fantasy, and curiosity as well as interpersonal factors such as competition, cooperation, and recognition (Bartle, 2003).

Conceptual Framework

The conceptual framework that guided this study was Keller's motivational model of learning (1979). Motivation is the most frequently used explanation for success or failure in completing complex tasks and is a pivotal concept in most theories of learning (Chang & Lehman, 2002). Keller (1979) believed external conditions could be successfully constructed to facilitate and increase learner motivation. According to Keller, motivation occurs when students' curiosity is aroused and sustained; the instruction is perceived to be relevant to personal values or goals; students have the personal conviction to succeed; and the consequences of the learning experience are consistent with students' personal incentives. Based on this, Keller developed the ARCS model (Keller 1984, 1987, 1999).

The ARCS component Attention refers to gaining attention, building curiosity, and sustaining active engagement in the learning activity (Keller, 2008). In this component, it is important to use a variety of approaches to gain students' attention. According to Keller, "people adapt to routine stimuli; no matter how interesting a given technique or strategy is, they will lose interest over time. Thus, it is important to vary one's approaches and introduce changes of pace" (p. 177).

The ARCS component Relevance includes concepts and strategies that establish connections between the instructional environment, which includes content, teaching strategies and social organization, students' goals (either extrinsic or intrinsic), learning styles, and past experiences (Keller, 2008). The Relevance component has been likened to authentic learning experiences based on constructivist approaches to learning. Other motivational concepts that help explain relevance are motives such as the needs for achievement, affiliation, and power (Keller, 2008).

The ARCS component Confidence incorporates variables related to students' feelings of personal control and expectancy for success (Keller, 2008). According to Keller, "confidence is achieved by helping students build positive expectancies for success and then experience success under conditions where they attribute their accomplishments to their own abilities and efforts" rather than luck or an easy task (p. 177). The Confidence component integrates concepts from self-efficacy theory. Self-efficacy theory involves "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1994, para. 1). Individuals are more likely to engage in activities for which they have high self-efficacy and less likely to engage in those they do not (Van der Bijl & Shortridge-Baggett, 2002). If students expect failure, they will avoid the task. If students anticipate success, they will approach the task (Heafner, 2004).

In the ARCS component Satisfaction, it is necessary for learners to have positive feelings about their learning experiences and to develop continuing motivation to learn (Keller, 2008). "Providing students with opportunities to apply what they have learned, coupled with personal recognition, supports intrinsic feelings of satisfaction" (Keller, 2008, p. 178). Keller adds students must feel that the amount of work required by the course was appropriate; there was internal consistency between objectives, content, and tests; and there was no favoritism in grading.

In writings on the validity of the ARCS model, Keller (Keller 2008, 2010; Keller & Suzuki, 2004) often cites research from Winiecki, Fenner, and Chyung (1999) and Chang and Lehman (2002). Winiecki et al. (1999) used the ARCS model to design and implement interventions that would decrease the dropout rate in a distance-learning program. According to Keller (2008), results from the Winiecki et al. study indicated that there were improvements in both learning and motivational reactions in all four motivational components of the ARCS model. Also, there was a significant reduction in the dropout rate, from 44% to 22%.

Chang and Lehman (2002) used the ARCS model in an experimental study to investigate effects of intrinsic motivation and embedded relevance enhancement within a computer-based interactive multimedia lesson for English as foreign language learners. Results indicated that the use of relevance enhancement strategies facilitated students' language learning regardless of learners' level of intrinsic motivation, the more highly intrinsically motivated students performed better regardless of the specific treatments they received, and intrinsically motivated students who learned from the program with embedded instructional strategies performed the best overall.

Means, Jonassen, and Dwyer (1997) compared the effects of the intrinsic relevance of course material with embedded, extrinsic relevance-enhancing strategies based on the ARCS model. The results of the study indicate that the learners, 100 undergraduate students enrolled in statistics and a human physiology class, had higher perceived motivation levels and better task performance. The embedded relevance strategies, such as the use of concrete language and examples, use of imagery and analogies, use of human-interest graphics and stories, enhanced motivation and improved performance, especially for the learners for whom the materials were not relevant.

Methods

Participants

Participants included a purposeful sample of 27 undergraduate preservice teachers from a small undergraduate college in the southwest with an enrollment of approximately 6,000 students. Participants were enrolled in a lower division required educational technology course during the fall 2016 semester. The course was offered online via Canvas, the learning management system used by the college.

The course demographics included 23 female participants and 4 male participants, of which there were 6 sophomores, 15 juniors, 2 seniors, and 4 post-baccalaureate students. Participants' majors included 9 elementary education majors, 10 secondary education majors, and 6 speech pathology majors. Two participants selected "Other" as their major. Two participants were certified classroom teachers and one participant was a substitute teacher. Two participants studied and used immersive technology prior to this course. Three participants had previously used augmented, virtual reality, or 3-D with education planning and/or teaching.

