Kansas Library Association College and University Libraries Section Proceedings

Volume 9
Number 1 *Going the Distance: Academic Library Planning for the Long-Term*

Article 4

2019

Effect of Virtual Reality on Learning Motivation and Academic Performance: What Value May VR Have for Library Instruction?

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Recommended Citation

Lund, Brady D. and Wang, Ting (2019) "Effect of Virtual Reality on Learning Motivation and Academic Performance: What Value May VR Have for Library Instruction?," *Kansas Library Association College and University Libraries Section Proceedings*: Vol. 9: No. 1. https://doi.org/10.4148/2160-942X.1073

Effect of Virtual Reality on Learning Motivation and Academic Performance: What Value May VR Have for Library Instruction?

Abstract

The research on whether Virtual Reality (VR) has a positive effect on student learning and engagement is limited. This study aims to examine what impact VR has on student learning motivation and performance. The study conducted by Wang (2017) revealed that VR had a marginally positive impact on student scores and a strong impact on students' learning engagement. It indicates that VR provides a small improvement in academic performance and a large improvement in student engagement. The application of VR in libraries focuses on providing the VR tools to learn subjects in STEM and history fields. For one-off instructional settings, the boost of learning motivation may increase interest in further investigation and retention. For semester-long courses, increased learning motivation may decrease student attrition or "failure" in the information literacy course.

Keywords

Virtual Reality, learning motivation, learning engagement, library instruction

Introduction

Virtual reality is a technology that can provide both affordable (less than $10 per user for Google Cardboard) and interactive learning experiences, which has garnered for it the interest of educators, including library instructors. However, little is known about the extent to which the technology actually improves student engagement or outcomes. Is there actual value to using virtual reality for instruction, or is it simply another tech fad? This paper describes an experimental study of student outcomes among a treatment group, which received virtual reality instruction, and a control group, which received traditional lecture instruction. The findings have potential implications for library instructors considering implementing this technology in their information literacy courses.

Literature Review

"Virtual reality is the computer-created counterpart to actual reality. Through a video headset, computer programs present a visual world that can, pixel-perfectly, replicate the real world – or show a completely unreal one" (Varnum, 2019, p. x). Virtual reality is distinct from augmented reality, which augments a real-world, real-time image (viewed through a cellphone camera) with computer-generated information, such as images, text, videos, animation, and sound (Lund & Agbaji, 2018). Virtual reality has been widely used in many fields to visualize and learn abstract concepts, such as medical science, engineering, architecture, product development, and geology (Portman, Natapov, & Fisher-Gewirtzman, 2015; Alhalabi, 2016; Moro, Stromberga, & Stirling, 2017; Barnes, 2017; Tudor et al., 2018). Research revealed that using VR as a teaching instrument significantly improves student's concepts understanding, test scores, and learning motivation, and decreases training costs and experimental risks.

Within their fundamental role of creating opportunities for learning and supporting education in society, libraries also focus on applying learning-friendly technologies to daily instructional activities, improving accessibility to research assistance, and increasing available information resources to users (MacWhinnie, 2003). Several researchers have explored the feasibility of using virtual reality in libraries. Poulter (1993) proposed a concept of an online catalog – virtual reality library – allowing users to browse an information space and shelf ordering for items within a computer-generated environment. This online catalog allowed users to access the information resources which either had no physical repository or had one that was not physically accessible to users (such as in off-site storage). After Second Life, an online virtual environment that allows users from education institutions conduct teaching and research experiments, was released in 2003, a virtual library project – the Second Life Library 2.0 – was initiated by Alliance Library System and OPAL (Swanson, 2007). It provided library services, such as access to library collections and databases, to real-world people via their virtual avatars through synchronous and asynchronous communication. Users of this service reported high satisfaction with it.

Both public and academic libraries have found uses for virtual reality technology in different areas of their public services. Carroll County Public Library in New Windsor, Maryland, demoed VR in high schools and art classes and provided outdoor demonstrations over the course of several years in the 2010s (Waite, 2018). As discussed by Oyelude (2018), Prince George's County Memorial Library System introduced VR in teen services activities, to good reception. Geisel Library of University of California, San Diego, makes VR headset available to the public for lending (The Library UC San Diego, 2018). The Claude Moore Health Science Library at the University of Virginia has used virtual reality to assist in the technical services of the library (Lessick & Kraft, 2017). One area where virtual reality has not been well-investigated in libraries is library instruction. The present study intends to push the discussion about virtual reality in libraries in the direction of instruction by providing evidence of positive instructional outcomes with virtual reality use.

