Virtual Reality Worlds and Education

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Introduction

The contemporary and future educational system must respond to the changing nature of our society. The current generation of students is tech-savvy and requires an interactive environment for positive engagement. For educators to remain relevant, it is inevitable educators transform the classroom to conform to emerging trends. Digital mediums provide users with easy access to information and new knowledge. In particular, virtual and augmented reality systems have emerged as effective and quality tools for enhancing learning processes.

Immersive technologies are now commercially prevalent, and this has given rise to the terms augmented reality and virtual reality, mediums that have become features of conventional discourse. Augmented reality connects virtual oobjects to the real world environment, while virtual reality immerses users in a digitally simulated space. As educators continue to explore opportunities available through VR and AR systems to support classroom activities, it is essential to find balance between pedagogy and this new technology. In this regard, educators must be actively involved in research, systems design, and implementation in classrooms.

This literature review explores current and existing literature on reality technologies. The paper reviews both augmented reality and virtual reality. In its essence, this literature review provides evidence for supporting adoption and implementation of virtual reality (VR) systems in classrooms.

Virtual Reality: A Background

Jowallah, Bennett & Bastedo (2018) provide a historical context of VR systems evolution. VR originated from computer-generated animations with a primary focus on military training. The invention of personal computers overshadowed further development of VR systems, as tech companies rushed to meet the rising demand for

PCs. At the turn of the twenty-first century, demand for personal computers declined as consumers' preferences shifted in favor of compact devices – tablets and smartphones. This shift helped set the stage for VR advancement.

Growth in the tech industry – particularly on smartphone capacity and competence – has since pushed manufacturers to explore new ways of integrating software that allows for positive engagement and interaction. Health and aviation industries also joined the military to pioneer VR technology for integration in the workplace. Nearly two decades into the twenty-first century and-global interest in VR technology has experienced exponential growth. New system developments appear focused on improving engagement and physical interaction used for support of problems in the educational sector.

Current Trends in Educational Sector

Passive lectured based instruction has been replaced with active learning strategies to meet the needs of the 21st Century learner. Research is clear regarding the correlation between passive learning and student disengagement. For example, Hu-Au& Lee (2017) found passive learning results in negative behavioral attitudes among students, which increases dropout rates due to poor performance and utter dissatisfaction with school activities. Hu-Au & Lee also reveal classroom-based learning is becoming redundant due to the widening gap between textbook content and actual happenings in the physical world. In this situation, modern learners are finding classroom instructions to be unrelated to the real world. Finally, our current *Experience Age* society includes consumers sharing and creating technologically enabled experiences. Internet-driven devices prompt new perspectives and successful navigation requires the workforce to acquire new skills with tech literacy, critical thinking, and empathy at the core of educational curriculum (Hu-Au & Lee, 2017)

Current educational trends support the need for VR's active learning and real-world relevance.

Improving Classroom Experience: Augmented Reality and Virtual Reality

Technology has revolutionized society, affecting the way we think, interact, and do things. This information age is characterized by smart technology. Today, the role of education is to prepare students for a technological smarty society (Kiryakova, Angelova & Yordanova, 2018). According to Kiryakova et al. (2018), new technologies enabled by improved pedagogical mechanisms allow creation of supportive learning environments where collaboration and interaction are enhanced for effective learning. Kiryakova et al. (2018) argue for use of technology as an educational tool. They base their premise on adopting augmented reality (AR), which integrates digital information with the physical environment where people interact. Virtual reality (VR) is a computer-generated environment representing a real situation (Fernandez, 2017). In response to modern educational challenges previously discussed, Kiryakova et al. (2018) design an approach for solving these new challenges. They assert a total shift from traditional practices – memorizing content and lectures – towards a focus on information analysis and evaluation and encouraging critical thinking and creativity in solving problems. Kiryakova et al. (2018) also advocate for smart education to replace prevalent traditional approach of teaching and learning. According to the authors, smart education is reliant on IT-enabled devices to support functions and processes, though it is premised on changing educational models to fit the needs of a digital generation.