Course Context

Participants completed a 4-week module on immersive technology, which included assignments using immersive technologies. Keller's (1983) ARCS model was used to design and develop the module. According to Keller, the ARCS model allows faculty and designers to evaluate whether the materials created and used in a course do in fact grab a learner's attention, appear important, establish trust, and leave the learner believing that the materials conveyed what they intended to convey. From a teacher preparation perspective, the ARCS model provides an opportunity for the preservice teacher to contemplate the materials they might create in such a way that they are more conscientious about their own professional classroom competencies (Keller, 2010).

Motivational design strategies based on the ARCS model used in this study included, but were not limited to, varied positions of photos, images, text, and background colors; a navigation side panel with minimal options that were easy to locate; online tutorials for all technology utilized in the course; an "ask the professor" link that was easily accessible to students from the homepage and discussion board located in the module; technical support from the professor via the telephone and video conferencing; examples of completed assignments; online resources such as a list of free apps; opportunities for students to work at their own pace with all tutorials and course resources such as podcasts and PowerPoint slides; use of positive, encouraging, congratulatory language with feedback and responses to questions; use of animations to bring attention to important information; and enlarged text and colorful font to highlight key concepts. These strategies are designed to make students' initial perceptions of the module seem easy to read and use and assist in gaining and maintaining students' attention and confidence (Keller, 1987; Keller & Burkman, 1993; Keller & Kopp, 1987; Keller & Suzuki, 1988).

A colleague who teaches educational technology courses evaluated the usability of the course and the immersive technology module before the course went live. Minor changes such as changing the typeface and font size, revising pages with lengthy text, and adding new pictures and video tutorials were applied to the module based on the recommendations.

During Week One, participants studied augmented reality and created an augmented reality project using the Arasma app. Augmented reality provides a live direct or indirect view of a physical, real-world environment whose elements are *augmented* (or supplemented or enhanced) by computer-generated sensory input such as sound, video, graphics, or GPS data. During Week Two, participants read about virtual reality in education, studied the SAMR model (Puentedura, 2015) of technology integration, and explored virtual reality apps using the free EON experience app. Participants then searched YouTube and the internet for three free virtual reality apps they would like to use in three different lesson plans.

To reduce the anxiety of finding

appropriate apps for the lesson plans, participants considered a list of free apps provided by the professor. Participants downloaded three different virtual reality apps to their smartphones or mobile devices, and created three different lesson plans that utilized each app to transform learning *above the line* according to Puentedura's (2015) model of technology integration, commonly referred to as the SAMR model. The SAMR model has two main components: enhancement and transformation. In the enhancement component, technology is used as a *Substitution* or for *Augmentation*. Above the line refers to the top tier of the model, the transformation component, where technology is used for *Modification* or *Redefinition*. The implication is that technology will most powerfully affect student achievement if it is used in the transformation component (Johnson, 2013/2014).

During Week Three, participants utilized Twitter and Pinterest as professional learning networks. They tweeted their thoughts of using immersive technology and shared how immersive technology can be used in the classroom. Then, participants searched for two individuals on Twitter who were tweeting about immersive technology (either augmented, virtual, or 3-D reality), and interacted with their tweets. Participants posted their responses to the following two items in Canvas, (1) what did you find on Twitter (provide a descriptive summary of the tweets), and (2) write a summary of your responses to the individuals you followed on Twitter. After reading about Pinterest and how educators use Pinterest in the classroom, participants ended the week by creating a Pinterest board. Participants' boards contained 12–15 pins on immersive technology. The links to their boards were posted in Canvas.

During Week Four, the final week of the module, participants viewed videos and examples on why and how to create 3-D lesson plans using EON Creator, an online 3-D creation tool. Participants' 3-D lessons were created using EON Creator, and had to include the following: one 3-D object (content topic), at least five annotations, one quiz with five questions relevant to the content, one YouTube video related to the object, one link to Wikipedia related to the object, one link to an internet website with more information on the object, one PowerPoint presentation with 3–4 slides that outline the main features of the object, and one audio file that describes a feature of the object.

While some participants owned their own headset, others borrowed a headset from the campus library. Participants received a lesson plan template with definitions and examples to guide them with their lessons' assignments.

Selected examples of participants' augmented reality projects using the Arasma app from Week One of the module included: homework lessons; book reviews; yearbooks; word walls; icebreakers; math reviews; and deaf and hard of hearing sign language flashcards. Participants' virtual reality lesson plans from Week Two of the module included apps to teach the following topics: the solar system; the monarch butterfly lifecycle; ancient Egyptian history; the extraction of gold from the earth; the extinction of rhinos; autobiographical and city tours of cities; displaced individuals from the Syrian refugee crisis; the history of Cuban dance; natural disasters; U.S. capitols; and articulation of words. Selected topics from participants' 3-D lesson plans from Week Four of the module included: the human heart, mouth, brain, and teeth; the statue of liberty; space shuttles; the skeleton system; the neuron cell; and ancient Egyptian leaders.

Data Collection and Data Analysis

This study utilized the Instructional Materials Motivation Survey (IMMS) (Keller, 2010) as the data source to answer the research question. The IMMS was selected because the survey contained critical motivational factors from the ARCS model. The IMMS was not used to examine preservice teachers' academic performance or motivational reactions compared to a control group after receiving enhanced strategies and instruction on immersive technology. This study simply reports preservice teachers' reactions to creating and interfacing with immersive technology and does not quantify technology outcomes produced by students.