Ken Varnum's (2019) book *Beyond Reality* discusses both theoretical and practical considerations for using virtual and augmented reality in libraries. Smith's (2019) chapter on information literacy instruction using virtual reality makes several statements that support the benefits of using virtual reality in library instruction. Smith notes that active learning methods (such as using virtual reality) have been shown to decrease failure rate in academic courses by over half (Smith, 2019, p. 87). Virtual reality provides a realistic understanding of concepts in context, as opposed to traditional instruction, which uses abstract terms to describe concepts. Similar to online learning, virtual reality would allow for asynchronous participation. While virtual reality may not be the best to simulate web searching, it can be an excellent platform to simulate the same decision-making processes that are key to being information literate (e.g., would you rather accept pills from a stranger at a bar or a nurse at a hospital? This tests students' ability to recognize context and authority).

Research Problem and Hypothesis

Our knowledge of whether virtual reality actually improves engagement or learning is extremely limited; the technology is being integrated into instruction with little evidence-based research to support it. This concern was stated well by Fowler (2015), who noted the existence of a large body of literature discussing how virtual reality could be used for instruction, without any literature investigating if it is effective or actually supports learning objectives. This study examines what impact virtual reality has on student learning motivation and performance, using a sample population of 39 students enrolled in a school in a semi-rural area of eastern Kansas. The hypothesis for this study is that virtual reality will improve engagement and learning among all students.

Methods

Wang (2017) examined the use of virtual reality in instruction among a group of 39 students, randomly assigned to either experimental or control groups. Learning motivation (engagement) was measured by the session of "interest and enjoyment" of the Intrinsic Motivation Inventory (IMI) (McAuley et al., 1989), and academic performance was measured by assignment scores. Quasi-experimental design using pretest and posttest was applied to measure the differences between the two groups and between the two tests. Questions in the two tests were the same. All participants took the pretest, served as the control factors which may affect the results of the posttest, one week before the lecture to measure their prior knowledge of the class subject and learning interest. During the lecture, both groups learned how the apparent brightness of the sun compared to other stars due to their relative distances from the Earth. The control group used flashlight as a class experiment to observe the relationship between the brightness of the sun and the distance to the sun; the experimental group use VR headsets, the iPod Touch, and the VR app VR-Explore Solar System in 3D to observe the brightness of sunlight and distances among planets in the solar system. Results of both pretest and posttest were collected by the researcher and analyzed using Analysis of Covariance (ANCOVA) in SPSS. This study describes the results and implications for library instructors considering virtual reality as an instructional tool.

Findings

Within the control (traditional instruction) group, scores on the assessment improved from 3.63/7 (SD = 1.21) to 4.1/7 (SD=1.24) from pre-test to post-test; within the experimental (virtual reality) group, scores on the assessment improved from 5.2/7 (SD = 1.1) to 5.25/7 (SD = 1.21). The ANCOVA revealed a weak, significant relationship, $F(1, 36) = 3.822$, $p = 0.05$. This shows that virtual reality had a marginal positive impact on student scores on the post-test assignment.

Learning motivation scores among the control group increased from 4.24/7 (SD = 1.48) to 4.79/7 (SD = 1.64) from pre-test to post-test. Among the experimental group, learning motivation increased from 5.19/7 (SD = 1.3) to 6.43/7 (SD = 0.93). The ANCOVA revealed a strong, significant relationship between the treatment (virtual reality) and outcomes, $F(1, 36) = 21.894$, $p < 0.001$. This shows that virtual reality had a strong impact on students' learning motivation (engagement).

