Assignment 2: Researching the Issue or Problem

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Introduction

Despite Immersive Virtual Reality in Education being a recent phenomenon, it has already managed to reach critical mass in terms of accessibility, functionality, and affordability. There is widespread dialogue on its potential as an educational application and specifically IVR’s learning affordances and impact on learners within K-12 curriculum (Jowallah, Bennett, & Bastedo, 2018). This widespread dialogue is consistent that IVR has enormous capability in our contemporary educational setting. However, research still lacks cohesive findings regarding best practices for pedological implementation. For students to remain competitive in future job markets, high emotional intelligence, collaboration, and negotiation skills, including critical thinking, innovativeness, and strong cognitive abilities, are required. IVR, in its nature, shows immense promise in developing these essential skills (Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2016). Research is consistent regarding the positive range of learning affordance IVR promotes.

Educators are now faced with multiple challenges as they attempt to bridge the gap between technical logistics with content that enhances and supports learning objectives, without ignoring individual learner needs. This literature review explores current literature focusing on IVR in education and the pedagogical foundations of IVR applications needed to improve teaching and learning within K-12 environment. This review highlights literature exploring the implications of blending pedagogy and technology within a balanced framework for successful integration of IVR in existing classroom systems. The review is structured to explore the following topics: IVR in Education, learning affordances of IVR; designing effective IVR learning spaces; and ethical and safe use of IVR in K-12 education. In this paper, Virtual Reality and Immersive Virtual Reality will be used interchangeably.

Immersive Virtual Reality: IVR in Education

Jowallah, et al. (2017) posits technology advancement presents educators with opportunity for innovation to improve outcomes, and VR has evolved to become an effective learning and teaching modality. Previously, VR systems were beyond reach for schools due to financial constraints, but this is changing due to the proliferation of smart devices that allow for affordable virtual experiences (Jowallah et al., 2017). Recent developments have seen the emergence of standalone virtual devices with computing processors inbuilt in HMDs, providing users with benefits similar to those of high-end devices. It is important for educators to identify different types of IVR and their functionality to clearly understand effects on students during their different stages of cognitive development.

Virtual Reality (VR) specifically refers to enclosed experiences within computer-generated spaces that have shut out physical surroundings to a large extent. Augmented Reality (AR) is described as experiences that superimpose digital elements onto real-world backgrounds or entities (Markowitz, Laha, Perone, Pea, & Bailenson, 2018). Immersive technologies are evolving with a multifaceted spectrum giving rise to a mix of digital and real worlds, now referred to as *Mixed Reality* (Bonasio, 2019). IVR experiences in a broad context include all virtual technologies common in educational settings.

The different features of IVR deliver distinct forms of immersion and feelings within the simulated environment. Users can have a “look around” experience or limited interaction and navigation (Parong & Mayer, 2018). IVR spaces can also be overly immersive, with users freely manipulating, interacting, navigating, and creating customized experiences (Southgate, Blackmore, Pieschl, Grimes, McGuire, & Smithers, 2019). Southgate (2018) posits immersive virtual reality has no clear definition and classifies it as; virtual reality facilitated through a head-mounted display (HMD), latter projects visuals directly to the user and tracks users' position in space. According to Bonasio (2019), the state of immersion in VR wholly engages users in an activity. It is an effective tool for knowledge transfer and identity, essential elements for positive learning outcomes. IVR's features are intensely experiential, eliciting diverse emotional and physiological responses on users, particularly when place and credible illusions are amplified (Southgate, 2018).

Learning Affordances of IVR

Perhaps the most important aspect of IVR for educators is optimization of learning affordances. Learning affordances are the inherent features within IVR that facilitate users to gain and retain knowledge in an educational setting. Bonasio (2019) asserts that the most effective educational practices are based on social constructivist learning approaches. In constructivist learning, students are involved in learning real tasks in an environment that is authentic and personally relevant to them. Bonasio (2019), while acknowledging the affordances of IVR, states that correct deployment, pedagogical relevance, and consistency, are the key to successful educational outcomes. Of particular importance is how Bonasio (2019) explores ways IVR can improve learning outcomes through easing user cognitive load – allowing direct and first-person conceptualization of complex tasks and structures. Bonasio's (2019) research cross-referenced pedagogical theory with case studies and data was collected through interviews with educational stakeholders. The findings reveal reducing user cognitive load increases engagement and allow learners to understand complex problems and retain acquired information for longer. This research is essential as developers continue to refine IVR education content.