The IMMS contains 36 items. All survey items included Likert-style response scales with a score of one being *Not True* and a score of five being *Very True*. An additional item was added to the end of the survey. It read, *After completing this module, I am excited to use the material (augmented reality, virtual reality, 3-D) learned in this module in my own classroom.*

The survey contained four components based on the ARCS model: (1) Attention, (2) Relevance, (3) Confidence, and (4) Satisfaction. The Attention component had 12 items, and the Relevance and the Confidence components both had nine items. The Satisfaction component had six items. Keller (2010) validated the survey with undergraduate preservice teachers enrolled in an applied educational psychology course. Selected example survey items included:

- These materials are eye-catching. (Attention)
- It is clear to me how the content of this material is related to things I already know. (Relevance)
- As I worked on this module, I was confident that I could learn the content. (Confidence)
- Completing the assignments in this module gave me a satisfying feeling of accomplishment. (Satisfaction)

Hu's (2008) study of motivation and usability in a self-paced online learning environment provided additional internal consistency and validity of the IMMS. The internal consistency estimate for the entire scale used in this study, based on Cronbach's α, was .87 (see Table 1). An acceptable α value should be above .70 (DeVellis, 2003).

SPSS Statistics was used to calculate descriptive statistics. Negative items in the survey were reversed before they were added to the response totals.

Table 1. IMMSS reliability estimates from this study.

Scale	Reliability estimate (Cronbach α)
Attention	.94
Relevance	.87
Confidence	.90
Satisfaction	.93
Total scale	.87

According to Keller (2010), there is no expectation of a normal distribution of responses because the survey is a situation-specific measure. Keller (2010) reminds others that one cannot designate a given score from the IMMS as high or low because there are no norms for the survey.

Findings

All 27 participants completed the IMMS online. The research question asked *what are the motivational reactions from undergraduate preservice teachers to enhanced, online immersive technology instructional materials*? A summary of the survey findings is provided below. Table 2 provides an overview of descriptive statistics from the survey.

After looking at the module, the majority of the participants either responded not true (*N* = 12, 44%) or slightly true (*N* = 28, 30%) to the survey item when I first looked at this module, I had the impression that it would be easy for me. Participants thought there was something interesting at the beginning of the module that got their attention (very true, N = 6, 22%; mostly true, N = 5, 19%; and moderately true, N = 7, 26%). Nearly all participants (*N* = 26) agreed the materials in the module were eye-catching (very true, *N* = 6, 22%; mostly true, *N* = 9, 33%, moderately true, *N* = 7, 26%, and slightly true, *N* = 4, 15%), helped keep their attention (very true, *N* = 5, 19%; mostly true, *N* = 6, 22%; and moderately true, *N* = 8, 30%), and agreed the module was not abstract (*N* = 17, 63%).

Participants thought the module contained content that was worth knowing (very true, N = 6, 22%; mostly true, N = 8, 30%; moderately true, N = 7, 26%; slightly true, N = 4, 15%, and not true, N = 2, 7%), and was relevant to their needs (N = 22, 81%) and interests (very true, N = 2, 7%; mostly true, N = 5, 19%; and moderately true, N = 9, 33%).

The majority of participants stated the module content related to things they already knew (very true, 1, 4%; mostly true, 6, 22%, and moderately true, N = 10, 37%), and agreed repetition in the module did not cause boredom (N = 16, 59%). Further, nearly all participants (*N* = 25) agreed that completing the module successfully was important to them (very true, *N* = 12, 44%, mostly true, *N* = 5, 19%, moderately true, *N* = 6, 22%, and slightly true, *N* = 2, 7%).

After reading the introductory information, participants felt confident that they knew what they were supposed to do (very true, *N* = 3, 11%; mostly true, *N* = 9, 33%; and moderately true, *N* = 8, 30%), and agreed that the organization of the module helped build their confidence in learning the materials (*N* = 14, 52%). As participants worked on the module, the majority of participants were confident they could learn the content (very true, *N* = 7, 26%; mostly true, *N* = 7, 26%, and moderately true, *N* = 8, 30%), and after working on the module for awhile, participants felt confident they would be able to complete the assignments (very true, *N* = 7, 26%; mostly true, *N* = 7, 26%, and moderately true, *N* = 6, 22%).

The majority of participants responded favorably to the survey item that asked "completing the assignments in this module gave me a satisfying feeling of accomplishment" (Very true, *N* = 4, 15%; mostly true, *N* = 10, 37%, and moderately true (*N* = 7, 26%). Nearly all participants responded very true (*N* = 12, 48%) or mostly true (*N* = 6, 22%) to the survey item 'it felt good to successfully complete this module.' An equal number of participants (*N* = 17) reported that the module stimulated their curiosity (very true, *N* = 5, 19%; mostly true, *N* = 7, 26%, and moderately true, *N* = 5, 19%), and that they enjoyed studying the module (very true, *N* = 5, 19%; mostly true, *N* = 7, 26%, and moderately true, *N* = 5, 19%).