The essence of both AR and VR in smart education is to enhance student engagement and interaction. The technologies in their nature support social skills and communication when in use. Kiryakova et al. (2018) present the advantages of AR

systems in education and shy from discussing the disadvantages of integrating the systems in classrooms. Nevertheless, smart education is not a panacea for shifting educational needs, and effective integration of reality systems requires intensive pedagogical considerations. Replacing real-world teaching experiences with virtual systems may lead to disillusionment. An effective strategy to counter disillusionment can be creating experiences that assist learners to better understand the situational context. Convergence of thought in existing literature emphasizes integration on the basis of a pedagogy according to distinct affordances of virtual reality applications.

Additional literature supports implementing VR to improve educational curriculums while highlighting the inherent challenges. Fernandez (2017) discusses the challenges of integrating technology as tools for improving educational outcomes. While acknowledging existing difficulties in adopting augmented and virtual reality systems within educational settings, Fernandez (2017) identifies a six-step for ease of integration and implementation. The six-step methodology for adopting VR and AR technologies is dependent on educational stakeholders – manufacturers, students, teachers, and iinstitutions Similar to Kiryakova et al. (2018), Fernandez (2017) discusses the difference between augmented reality and virtual reality and their application in educational settings. Their merging of concepts is common regarding effectiveness of the two technologies in improving educational outcomes – positive student engagement and better interactions. Combining AR and VR applications with smartphones is another strategy to improve classroom instruction. Currently, smartphones can be used as display devices for reality applications, and this is driving adoption in the education sector. The majority of students have access to a smartphone, with manufacturers now focusing on developing relevant software to fit needs. Institutions must equally facilitate adoption by encouraging and enabling

teachers to train and understand the technology for implementation in functions and processes (Fernandez, 2017).

Implications of Educational Application

The role of the gaming industry in enhancing capacity of these technologies is a recurring theme in most literature (Fernandez, 2017). Additionally, gaming can also be applied to improve classroom outcomes. Chess & Booth (2013) explore the use of alternate reality games (ARG) as classroom tools and found them ideal for supporting collaborative learning practices, social skills, and understanding new media innovations. Hardware and software development in gaming is driven by opportunities for profit, and these technologies continue to improve and become more affordable. As such, gaming devices ease the transfer of competencies to educational settings, with the only consideration being relevant content.

For face-to-face education, future efficient systems in virtual reality will offer to replicate actual situations in real-time and on ad hoc basis – without the need to create new systems from scratch. According to Fernandez (2017), future trends also require presence of virtual laboratories that support continuous system development and integration. On the other hand, the future of face-to-face learning enhanced by augmented reality will be reliant on sharing of customized digital images in real-time. Students in a classroom can view and interact with these digitized models. Alternatively, virtual applications can provide students with tailored experiences to motivate them to pursue STEM professions. Already, applications exist that allow students to go on virtual field trips and experience life in a select professional environment or to interact with an established mentor. VR unique affordances grant students the capacity to develop visual and flexible objects to symbolize knowledge, a competence lacking in traditional learning model.

Online education is the leading beneficiary of reality applications. Internet-enabled learning has experienced unprecedented exponential growth. However, and according to Fernandez (2017), this growth is attracting many new entrants, leading to increased competition and over-supply of educational products and services. This scenario eventually cheapens educational outcomes with products unable to meet professional standards, as interactive platforms lack the capacity to effectively train students. To pre-empt deterioration of online educational experiences, Fernandez (2017) argues for comprehensive pedagogical considerations before integrating augmented and virtual reality systems. For online education, VR as a model for specialized training can provide users with emotional and physical responses, similar to a physical presence, and help them operate in a familiar environment. These new virtual experiences for distant learners will promote student retention.