Leung, Zulkernine, & Isah (2019) equally recognize the capacity of virtual reality to provide users with an exploratory learning environment that facilitates students in learning through experimentation. Leung et al. (2019) research investigated application of VR in encouraging interdisciplinary communication. In highlighting the impact of virtual reality over traditional learning approaches, their study identifies teaching of abstract subjects as an area that enjoys the benefits of IVR technology. According to Leung et al. (2019), virtual reality simulations for students of astrophysics allows them to experience abstract aerospace in a 3D projection. Too often, students involved in abstract courses experience limitations as they are not able to conduct experiments in classrooms and rely on their own imagination and instructor's explanation. Implementing IVR in abstract courses allows learning to be transformed into a 3D realm that cannot be achieved with traditional teaching methods.

The convergence of thought on IVR's ability to transform learning is found in merging of learning theories with the technology. The distinct affordances of IVR need to be aligned with the elements of theories in learning to effectively develop educational applications (Leung et al., 2019). Templeton's (2019) study examines the pedagogical effect of virtual learning spaces on student's academic performance in K-12 settings and concludes that IVR devices increased student motivation and interest, including enhancing collaboration amongst the users.

Prior to the study, Templeton (2019) identified lack of research on affordances of virtual systems and their impact on educational outcomes and sought to fill the gap. Templeton's (2019) study engaged students in K-12 and used 3D devices, whereby participants explored the world and other scientific phenomena, experiences that offered these learners real-life experiences. Though Templeton (2019) concurs on the benefits of IVR for improved academic performance, the research faced limitations due to adverse reactions by users who experienced motion sickness, excess stimulation, and technical hitches. In this regard, the scholar posits need for greater investigation on user safety and health while engaging in virtual reality environments.

Johnston, Olivas, Steele, Smith, & Bailey (2017) sought to recognize and categorize apparent practices and principles of pedagogy, that are not expressed in select virtual reality applications for education. Johnston et al. (2107) found the majority of VR applications in the public domain offered experiential learning. Others were found to offer constructivism, discovery, situational, and direct learning models. According to Johnston et al. (2017), educators and VR developers need to work together for clear pedagogical foundations that support curriculum improvement. While it is clear that IVR offers a variety of education applications, more research is needed to pinpoint the specifics of how best to implement specific applications.

For educators learning affordances inherent in IVR systems serve as a guide during purchasing, training of faculty, and aligning software and hardware to student and curriculum needs (Johnston et al., 2017). IVR systems are evolving, with better functional models being introduced in the market. However, due to this rapid development, Johnston et al. (2017) identified a gap in literature regarding articulating pedagogy in educational virtual reality systems. In addition to building on current literature, Johnston et al. (2017) study provide educators with new and improved ways of learning and teaching made possible by IVR applications. Johnston et al. (2017) acknowledge that virtual reality educational applications are becoming pedagogically sustainable and offering learners unprecedented opportunities to experience and understand the world. The available IVR applications provide students with different learning experiences, and it is upon teachers to identify the applications that maximize educational outcomes and with relevant pedagogies (Johnston et al., 2017).

Hu-Au & Lee (2017) research lists essential skills that students need to thrive in this digital age, and these include creativity, empathy, computation knowledge, systems thinking, and abstract thinking. These critical skills are challenging to teach, and according to Hu-Au & Lee (2017), IVR in its features and functionality offers educators a unique opportunity to impart these skills. Hu-Au & Lee (2017) recognize the affordances within IVR systems that improve teaching and learning. Hu-Au & Lee (2017) premise their paper on a shift from *Information Age* to *Experience Age,* with contemporary learners opting for learning experiences that are connecting, shared, and technologically mediated. Traditional instructional models do not offer students these engaging experiences.