Participants enjoyed the module "so much" that they wanted to learn more about the topic (very true, *N* = 7, 26%, mostly true, *N* = 5, 19%, and moderately true *N* = 4, 15%), and shared that they learned things that were surprising and unexpected (very true, *N* = 22%; mostly true, *N* = 10, 37%; moderately true, *N* = 6, 22%; slightly true, *N* = 3, 11%, and not true, *N* = 2, 7%). The majority of participants agreed that after completing the module, they were excited to use immersive technology in their own classroom (very true, N = 5, 19%; mostly true, N = 5, 19%; moderately true, N = 9, 33%; slightly true, N = 3, 11%; and not true, N = 5, 19%).

Discussion

This study collected data on preservice teachers' motivational reactions to an online course module on immersive technology designed using the ARCS model. The results of this study shed light on new opportunities for teacher educators to become familiar with immersive technologies, and suggest that such immersive technology tools and instructional design strategies should be integrated into teacher preparation curricula. As seen in this study and supported by re-

Table 2. Descriptive statistics from the IMMS survey.

Components	***M***	***SD***
Attention	3.65	1.24
Relevance	3.45	1.07
Confidence	3.28	1.21
Satisfaction	3.29	1.36
Additional Survey Question: Excitement for future use in classroom	3.07	1.33

N = 27

search, incorporating the ARCS model into the instructional design of a course enhances the motivational impact of instructional materials and activities (Proske, Roscoe, & McNamara, 2014).

The ARCS component Attention received a mean score of 3.65 (SD = 1.24). Participants, overall, believed that the strategies used in the module aroused and sustained their curiosity and interest in immersive technology. There may have been a novelty effect for participants when asked to leverage immersive technology within their teacher preparation experience. As discussed, the use of contemporary immersive technologies within teacher education is limited and hence, for many students, being assigned to put on a virtual reality headset and enter an immersive environment could have been stimulating primarily because it was new.

Keller (1987) argues that a motivational challenge with students is sustaining their attention and an important component of attention is variability. "No matter how interesting a given topic is, people will adapt to it and lose interest over time" (Keller & Suzuki, 2004, p. 231). The variability in the immersive technology module sustained participants' attention throughout the module. Participants became active participants in the learning process through the design of the module and hands-on practice with immersive technologies and lesson planning. Participants utilized different approaches to learn and apply immersive technology including the use of Twitter and Pinterest, which grabbed their attention until the module ended. When leveraged effectively, communication mechanisms such as Twitter and blogs can support increased engagement and motivation, group action, individual transformation, and shared meaning-making opportunities (Dawley & Dede, 2014).

Further research is needed with preservice teachers to see if this protocol continues to motivate them in their teaching practice after they complete their preparation programs. It would be interesting to see if immersive technology made preservice teachers contemplate their need as educators to keep abreast of technological developments, and whether this excited or depressed them. The need for preservice teachers to keep abreast of technological developments was not measured in this study.

The fact that the component Relevance did not see a dramatic drop-off from the Attention component (*M* = 3.45, SD = 1.07) in participants' responses suggests that participants recognized the importance of the technology and its relevancy to their future practice. The strategies used in the module were linked to participants' needs and interests. The module allowed participants to act on their thoughts, ideas, and experiences for self-directed learning (Cobb, 2007), and allowed them to embrace a new personalized and individualized learning platform (Dieker et al., 2014). Participants were able to choose their own apps, social media followers, design of their Pinterest boards, and lesson plan topics for this study. This allowed participants to create lessons and complete assignments that were aligned with their own goals and motives.

The relevance of the module allowed participants to make connections from the content of instruction to participants' future responsibilities as teachers (e.g. lesson planning and integration of technology in the classroom). Survey data suggest that participants believed the immersive technology module helped build their pedagogical knowledge in such a way that they would be better equipped to serve their future students. This was also supported by lesson plans submitted for assessment and course evaluation comments from participants. One participant commented on immersive technology and stated:

> [The instructor] was very effective in opening up my eyes to new tools that could be used in the teaching field. Some of them were geared at teaching, while some of them were not, and it was the ones that were not specifically teaching-related that opened up my eyes to the fact that a variety of technological tools [virtual reality] can be used in the classroom if one has the imagination to implement it.

The majority of comments from participants in the course evaluation echoed the same level of excitement to someday implement immersive technology in the classroom. Further research should incorporate qualitative data to confirm if preservice teachers see immersive technology as a relevant and important element of their emerging pedagogical skills.

It should be noted that most participants struggled to develop lesson plans "above the line" according to the SAMR model (Puentedura, 2015). This was not a surprise since most participants studied the model for the first time in the course and had few opportunities to see and read about teaching that modifies or redefines the curriculum using technology. This may have affected participants' confidence to work with immersive technology.