Chess & Booth (2013) support the integration of Alternate Reality Game (ARG) in classrooms as an effective tool for education. In their article, *"Lessons down a rabbit hole: Alternate reality gaming in the classroom"* Chess & Booth (2013) assert that ARGs can complement teaching through shared learning practices and focus on new media literacy competence. The contemporary student thrives on a participatory learning culture, with ARGs in their nature, promoting group knowledge – collective intelligence. ARGs allow students to learn from their failures and encourage social learning. Additionally, use of ARGs in the classroom provides a safe environment for adapting to new media literacies, essential tools for modern learning. Chess & Booth (2013) used Participatory Action Research to explore adoption of alternate reality gaming (ARG) in classrooms. An ARG, in its nature allows for challenges, tasks, and rewards, with participants engaging through digital and real

mediums. These affordances grant capacity to model educational challenges, inspire creativity and collaboration in classrooms (Chess & Booth, 2013).

There is a dearth of literature focusing on ARG adoption for educational purposes. Chess & Booth (2013) findings on integrating ARG in college classrooms indicate a relevant pedagogical tool that improves student attention, inspires, and is responsible for better student performance. Chess & Booth (2013) add literature providing pedagogical justification for integrating reality applications for improved classroom processes. However, educators must act cautiously with adopting ARGs as students may view it as just another entertainment device not worthy for learning purposes. As mentioned earlier, at the core of an effective ARG in education is its pedagogy and related affordances.

Integrating Virtual Reality in Classrooms

Literature regarding strategies for integrating VR in classroom is abundant. O'Connor & Domingo (2016) identify ways of creating virtual environments that inspire, engage, and inform users. Easy access to open source software has reduced costs of building VR spaces and equally allowing educators the option to tailor applications according to relevant needs. According to O'Connor & Domingo (2016), educators can provide students with immersive learning opportunities by using and remodeling widely available virtual environments to be responsive to student needs. The essence of VR in educational settings is ensuring students are motivated and involved. O'Connor & Domingo (2016) provide educators with knowledge and guidance on how to develop virtual environments that conform to student requirements and situations. Their article empowers educators to create inexpensively tailored, immersive virtual spaces that are not complex. In their approach for designing basic virtual environments for classrooms, O'Connor & Domingo (2016) advocate for the creation of telepresence – a shared immersive virtual environment, for an effective way to foster

community and engagement. The digital student is inspired by telepresence, and for online educators, in particular, the challenge is in developing sustainable virtual communities (O'Connor & Domingo, 2016).

O'Connor & Domingo (2016) advance creation of effective virtual reality environments for educational settings by emphasizing designing for inspiration and involvement. Their observation is aligned to the changing educational needs of modern students; the latter requires motivating and interactive spaces to enhance learning experiences. Effectiveness of these integrated virtual reality systems must be evaluated. Specifically, for instructors assessing interpersonal and communication interactions, it may simply involve keen observation, documentation, and actions similar to face-to-face experiences. *Google Expeditions* is an appropriate example of a relevant VR experience. This application takes students on virtual tours to outer space, deep sea, and other educational settings, inspiring learner interest in the related spaces while providing shared experiences for improved classroom discussions and improving student engagement. The innovative and entertaining nature of VR inspires students and helps teachers instruct subjects that are perceived as difficult and boring. Additionally, virtual reality provides learners with an immersive and heightened sense of presence compared to prevalent educational environments.

Johnston, Olivas, Steele, Smith & Bailey (2017) apply qualitative research to establish and classify elements and practices of teaching that are ideal, though absent in VR applications developed for education. O'Connor & Domingo (2016) thoughts on creating virtual environments that inspire and engage collaborate with Johnston et al. (2017) emphasis, on designing VR systems using clear pedagogical structures. The converging premise of these authors is; encourage educators and VR designers to work together for a common goal – building perceptions, inspiring reflection, innovation, and measurable

outcomes. VR educational applications are creating unprecedented opportunities for viewing the world, and it is vital they remain pedagogically relevant (Johnston et al. 2017). In their scholarly study, Johnstone et al. (2017) established that the predominant pedagogical basis of virtual reality educational applications is experiential learning with discovery learning far behind. In experiential learning, students are actively involved in exploring, conceptualizing and constructing knowledge within the simulated environment. Discovery learning is not a prevalent pedagogical feature within VR applications, though it was noted as the second most prevalent. In discovery learning, students understand new concepts through self-discovery (Johnston et al., 2017). Other pedagogical features noted but not prevalent were constructivism and direct instruction, in order of prevalence. This study validates the essence of integrating VR systems for educational purposes – positive engagement and inspiring interactions.