Hu-Au & Lee (2017) emphasize on capacity of IVR to provide constructivist learning, an approach that enables students to discover new knowledge from meaningful interactions. This affordance allows students to engage in realistic problem solving and even enhances collaboration among peers, features that are obviously lacking in traditional learning models. A further disconnect in classrooms identified by Hu-Au & Lee (2017) is absence of situated learning, where students only memorize facts while isolated from the context. With IVR, students enjoy situated learning in a simulated environment that is easily accessible (Hu-AU & Lee, 2017). Hu-AU & Lee provide the most comprehensive research specific to IVR's learning affordance capabilities.

Bonasio (2019) points out the failure of traditional instructional approach to effectively transfer knowledge, as students who emerge as academically proficient are unable to use acquired skills in the real world. According to Bonasio (2016), IVR is ideal for enabling situated learning and motivates students to build their own learning experiences. Bonasio (2019) sought to identify how immersive applications can reduce user cognitive load to positively impact on academic outcomes. Such a reduction improves student engagement and knowledge transfer as IVR can effectively simulate realistic situations within a desirable pedagogical context. Hu-Au & Lee (2017) also expound on the promise of virtual reality applications to improve education through situated experiential learning that features; sense of presence, interaction between instructors/students or peer to peer, and complexity of real-world situations.

The positive impact of IVR in education notwithstanding, the transformational power of these applications in education will be realized through comprehensive experiences that immerse learners in relevant contexts with realistic practices, strong narratives, and connections to real-world outcomes (Bonasio, 2019).

Bonasio (2019), while presenting opportunities derived from IVR in education, fails to provide a pedagogical framework that can effectively integrate these applications in the classroom. However, the scholar recognizes need to align safety and ethics with these innovations. Kaminska, Sapinski, Wiak, Tikk, Haamer, Avots, Helmi, Ozcinar, and Anbarjafari (2019) highlight various virtual reality applications that have been adopted in select academic disciplines. Kaminska et al. (2019) also acknowledge the emerging role of IVR to enhance teaching and learning by creating interesting and engaging forms of gaining information. Kaminska et al. (2019) paper take a different approach from existing literature. It classifies virtual reality applications based on their learning outcomes and objectives: retention and understanding, use of acquired knowledge in a typical situation, and use of new knowledge in a difficult situation. This approach also focuses on the level of immersion and the related hardware required to meet defined objectives and outcomes.

According to Kaminska et al. (2019), virtual reality applications for knowledge retention and understanding are dedicated to enabling students to acquire theoretical information, and users do not need to be deeply immersed in the simulated environment. Hardware in use is simple; HMD with basic input devices or wall/monitor-based projections. Google Expeditions provided through Google Cardboard is an excellent example of IVR for retention and understanding (Brown & Green, 2016). Virtual reality applications to teach practical skills require a deeper immersive environment that includes control features, and these can be achieved by use of HMDs supported by external sensors (Kaminska et al., 2019). These applications are effective for helping children to learn sciences and social studies.

Kaminska et al. (2019) third taxonomy based on teaching users how to apply acquired knowledge for tackling difficult problems require virtual reality applications that are intensively immersive with pedagogically relevant educational content. These applications are normally applied in medical and engineering studies. According to Kaminska et al. (2019), the various VR applications and devices are limited capacity for graphics and display that can disrupt immersion, and system developers need to work on maximizing reality experiences. Moreover, deeper realistic IVR environments need powerful computer hardware and fast Internet, and this means higher costs (Kaminska et al., 2019). Kaminska et al. (2019) also recognize adverse side effects of using HMDs, and these include; anxiety, addiction, motion sickness, and lost perceptions on time and space. The scholars note the absence of literature that explores effects of using HMDs on children and urge for research to fully understand the impact of these applications on user health.

Designing Effective IVR Learning Spaces

As we seek to find a blend between pedagogy and technology for IVR in education, it is incumbent to redesign classrooms to support these transformative technologies. Southgate et al. (2019) recognize need to create smart learning environments with multi-use and adaptable physical spaces for effective learning and teaching. Elkington & Bligh (2019) explore various case studies that sought to understand interplay between three conventional features of effective learning space design; pedagogy, technology, and space. According to the researchers redesigning learning, spaces are key to successful integration of technology in education.