Overall, participants felt somewhat confident (*M* = 3.28, SD = 1.21) in their abilities to complete the module. Heafner (2004) reminds us that students' use and familiarity with technology makes technology more interesting for students. Participants studied immersive technology during Week Seven, midway through the 15-week semester. They used technology skills from previous modules in the course to approach and complete the immersive technology module. When challenging and engaging academic tasks build upon students' prior background knowledge and enable students to construct their own understanding of the content, they are more apt to enhance motivation and increase self-confidence in their cognitive abilities (Heafner, 2004).

Given the amount of technology participants studied prior to the immersive technology module, the score for the Confidence component was unexpected (*M* = 3.28, SD = 1.21). Participants, overall, believed that the strategies used in the module helped them develop a positive expectation for successful achievement with content from the module. However, the EON Creator server was offline for half of the semester and caused anxiety and frustration among participants. This may have contributed to participants' lower confidence scores. Some participants posted their 3-D lessons online before the EON Creator became unavailable; however, several participants were not able to post their lessons online because the EON Creator server was down.

Even though participants relied on their peers, the internet, and the instructor for technical assistance, a few participants shared in email and informal discussions during office hours that studying online rather than on campus increased their unease with the immersive technology tools. It is unknown if the failure of the EON Creator server and the inability to post participants' 3-D lesson online contributed to the unease.

In the end, participants took responsibility for their own performance; were persistent; developed creative, content specific projects; and were excited about sharing them with each other and others outside of the course. In fact, three students who completed the same technology course during different semesters presented their use of immersive technology at the annual undergraduate research and creative works conference sponsored by the institution of the researcher of this study, and won first place for best panel presentation. With improved output, students took pride in the products they created. When this happens, students' self-efficacy can increase and improved outputs can positively affect student motivation (Heafner, 2004).

Further research should explore if the lower confidence score meant that the preservice teachers lost confidence because of their engagement with technology. Would they have been equally confident, or more confident, had they not had to develop lesson plans with these newer tools?

The Satisfaction component (*M* = 3.29, SD = 1.36) demonstrated that generally participants were pleased with the module in advancing their developing practice, and felt the amount of work was appropriate. Participants believed that the strategies and assignments used in the module provided positive reinforcement for their effort in completing the module. People like the feeling of achievement that results from successfully completing a meaningful learning activity (Keller, 1987). Enjoyment through the use of technology significantly influences positive attitudes and reinforces intentions to use technology (Davis, 1989). When preservice teachers have positive experiences after undergoing challenging tasks in teaching, there is a greater chance of an increase in their positive outlook in future teaching situations (Wood, Mueller, Willoughby, Specht, & Deyoung, 2005).

As noted earlier, participants were excited to use immersive technology in their future classrooms. One participant wrote in the course evaluation, "[the module] challenged me to use many different kinds of technology and relate them to real life scenarios. I look forward to applying a lot of what I learned to my own classroom." Participants' overall satisfaction with the module suggests that the design of the module and participants' familiarity with immersive technology contributed to their belief in their ability to accomplish challenging tasks. The immersive technology module captured preservice teachers' attention and interest in immersive technology, and solidified the decision to include and expand the module in future course offerings.

Implications for Teacher Education

In teacher education, the possibility of creating and interacting in environments in which preservice teachers experiment with a variety of decisions and outcomes without placing any real students at risk should be an exciting prospect for teacher educators (Brown, 1999). Brown argues that although simulated classrooms offer an alternative to teacher training, they should not replace field experiences and other traditional methods of teacher training any more than sophisticated flight simulators can replace actual time flying an aircraft.

As enrollment in online education and blended learning environments increases, immersive technologies will play an important role in students' learning experiences (Dawley & Dede, 2014). The implications for teacher educators with online and blended education are profound. These implications should include ongoing professional development for teacher educators in pedagogical and technical skills and ongoing professional development for instructional designers who work with teacher educators to develop online courses that utilize immersive technology.

Another implication for teacher educators and schools and colleges of education is to allow preservice teachers to use their mobile devices in brick and mortar classrooms to leverage the delivery of instruction. Incorporating an instructional model that utilizes devices students already own and use outside the classroom not only reduces the amount of hardware and networking investment required from education budgets, but also flattens the learning curve for students (Dunleavy et al., 2009).

Administrators such as deans, associate deans, and department chairs should purchase virtual reality headsets and keep them in the library or teaching and learning center for faculty members to explore at their leisure. Having virtual reality headsets on site eliminates the requirement for faculty and students to purchase their own headset. Administrators could reserve time during faculty meetings for technology training sessions where faculty members work in groups to learn immersive technology and discuss the ARCS model and ways immersive technology can support academic content that leads to effective instructional design.

Administrators could also conduct one or more faculty meetings virtually using immersive technology. This would allow faculty time to play with the technology with the intention of increasing their efficacy and motivation to use the technology, and would provide a safe environment for faculty to adjust to the technology before using it in their classrooms with students. At the K-12 level, administrators can use immersive technology for induction training of new teachers (Dieker et al., 2014). Teacher educators familiar with immersive technology can help facilitate these training sessions.