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Johnston et al. (2017) in their findings established that majority of VR applications are student-centered – self-exploration, experience, and questioning. Learner-centered pedagogies are aligned to the premise of our study – integrating virtual technology to improve classroom experiences. Johnston et al. (2017) study provide insight into the need to develop new pedagogical features relevant to the needs of modern students. It is notable the majority of existing applications are largely focused on experiential, discovery,

constructivism and direct learning. Accordingly, it is upon educators to collaborate with VR designers in developing applications that are relevant to pedagogical principles.

Parong & Mayer (2018) employ interest theory and cognitive theory to compare teaching effectiveness of immersive virtual reality and teaching sciences with desktop slideshow as a medium. Additionally, the research sought to understand the effectiveness of including a generative learning approach to a virtual reality lesson. In generative learning, students engage in suitable cognitive activities – selecting, organizing, and integrating information for useful purposes – during lessons. Educators are on the lookout for compatible and complementing technology to aid in teaching and learning. Parong & Mayer (2018) study enhances our understanding of the use of technology to improve teaching of subjects that students have difficulty comprehending. In their experiments, the authors establish that students who experienced immersive VR lessons had higher rates of motivation, engagement, and interest retention.

Although results from Parong & Mayer (2018) study indicate, there is no significant difference in conventional science teaching and instruction under immersive virtual reality, reducing justification to invest in the latter. Nonetheless, Parong & Mayer (2018) acknowledge that students prefer VR systems as they are more inspiring compared to conventional media, and when applied with generative learning can retain or improve learning outcomes. Parong & Mayer (2018) paper through exploring opportunities for adopting immersive VR for teaching sciences, provides us with introductory literature on this new approach. Additionally, the paper adds to literature in support of integrating VR applications in classrooms.

Monetary Considerations Regarding VR Implementation

Brown & Green (2016) analyze VR ccostand application in classrooms and assert the technology is turning out to be inexpensive or even free and is effective as an instructional

tool and medium that enables learners to improve on their experiences. The authors base their arguments on practical understanding and application of emerging VR technology for instructional purposes. The two are conversant with VR application use and provide credible insight from their experiences and research. Brown & Green (2016) explore and provide briefs on various software and hardware available in the market and which is relevant for application in educational settings, most of which are available at practically no cost.

Immersive VR as a relatively new phenomena is perceived as expensive and not yet ready for adoption in classrooms. Brown & Green (2016) dispel the notion of high cost and provide a brief on inexpensive, easily adaptable, and resilient applications, ideal for classrooms. The involvement of leading tech companies in development of accessible applications is an incentive for educators to invest in adoption. Brown & Green (2016) identify Google Street View App as a useful tool that can be integrated into classrooms to simulate select environments. Mattel's View-Master can be accessed through smartphones or tablets, transposing users into a virtual world. Brown & Green (2016) paper is based on scholarly experience and provides credible insight on affordability and application of VR technology for educational purposes. This article also widens the scope of literature focusing on affordances and cost-effectiveness of VR systems and validates integration in classroom settings.

VR Impact on Learning Experiences

Ying, Jiong, Wei, Jingchun & Xiaopeng (2017) explored ways of improving teaching skills and curriculum development, came up with an innovative model – Virtual Reality based Education eXpansion (VREX). According to these scholars, VR systems are effective tools for modernizing educational ecosystems, including curriculum improvement and enabling learners to understand abstract subjects. The traditional classroom seeks to impart knowledge through; speaking, listening, writing, and reading. Integrating VR provides

learners with an innovative dimensional model to include touching and feeling – simulated environments. According to Ying et al. (2017), VR improves classroom experiences through; efficiency and effect, real-time feedback, low cost, and safe teaching environment. Ying et al. (2017) literature uphold the assertions on the effectiveness of VR applications in classrooms.

