The Integration of Virtual Reality in K-12 Classrooms

Abstract

Virtual reality (VR) has been recognized for many years as an emerging technology. The purpose of this literature review was to examine research on the use of VR in K-12 classrooms. Eleven studies were identified for analysis to understand the adoption of VR and the technology integration strategies used. As reflected in the research literature during 2016-2020, VR is more commonly found in Asian countries than in the United States. Furthermore, research tends to be confined to a single grade, subject, and topic, revealing a fragmented approach to technology integration. The findings and small sample size reveal that VR has yet to significantly impact K-12 classrooms. The implications of the findings for future research and development are examined.

Keywords: virtual reality, technology integration, research, K-12 education

Introduction

Immersive technology swiftly piques and maintains our learners' interest in a multitude of ways. Students in elementary schools can now accomplish just that due to technologies such as virtual reality (VR). VR, sometimes referred to as *hybrid reality*, is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time" (Liou & Chang, 2018, p. 1). For example, students today take virtual field trips to sites like ancient civilizations, world-class museums, spacewalks in the international space station, explore wildlife on a safari, dive into action under the ocean, and traverse the human body from the inside out.

A variety of phrases are used in the literature to characterize the use of technology to produce experiences that are not achievable in the actual world: augmented reality, extended reality, immersive reality, and mixed reality. Previous VR scoping reviews (Pellas, Dengel, & Christopoulos, 2020) and VR literature reviews (Mikropoulos & Natsis, 2011) have noted the disparity between support for the promise of VR and the narrow STEM oriented applications in the classroom. Both studies call for more attention to learning affordances in virtual environments (e.g., spatial knowledge representation, experiential learning, engagement, contextual learning and collaborative learning) and increased attention on measuring students' learning performance.

The purpose of this literature review is to summarize what is known about the use of virtual reality in K-12 classrooms during the years 2016-2020 as this emerging technology entered the marketplace and conceivably the classroom, as this technology was adopted. The theoretical framework for the research extends the work of Rogers (1962) and Moore (1991) concerning the adoption of innovation. With the prediction posed by the 2019 Horizon Report

(Alexander, et al., 2019) that mixed reality would experience a time-to-adoption horizon of two to three years (p. 5), we examine the nature of VR curriculum integration (Fogarty, 1991) within the K-12 curriculum. The current review contributes to the literature by providing information on the potential K-12 classroom application of VR by assisting teachers, administrators, and technology specialists who are considering the adoption of VR beyond STEM curricula.

The following research questions guided the investigation:

RQ1: What is known about the rate of adoption and degree of technology integration of VR in K-12 classrooms?

RQ2: What types of research methodologies have been used to study VR in K-12 classrooms?

Methods

Identifying Relevant Studies

Four databases (Academic Search Complete, APA PsychoInfo, ERIC, and Library and Information Science Source) were identified as indexing relevant educational technology literature. The databases were searched concurrently using EBSCOhost as available through the BLINDED university library. The search was delimited to the five-year period 2016 – 2020 since VR technologies were initially introduced in 2014 (Robertson, 2014).

The search term was constructed by searching for virtual reality or VR (in the article title) AND research (anywhere in the text) AND elementary and secondary education (anywhere in the text). This yielded a set of 55 articles that were reviewed for relevance. If relevant, the article title was entered into Google Scholar to forward chain (cited by) and the new list of articles were examined for relevance (see Figure 1). Inclusion criteria were established as follows: research published in referred journals between 2016 and 2020, full text available in English, classroom

research conducted in grades K-12. Dissertations, conference proceedings, and white papers were excluded as were papers that did not explicitly collect data from teachers and students using VR in the classroom. In the end, the literature search procedures resulted in a corpus of 11 research articles that formed the basis of the current study examining the integration of VR technology into the K-12 classroom.