The survey score from the final survey item that gauged preservice teachers' excitement to use immersive technologies when they teach (M = 3.07, SD = 1.33) makes it interesting for future researchers to delve deeper into understanding the students' engagement or frustration with these technologies. Preservice teachers who study immersive technology should apply it during methods courses, student teaching, and/or when in the classroom as a substitute teacher or completing practicum hours. Teacher educators should observe preservice teachers using immersive technology in the classroom and assist with the development of lesson plans and units that connect immersive technology to the curriculum.

As discussed earlier, the IMMS was not used to examine preservice teachers' academic performance and motivational reactions compared to a control group. Research is needed to understand motivation and performance gains using the ARCS model with groups of preservice teachers who use immersive technology with and without enhanced strategies and enhanced instruction.

Limitations

There were a few limitations to this study. The sample size was small (N = 27) and included one single course offered one time through one institution; therefore, the findings should not be generalized. This study relied on self-reported survey data from participants. An overarching issue with self-reports is credibility. Even when respondents do their best to be forthright and insightful, their self-reports are subject to inaccuracy (Paulhus & Vazire, 2009).

According to Song and Keller (2001), "the use of self-report methods for measuring motivation [is] limited in that such methods [require] students to indicate their perceived motivation level, which might have been different from their actual amount of effort-a more accurate measure of motivational behavior" (p. 20). Participants may not be able to provide the level of detail, or use the concepts that the researcher is interested in collecting (Barker, Pistrang, & Elliot, 2002).

An additional limitation was the use of one outside expert to evaluate the usability of the module. Nielsen and Mack (1994) recommend using the mean of a set of severity ratings from three evaluators for usability inspection purposes. This study was also limited in the number of weeks for data collection. The topic of immersive technology was covered in a 4-week module. Longer modules, perhaps even an entire course, on immersive technology and educational technology theory would have increased participants' interaction with and utilization of the technology.

Lastly, this study was confined to a solitary group operating with one particular teaching modality (online) and a single instructor. Further research should be conducted to validate this experience, not only with other groups who are learning primarily online, but also with those who are learning on ground and in blended/hybrid environments.

Conclusion

Immersive technologies have had a long path to the classroom. For some, there may be too many constraints or risks associated with using these tools in the classroom (Graziano & Daley, 2017). As commercial opportunities continue to grow, so will engagement for educational purposes (Dawley & Dede, 2014). As seen in this study, preservice teachers are not only able to integrate these technologies into their starting pedagogical toolkit, but they are also impacted motivationally to use immersive technology with their own future instructional design. The opportunity, therefore, in further research and practice is quite profound. Leveraging these tools, particularly as they come down in costs, could be a boon for teacher educators and instructors of educational technology and their charges to foster real changes in education, particularly in the development of progressive pedagogies and learning strategies and the arrangement and delivery of content (Graziano & Daley, 2017).

References

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). *NMC Horizon Report: 2017 Higher Education Edition*. Austin, TX: The New Media Consortium.

Aldosemani, T. I., & Shepherd, C. E. (2014). Second life to support multicultural literacy: Pre- and in-service teachers' perceptions and expectations. *TechTrends*, *58*(2), 46–58.

Andreasen, J. B., & Haciomeroglu, E. S. (2009). *Teacher training in virtual environments*. Paper presented at the annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Atlanta, GA.

Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N., & Jin, M. (2008). The use of immersive virtual reality in the learning sciences: Digital transformations of teachers, students, and social contexts. *The Journal of the Learning Sciences*, *17*(1), 102–141.

Bailey, F., & Moar, M. (2001). The vertex project: Children creating and populating 3 D virtual worlds. *International Journal of Art and Design Education*, *20*(1), 19–30.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (pp. 71–81). New York, NY: Academic Press.

Barker, C., Pistrang, N., & Elliot, R. (2002). *Research methods in clinical psychology: An introduction for students and practitioners.* West Sussex: Wiley.

Bartle, R. (2003). *Designing virtual worlds.* Indianapolis, IN: New Riders Publishing.

Bousfield, T., Dieker, L., Hughes, C., & Hynes, M. (Eds). (2016). *Proceedings of 4th National TLE TeachLivE™ Conference 2016: Virtual Human Interactive Performance.* Orlando, FL: University of Central Florida.

Brown, A. H. (1999). Simulated classrooms and artificial students: The potential effects of new technologies on teacher education. *Journal of Research on Computing in Education*, *32*(2), 307–318.

Castenada, L., & Pacampara, M. (2016). Virtual reality in the classroom: An exploration of hardware, management, content and pedagogy. In G. Chamblee & L. Langub (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 527–534). Chesapeake, VA: Association for the Advancement of Computing in Education.

Chang, M. M., & Lehman, J. D. (2002). Learning foreign language through an interactive multimedia program: An experimental study on the effects of the relevance component of the ARCS model. *CALICO Journal*, *20*(1), 81–98.

Cobb, S. (2007). Virtual environments supporting learning and communication in special needs education. *Topics in Language Disorders*, *27*, 211–225.

Dawley, L., & Dede, C. (2014). Situated learning in virtual worlds and immersive simulations. In J. M. Spector, J. Ellen, & M. J. Bishop (Eds.), *The handbook of research for educational communications and technology* (pp. 723–734). New York, NY: Springer.