Evans (2018) paper examined gaming concepts to show faculty members and administrators at a university, the potential of virtual reality in the classroom. This recent publication explores modern educational trends in the age of technically oriented students. Similar to discussed literature on this subject, Evans (2018) views VR applications as a revolutionary tool for resolving new and emerging educational problems. According to Evans (2018), both augmented and virtual reality can be integrated into multiple fields. Accessibility and affordability now reduce fear associated with the use of these technologies. Nonetheless, users have to be considerate of physical and health-related concerns. In his observations of users Evans (2018) noted risks of experiencing emotional sickness, and there is a need to have object free spaces to ensure users are engaged safely.

Sociological Implications of VR

Yeh, Lan & Lin (2018) add to the dearth of literature examining the impact of virtual reality systems on learning experiences. Yeh, Lan & Lin (2018) employ qualitative research methodology to examine how children work together in creating their own stories within virtual environments. The researchers sought to find out any gender-related influences in these educational environments. Yeh et al. (2018) findings on student collaboration were derived from process-solution analysis, with their presentation focused on two areas; collaboration process, and nature of groups' final collaborative creations. There were notable gender differences during the study. The study indicates boys being more skilled then girls at flying avatars and altering perspectives. Girls tend to become disoriented by their own

perspective and avatars. This research reveals the importance of teachers being aware of potential gender implications when using VR activities.

Yeh et al. (2018) also examined verbal data findings regarding individual and group interactions. Results reveal females recording higher verbal data than their male counterparts. This study found girls were more inclined to ask questions, use inappropriate llanguage, and quarrel. However, Females tend to have greater collaborative spirit mainly due to better verbal communications, with males oriented towards actions. Group leadership is also a factor affecting the nature of collaboration, with strong leadership manifesting greater teamwork. According to Yeh et al. (2018) students involved in the study felt the learning experience was enlightening and interesting, gender notwithstanding.

Yeh et al. (2018) study is a game-based learning approach, and the authors thought it ideal for new generation students. The concept of incorporating gaming in teaching is closely related to use of VR technology. Nonetheless, teachers have to factor gender influences as females need more support compared to males. Moreover, the support must also include a framework for dealing with these learning differences between genders.

Student and Teacher Response to VR Implementation

Domingo & Bradley (2017) employ grounded theory methodology to establish student perceptions of use and value for 3D virtual environments. Their paper seeks to guide future integration of virtual spaces within teaching courses. Domingo & Bradley (2017) study focuses on higher educational programs delivered through online platforms and aims to bridge the disconnect between learners and instructors. Online educational institutions have adopted 3D virtual environments as a way of improving student engagement and to provide greater immersive learning experiences. Integrating virtual environments in online education creates a learning community, and this contributes to student motivation. Within these virtual spaces, learners can move, explore, and communicate (Domingo & Bradley, 2017).

Domingo & Bradley (2017) point out the challenges that inhibit adoption – lack of suitable hardware, poor Internet connection, and student's resistance to change. Domingo & Bradley (2017) concur with Brown & Green (2016) on the ease of virtual integration through the adoption of alternative low-cost or free open source software. Student perceptions of virtual reality environments are influenced by their experiences and available technological resources, with poor experiences and lack of resources leading to negative perceptions. Through continuous exposure to 3D virtual spaces, learners adjust and report positive experiences. Nonetheless, recurring challenges according to Domingo & Bradley (2016) that negatively impacted student perceptions were technical hitches. This realization of technical difficulties blurring experiences within virtual environment points at the need to identify hardware and software ccompatible with educational settings. The gaming industry has enabled students to transition into the virtual world, and their expectations are based on experiences playing with these tech devices. However, for students, educational use of virtual systems has to occur seamlessly without any technical difficulties (Domingo & Bradley, 2016). This paper contributes to existing literature on adoption of VR applications for classrooms and reveals the need for educators to work with manufacturers to identify appropriate applications that improve learning performance.