Results

To address the research questions, four descriptive analyses were performed. To understand the rate of adoption of VR and the technology integration strategies used, in K-12 education, each article was coded by the country in which the research was conducted. Of the 11 studies identified in this study, the majority were conducted in Taiwan (n=4, 36%). Other countries were United States (n=3, 27%), Turkey (n=2, 18%), South Korea (n=1, 9%), and Brazil (n=1, 9%).

To understand where and how VR is being used, each article was coded relative to its integration model (Fogarty, 1991), the grade level, and the subject area. The results indicate that majority of studies (n=10, 90%) were conducted in accordance with the Fragmented curriculum integration model (within a single subject, unconnected to other subjects/disciplines). Science was the most common subject area (n=4, 36%) and the grade level varied between first and ninth grade. Most common grade levels were fourth grade (n=2, 18%), fourth and fifth grade combined (n=2, 18%), and sixth and ninth grade (n=2, 18%).

The type of VR hardware and software was coded for each article to provide insight about whether or not there was a common toolkit being adopted. The results indicate the most common type of VR being adopted was the VR headset (n=4, 36%). Although fully immersive VR is one of the most common uses of this immersive environment, there are other formats

including desktop VR, 360 Video, CAVE, immersion room which are further categorized into three categories of non-immersive, semi-immersive, and fully immersive.

Finally, each article was analyzed concerning the type of research methodology used. A majority of the studies were conducted using qualitative methods (n=4, 36%). The other research methodologies included: mixed methods (n=2, xx%), quantitative (n=2, xx%), unable to discern (n=2, xx%), and quasi-experimental (n=1, 9%). The number of participants in each study ranged from 26 – 145 students.

Discussion

The purpose of this study was to review the research literature in order to understand the rate of adoption of VR technology in K-12 education. Given what is known about the adoption of innovation (Moore, 1991; Rogers, 1962), and expert prognostication (Alexander, et al., 2019), it was anticipated that VR would be adopted at a rate of 2-5% by 2022. However, the existing research evidence suggests that VR is still a novelty in most countries as well as the United States.

The use of VR in K-12 classrooms as it has been implemented through research studies has used a fragmented model of technology integration. That is, efforts are often defined to a single grade level classroom, and a single instructional topic, without efforts to integrate multiple subjects. This is likely an issue associated with curriculum development and teacher training rather than any intrinsic limitations of the VR hardware. VR headsets (HMDs) are expected to rise in popularity as commercially accessible devices such as the HTC Vive, Google Cardboard, and Oculus Rift become more widely available.

As noted in previous reviews of the VR literature (Mikropoulos & Natsis, 2011; Pellas, Dengel, & Christopoulos, 2020), this study found fundamental deficiencies in the description of

the research methods and the lack of attention to measuring student learning outcomes. Clearly more work is needed in this area to convince administrators that VR is a good investment and will provide powerful learning experiences for students when integrated effectively into the curriculum.

Limitations of the Current Study

The focus on 2016-2020 was anticipate to be a period of early adoption of VR in K-12 schools given the emphasis on VR as an emerging technology in the literature since 2014. The limited VR evidence base to-date in K-12 education may also be a function of factors associated with the publication delay associated with research.

This study did not include VR at the post-secondary level or the use of VR in teacher education. However, the limited research base raises questions about the relationship between in-service teacher use of technology and their pre-service preparation. As a result, the current study provides an incomplete picture of the rate of VR adoption in education.

Recommendations for Future Research

Further research is required to better understand the types of VR media that can be used with VR hardware as it becomes more available. In addition, more attention is needed to the learning affordances provided by VR (Ritz & Buss, 2016) in order to understand its unique contribution to enhanced learning outcomes.

Conclusion

The data from this study suggest that the adoption of VR is slower than predicted in K-12 education. Whereas existing research suggests that VR technologies have promise for providing engaging and immersive learning experiences, to-date the research has not documented the integration of this technology into the curriculum. As previously stated, more sumptuous

emphasis needs to be placed on learning affordances in virtual environments (for example, spatial knowledge representation, experiential learning, engagement, contextual learning, and collaborative learning) and increased emphasis on measuring students' learning performance.

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Figure 1

Study Selection