Dede, C. (2009a). Introduction to virtual reality in education. *Themes in Science and Technology Education*, *2*(1), 7–9.

Dede, C. (2009b). Immersive interfaces for engagement and learning. *Science*, *323*(5910), 66–69.

Dede, C., & Barab, S. (2009). Emerging technologies for learning science: A time of rapid advances. *Journal of Science Education and Technology*, *18*(4), 301–304.

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2nd ed.). Thousand Oaks, CA: Sage.

Dieker, L., Grillo, K., & Ramlakan, N. (2011). New technology and virtual environments: The impact of a summer camp on gifted students interested in STEM careers. *Gifted Education International*, *28*(1), 96–106.

Dieker, L. A., Hynes, M., Hughes, C., & Smith, E. (2008). Implications of mixed reality and simulation technologies on special education and teacher preparation. *Focus on Exceptional Children*, *40*(6), 1–20.

Dieker, L. A., Rodriguez, J. A., Lignugaris/Kraft, B., Hynes, M. C., & Hughes, C. E. (2014). The potential of simulated environments in teacher education: Current and future possibilities. *Teacher Education and Special Education*, *37*(1), 21–33.

Dunleavy, M. (2010). *Persistent design challenges: Augmenting reality for learning with* wireless mobile devices. Invitation Symposia at Society for Information Technology and *Teacher Education (SITE)*. San Diego, CA.

Dunleavy, M., & Dede, C. (2014). Augmented reality teaching and learning. In J. M. Spector, J. Ellen, & M. J. Bishop (Eds.), *The handbook of research for educational communications and technology* (pp. 735–746). New York, NY: Springer.

Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations. *Journal of Science Education and Technology*, *18*(1), 7–22.

Freina, L., & Ott, M. (2015). *A literature review on immersive virtual reality in education: State of the art and perspectives.* Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.725.5493

Gee, J. P. 2003. *What video games have to teach us about learning and literacy.* New York, NY: Palgrave/St. Martin's.

Gonzalez, T. (2011). *Training professional school counseling students to facilitate a classroom guidance lesson and strengthen classroom management skills using a mixed reality environment* (Unpublished doctoral dissertation). University of Central Florida, Orlando.

Google Expeditions (2017). Retrieved from https://edu.google.com/expeditions/#about

Graziano, K. J. & Daley, S. (2017). Preservice teachers' motivational reactions to online instructional materials on immersive technology. In P. Resta & S. Smith (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2017* (pp. 757–765). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Gregory, S., Dalgarno, B., Campbell, M., Reiners, T., Knox, V., & Masters, Y. (2011). Changing directions through VirtualPREX: engaging pre-service teachers in virtual professional experience. In G. Williams, P. Statham, N. Brown & B. Cleland (Eds.), *Changing demands, changing directions: Proceedings of ascilite 2011* (pp. 491–501). Hobart: University of Tasmania.

Gregory, S., & Masters Y. (2012). Real thinking with virtual hats: A role-playing activity for pre-service teachers in Second Life. *Australian Journal of Educational Technology*, *28*(3), 420–440.

Heafner, T. (2004). Using technology to motivate students to learn social studies. *Contemporary Issues in Technology and Teacher Education*, *4*(1), 42–53.

Hew, K. F., & Cheung, W. S. (2010). Use of three-dimensional (3-D) immersive virtual worlds in K-12 and higher education settings: A review of the research. *British Journal of Educational Technology*, *41*(1), 33–55.

Hoban, G., Loughran, J., & Nielsen, W. (2011). Slowmation: Preservice elementary teachers representing science knowledge through creating multimodal digital animations. *Journal of Research in Science Teaching*, *48*(9), 985–1009.

Hu, Y. (2008). *Motivation, usability and their interrelationships in a self-paced online learning environment* (Doctoral dissertation). Virginia Polytechnic Institute and State University.

Johnson, D. (2013/2014). Power up! / Teaching above the line. *Educational Leadership*, *71*(4), 84–87.

Kaufmann, H., Schmalstieg, D., & Wagne, M. (2000). Construct3D: A virtual reality application for mathematics and geometry education. *Education and Information Technologies*, *5*(4), 263–276.

Ketelhut, D. J., Nelson, B. C., Clarke, J., & Dede, C. (2010). A multi-user virtual environment for building higher order inquiry skills in science. *British Journal of Educational Technology*, *41*(1), 56–68.

Keller, J. M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development*, *2*(4), 26–34.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383–436). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance & Instruction*, *26*(8), 1–7.

Keller, J. M. (2008). First principles of motivation to learn and e3-learning. *Distance Education, 29*(2), 175–186.

Keller, J. M. (2010). *Motivational design for learning and performance:The ARCS model approach*. New York, NY: Springer.

Keller, J. M., & Burkman, E. (1993). Motivation principles. In M. Fleming and W. H. Levie (Eds.), *Instructional message design: Principles from the behavioral and cognitive sciences*. Englewood Cliffs, NJ: Educational Technology Press.

Keller, J. M., & Kopp, T. W. (1987). Application of the ARCS model of motivational design. In C. M. Reigeluth (Ed.), *Instructional theories in action: Lessons illustrating selected theories and models* (pp. 289–320). Hillsdale, NJ: Lawrence Erlbaum Associates.