According to Elkington & Bligh (2019) an ideal IVR learning space should be cognitively and socially integrated, transparent, enabling, stimulating, and associative. Though these concepts of learning spaces are discussed in relation to higher education settings, they are constructivist and can be equally replicated in K-12 settings. A notable case study analyzed by Elkington & Bligh (2019) stresses the importance of supporting learning spaces and virtual reality infrastructure with pedagogical practices. The two researchers concur on the positive impact pedagogy delivers on student learning and engagement that leads to better understanding, enhanced critical thinking, and problem-solving in their subjects of interest. In yet another case study analyzed in the paper, it was discovered that use of vibrant colors and furnishings inspired student creativity and increased collaboration in their areas of study. Elkington & Bligh (2019) adds on existing literature that explores pedagogy and technology, providing valuable insight on redesigning learning spaces to accommodate virtual reality. Their approach provides us with three pillars – pedagogy, technology, space design – as the foundation for effective integration of IVR in classrooms.

Crabb, Clarke, Alwaer, Heron, & Laing (2019) take a different approach to designing learning spaces; they urge for collaboration with students in the design process. Their paper focuses on higher education spaces, and deductions can be applied in K-12 educational settings. An ideal learning environment is based on inclusivity, and Crabb et al. (2019) identify visual, cognitive, and communication access, as integral components necessary for building successful environments. For the scholars, learning spaces that are facilitated by technology have to support and motivate learners, assertions that are shared by existing literature on IVR in education. Crabb et al. (2019) also acknowledge learning spaces have to enhance collaboration, offer personalized, and these flexible environments, and remain inclusive amid changing needs of students.

Research is conclusive that technology integration in classrooms is rendering obsolete traditional learning spaces. Crabb et al. (2019) observe that conventional learning spaces are rigid, driven by superficial learning and teaching models. Crabb et al. (2019) sought to understand students' perception concerning their learning spaces and what facilitates successful learning. In their research – inviting students to create learning spaces of the future – Crabb et al. (2019) realized that students still maintained 'centrality' of instructors even in the technologically facilitated environments. The researchers had assumed that technology would be central in the new learning spaces. The students felt that an instructor's 'centrality' in technologically-enabled learning spaces, enhanced collaboration between the two parties. Moreover, for the students involved in the research, technology remains an afterthought during the design process, and what emerged as most important is for the learning spaces to fit the needs of both students and instructors (Crabb et al., 2019).

Leahy, Holland, & Ward (2019) offer insight on how K-12 learning spaces and experiences can be influenced by emerging and new technologies, in our case, IVR. Leahy et al. (2019) adopted a future study methodology approach to discover future educational transformations driven by augmented reality, artificial intelligence, and smart material technologies within K-12 educational settings. Leahy et al. (2019) analysis of education futures prompted by open learning spaces, as an effective medium for IVR in education. The traditional classroom was designed to simply transmit knowledge and prepare students for a definitive job market and to further entrench a desired social order (Leahy et al., 2019). The "open classroom" movement that began in the United States sought to transform "retrogressive" educational practices through redesigning learning spaces to be more open and flexible. Similar to previously discussed literature, Leahy et al. (2019) agree that open learning spaces enhance interaction and collaboration between students, teachers, and even peers. Open classrooms offer educators the opportunity to reimagine and reinvent learning spaces with the relevant pedagogies therein, to effectively integrate IVR in education. Leahy et al. (2019) paper add on to our understanding of the urgent need to redesign our learning spaces.

Ethical and Safe Use of IVR in K-12 Education

Current literature reveals successful integration of IVR in education is ultimately dependent on ethics and safety in relation to exposure of children to these applications (Evans, 2018). Therefore, a review of relevant literature regarding ethical and safe use of IVR must be addressed to comprehensively identify IVR's pedagogical best practices. Southgate et al. (2019) point at a child's cognitive development and the impact of highly immersive virtual environments. It is critical for educators to factor cognitive dimensions of how younger learners comprehend what is real and what is simulated (Southgate et al., 2019).