> Moving into the future, it is inevitable that VR applications will be part and parcel of our educational systems. Despite the revolutionary nature of VR technology in the learning environment, questions persist on issues of, developmental psychology and general education of the child. Zlokovi, Cernetic & Dobrnjlc (2009) examines perception of VR systems as panacea for improving educational standards. Zlokovic, Cernetic & Dobrnjic (2009) argue that VR if unchecked may impact negatively on children's cognitive development. Currently, mass media portrays VR as a revolutionary progressive educational tool. According to Zlokovic et al. (2009),

children stand at risk of 'existing' only in the virtual world – virtual family, education, and even virtual friends.

Advocates of adopting VR systems for education purposes insist that adoption is to cater to the changing needs of contemporary students. Nevertheless, Zlolovic et al. (2009) question reasons behind schools losing their relevance, despite operating in the age of tremendous scientific innovations. The authors believe children ought not to lose out on values as a consequence of integrating VR in educational settings. Zlokovic et al. (2019) study is an eye-opener for educators not to blindly adopt VR applications but to weigh on other issues that can negatively impact on learning abilities. However, it is notable that VR is effective in providing users with new perspectives, opportunities for empathy, and capacity to understand difficult models, features that overshadow related negative associations.

Patterson, Carrillo & Salinas (2012) examine the use of VR to improve students' global competencies – knowledge, intercultural adaptability, empathy, and acceptance – found VR applications had a positive influence on classroom activities. Patterson et al. (2012) study used a global virtual classroom providing learners with the opportunity to connect with peers living in distant places. Additionally, students shared course content in a virtual environment enabling them to develop new scholarly relationships. Within these environments' students were prompted to be creative in communicating with peers speaking a foreign language (Patterson et al. 2012). Patterson et al. (2012) study and Domingo & Bradley (2016) focus VR affordances for online education immensely contributes to existing literature on the subject and the importance of VR applications for improving educational outcomes.

Chen (2012), in examining the impact of VR systems in high school learning found students involved in the research viewed the technology as an effective tool in

their academic programs and pursuits. Chen (2012) adopted a virtual reality course to study high school students' perceptions of the technology and results revealed an enhanced understanding of importance and performance of VR systems, and new use of the technology for career planning and development. In career planning and development, VR applications enabled students to explore opportunities available in occupations that are difficult to comprehend.

Summary

Literature advocating for the adoption of VR as an effective tool for classroom activities argues the technology fulfills the needs of *Experiential Age*, and in a manner, they find appropriate. Our existing education system requires renewed engagement, realistic experiences that enhance learning, features that VR delivers, and has potential to create new spaces that have traditionally been inaccessible. However, effective integration of VR applications is dependent on blending pedagogy and technology within a well sought out fame work. Integrating VR in classrooms provides learners with an innovative dimensional model that may include touching and feeling – in simulated environments. In the reviewed literature, convergence of thought indicates reality technology offers students informal and innate mediums for successful interactions with multimedia lessons, resulting in effective engagement and greater learning.

The most significant opportunity of integrating VR in classrooms is use for constructivist learning – supporting students to develop on knowledge through expressive experiences. In these expressive experiences' learners engage in real challenges, identify solutions and even collaborate with peers. From the discussed literature, reality technologies can expand boundaries of traditional educational settings to become more creative, engaging and receptive to the needs of modern 'experiential' learners. Literature on the effects of immersive virtual reality in classroom settings is still nascent. There is also a need for

comprehensive studies on the impact of immersive virtual reality, including the pedagogical possibilities of immersive virtual reality. Additional studies will ensure affordances that these technologies are leveraged for collaboration, creativity, and broader learning.

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