Discussion

This study indicates that virtual reality, when used in instruction, may provide a small improvement in academic performance and a large improvement in student engagement. This finding aligns well with Smith's (2019) discussion about virtual reality in information literacy instruction and indicates that virtual reality may play a major role in student retention, given the statistic that interactive instruction reduces failure rate by over one-half. Students were significantly more motivated to learn when using virtual reality than when receiving traditional instruction. Over time, such as multiple instructional sessions, learning motivation may result in greater retention and overall performance (Zahay, Kumar, & Trimble, 2017).

Many of the current uses of virtual reality in libraries, as identified in the literature review, focus on providing the virtual reality tools to learn subjects in STEM and history fields (Lessick & Kraft, 2017; Oyelude, 2018; Waite, 2018). There is, however, great opportunity for utilizing virtual reality in information literacy instruction, as Smith (2019) notes. The findings of this study show that the use of virtual reality in instruction, as described by Smith, likely will result in greater learning motivation among the students and positively affect student performance. For one-off instructional settings, this boost in learning motivation may increase interest in further investigation and retention. For semester-long courses, the increase in learning motivation may decrease student attrition or loss of interest in the information literacy course. While it is likely not feasible to use virtual reality in every information literacy class, the integration of virtual reality within select sessions may be an effective way to re-engage students throughout a semester.

These findings are further bolstered by similar results for the use of (closely related) augmented reality technology in library instruction. Several studies throughout the professional literature of librarianship have found that augmented reality improves student outcomes within the context of library instruction (Arnheim & Spiller, 2014; Chen & Tsai, 2012; Walsh, 2010; Wang, Chen, Hong, & Tsai, 2013). With the preliminary evidence of Wang's (2018) study, there is reason to believe the findings of these studies may extend to virtual reality library instruction.

There are a couple limitations of virtual reality that should be noted by instructional librarians integrating virtual reality in instruction. There are several health risks (in very rare instances can provoke seizures in those who are susceptible, and can easily cause motion sickness and eye strain) (Nichols & Patel, 2002). The technology is not accessible to individuals with severe vision loss, due to its largely-visual format (though virtual reality has been shown to have positive social impacts for individuals with other physical and hearing disabilities) (Maidenbaum, Levy-Tzedek, Chebat, & Amedi, 2013). These limitations may be barriers that would make using virtual reality in a given course infeasible.

Conclusion

Library instruction can benefit from integrating active learning practices, including the use of virtual reality, in classes. Virtual reality may significantly improve student engagement and increase student performance. This is important for students who may only have limited exposure to academic librarians through one-off sessions. As virtual reality technology becomes more accessible to library instructors through affordable avenues like Google Cardboard, it may provide a cheap, practical way to engage students without significant additional preparation on the part of the instructor.

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Appendix: Sample Assessment of Learning and Learning Motivation

Pre-/Post- Test Sample Questions

1) Evidence of the earth's daily rotation can be found by _____.
    a. NASA video of the earth
    b. The rising and setting of the sun
    c. The change in shadow size throughout the day
    d. Movement experienced on earth
2) Different constellations can be observed in summer months versus winter months due to _____.
    a. Temperature change on earth
    b. Sunlight reflected during the summer
    c. The orbit of the earth around the sun
    d. Constellations change in intensity throughout the year
3) A star can be distinguished from a planet in the night's sky based on _____.
    a. Movement of the object
    b. Size of the object
    c. Brightness of the object
    d. Color of the object
4) Changes in the moon's shape over the course of a month occur due to _____.
    a. Movement of the earth's shadow
    b. Orbit of the moon around the earth changes the angle of the sun's reflection
    c. Orbit of the moon on its axis changes the reflection of the sun
    d. The moon and earth orbit at different speeds around the sun
5) Space travel to Jupiter is impossible due to _____.
    a. Distance between earth and Jupiter is too great
    b. Jupiter is comprised of gas
    c. The surface of Jupiter is too cold
    d. The surface of Jupiter is too large

e.

Motivation Inventory

Post-Experimental Intrinsic Motivation Inventory							
Agreement (Likert)	Not true at all 1	2	3	Somewhat true 4	5	6	Very true 7
I enjoyed doing this activity very much							
This activity was fun							
I thought this was a boring activity							
This activity did not hold my attention at all							
I would describe this activity as very interesting							
I thought this activity was quite enjoyable							
While I was completing this activity, I was thinking about how much I enjoy it							