Bailey & Bailenson (2017), in examining IVR and the developing child postulate that young children, unlike adults, react differently to sensory salient and immersive applications, as these experiences are overly vivid and appear real. A child's cognitive and behavioral response to IVR, if real, may either have a positive or negative impact, prosocial education, or increased materialism, respectively (Bailey & Bailenson, 2017). The inherent affordances of IVR can be overwhelming to a child's automatic responses and cognitive abilities as these applications connect with human senses creating an illusion of being embedded in the simulated environment (Bailey & Bailenson, 2017). As such, young children can fail to comprehend the difference between what is real and what is virtual. From Bailey & Bailenson (2017) observations, the effect of IVR on children depends on age, cognitive ability, and type of immersive applications used. Bailey & Bailenson (2017) acknowledge that education and psychology researchers are yet to fully explore how IVR impacts on cognitive development of young learners. Similarly, Jowallah et al. (2017) assert how IVR system developers largely focus on creating applications that enhance engagement and physical interaction, which results in the need to explore issues of safety and health for young users. Since literature reveals age set determines how a child reacts to IVR exposure, more specific research is needed in this area. In this regard, it is the responsibility of educators and IVR developers to establish what applications and content are appropriate and at what age.

Sobel (2019) reports on the findings of a one-day convention organized at Arizona State University to reflect on how immersive media impacts child development at a time when these types of media are becoming pervasive in the lives of children. Participants in the discussion included education leaders, researchers, pediatric medicine, technology policy, and application developers. Sobel (2019) and Bailey & Bailenson (2019) have a convergence of thought on IVR's capacity to either harm or benefit the user due to the application's prospective realism.

Issues that were of great concern in the discussions were: physical and psychological impact, applications and devices must be safe for use; appropriateness of medium, what and why of using immersive applications for learning; content suitability, need to involve children during design and creation of content; role of adults, latter influence how children interact with immersive media, particularly teachers who are responsible for integration in classrooms; design, development, and distribution process, prior to allowing children to use it is important to test for safety and effectiveness (Sobel, 2019).

The Arizona State University convention on impact of immersive media on children recognized need for regulation and formalization of the industry, with an oversight role by the Federal Communications Commission (FCC) to ensure safe use. Another notable contribution of the meeting is establishment of data protection for minors using immersive media through updating Children’s Online Privacy Protection Act (COPPA) to reflect on the same. Lastly, participants raised the issue of enacting a guideline to regulate advertising within immersive media environments (Sobel, 2019).

Additional IVR research reveals the importance of addressing the ethical aspects involved in implementation. Black (2017) explores virtual reality in K-12 history education and while acknowledging benefits of these applications identified ethical challenges. Though virtual reality is effective in arousing empathy, there is risk of going overboard and subjecting users to dark and traumatic events, and this impacts negatively. Moreover, virtual reality as a powerful learning tool must be designed with accountability and sound pedagogical to avoid manipulation and trivialization of experiences (Black, 2017).

Conclusion

Today, educators have recognized the capacity of IVR to transform learning and teaching through enhanced engagement and collaboration, including effective delivery and retention of information. Literature is abundant and conclusive regarding the multiple factors involved in implementing IVR in the educational setting. The unique capabilities of IVR applications are yet to be fully exploited, and educators need to align pedagogy and technology for successful integration in classrooms (Domingo & Bradley, 2018). According to Bonasio (2019), to maximize the impact of immersive learning, educators must extend experiences that have rich contexts with robust narratives, realistic practices, and connected to the real-world. Additionally, educators must also consider the architectural layout of the learning spaces as these are equally responsible for successful integration of IVR in education (Häkkilä, Colley, Väyrynen, & Yliharju, 2018). Lastly, though there is a shortage of literature which cohesively draws conclusions regarding safety and ethics, it becomes apparent educators need to make informed decisions on selecting appropriate content and devices that do not infringe on user privacy and cognitive development.

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