Keller, J. M., & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design. In D. H. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp. 401–434). Hillsdale, NJ: Erlbaum.

Keller, J. M., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Journal of Educational Media*, *29*(3), 229–239.

Lee, E., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers & Education*, *55*(4), 1424–1442.

Loomis, J. M., Blascovich, J. J., & Beall, A. C. (1999). Immersive virtual environment technology as a basic research tool in psychology. *Behavior Research Methods, Instruments, & Computers*, *31*(4), 557–564.

Mahadzir, N., & Phung, L. (2013). The use of augmented reality pop-up book to increase motivation in English language learning for national primary school. *Journal of Research & Method in Education*, *1*(1), 26–38.

Mahomedy, Z. (2015). *What is immersive technology*? Retrieved from http://www.immersiveauthority.com/explain-immersive-technology/

Means, T. B., Jonassen, D. H., & Dwyer, R. M. (1997). Enhancing relevance: Embedded ARCS strategies vs. purpose. *Educational Technology Research and Development*, *45*(1), 5–18.

Myers, D., Starrett, T., Stewart, M., & Hansen-Thomas, H. (2016). Using virtual reality technology to enhance instruction in teacher education programs. *Proceedings of the 4th National TLE TeachLivE™ Conference*. Orlando, FL. 1-3 June (pp. 51–55). Retrieved from http://teachlive.org/wp-content/uploads/2016/09/TLE-Proceedings-2016.pdf

Nielsen, J., & Mack, R. L. (1994). *Usability inspection methods*. New York, NY: Wiley.

Paulhus, D. L., & Vazire, S. (2009). The self-report method. In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp. 224–239). New York, NY: Guilford.

Peterson, M. (2006). Learner interaction management in an avatar and chat-based virtual world. *Computer Assisted Language Learning*, *9*(1), 79–103.

Proske, A., Roscoe, R. D., & McNamara, D. S. (2014). Game-based practice versus traditional practice in computer-based writing strategy training: Effects on motivation and achievement. *Educational Technology Research and Development*, *62*(5), 481–505.

Puentedura, R. R. (2015). *SAMR: Approaches to implementation*. Retrieved from http://hippasus.com/rrpweblog/archives/2015/04/SAMR_ApproachesToImplementation.pdf

Rosenbaum, E., Klopfer, E., & Perry, J. (2007). On location learning: Authentic applied science with networked augmented realities. *Journal of Science Education and Technology*, *16*, 31–45.

Salzman, M. C., Dede, C., Loftin, R. B., & Chen, J. (1999). A model for understanding how virtual reality aids complex conceptual learning. *Teleoperations and Virtual Environments*, *8*(3), 293–316.

Schrader, P. G. (2008). Learning in technology: Reconceptualizing immersive environments. *AACE Journal*, *16*(4), 457–475.

Solak, E., & Cakir, R. (2015). Exploring the effect of materials designed with augmented reality on language learners' vocabulary learning. *The Journal of Educators Online*, *13*(2), 50–72.

Song, S. H., & Keller, J. M. (2001) Effectiveness of motivationally adaptive computer-assisted instruction on the dynamic aspects of motivation. *Educational Technology Research and Development*, *49*(2), 5–22.

Straub, C., Dieker, L., Hynes, M., & Hughes, C. (n.d.). *TLE TeachLivE year 3 research report*. Retrieved from http://teachlive.org/wp-content/uploads/2016/09/2016-TeachLivE-Year-3-Technical-Report.pdf

Vince-Garland, K., Vasquez, E., III, & Pearl, C. (2012). Efficacy of individualized coaching in a virtual reality classroom for increasing teachers' fidelity of implementation of discrete trial teaching. *Education and Training in Autism and Developmental Disabilities*, *47*, 502–515.

Warburton, S. (2009). Second Life in higher education: Assessing the potential for and the barriers to deploying virtual worlds in learning and teaching. *British Journal of Educational Technology*, *40*(3), 414–426.

Winiecki, D., Fenner, J. A., & Chyung, Y. (1999). Evaluation of effective interventions to solve the drop out problem in adult distance education. In B. Collis & R. Oliver (Eds.), *Proceedings of EdMedia: World Conference on Educational Media and Technology 1999* (pp. 51–55). Waynesville, NC: Association for the Advancement of Computing in Education (AACE).

Wood, E., Mueller, J., Willoughby, T., Specht, J., & Deyoung, T. (2005). Teacher's perceptions: Barriers and supports to using technology in the classroom. *Education, Communication & Information*, *5*(2), 183–206.

Wu, H., Lee, S., Chang, H., & Liang, J. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education*, *62*, 41–49.

Dr. Kevin J. Graziano is a professor in the School of Education at Nevada State College, the associate chair of the Consultative Counsel for the Society for Information Technology and Teacher Education (SITE), the former chair of the American Association of Colleges for Teacher Education's (AACTE) Committee on Innovation and Technology, and the former co-chair of the SITE's mobile learning SIG.