International Journal of Web-Based Learning and Teaching Technologies
Volume 19 • Issue 1

Effectiveness of Virtual Reality on Learning Engagement: A Meta-Analysis

Jingyuan Chen, Zhengzhou Railway Vocational and Technical College, China*
Zongjian Fu, Zhengzhou Railway Vocational and Technical College, China
Hongfeng Liu, Zhengzhou Railway Vocational and Technical College, China
Jinku Wang, Henan Technical Institute, China

ABSTRACT

With its immersive, interactive, and creative capabilities, virtual reality (VR) has been widely used in educational settings to provide students with challenging real-world experiences. As a result, interest in its effectiveness has grown. The goal of this meta-analysis is to examine how VR technology affects students' motivation to study. A comprehensive analysis of the literature up to December 2022 revealed 15 randomized controlled trials or quasi-experimental studies. These studies were also coded to examine the moderating effects of their features, such as types of learner engagement, learner stages, learning domains, types of VR technology, and the moderating effect of knowledge types. The results indicate a large effect of VR on student engagement in learning (g=0.85). Furthermore, the findings of the moderator analysis demonstrate that VR has a more significant impact on cognitive engagement, higher education learners, immersive VR experiences, the field of art education, and procedural knowledge learning.

KEYWORDS

Education, Information Technology, Learning Engagement, Meta-Analysis, Virtual Reality

INTRODUCTION

Virtual reality (VR) is a technology that offers students the opportunity to engage with a computer-generated environment, allowing them to tackle complex problems directly (Burdea & Coiffet, 2003). Immersion, interaction, and imagination are the key features of VR that enable students to experience real-world scenarios, enhance their learning motivation, and yield positive learning outcomes (Radianti et al., 2020). VR allows for specialized skill training, such as flying an aircraft or operating a vehicle, as well as the observation of microscopic or macroscopic events, such as examining biological tissues. In recent years, the increasing power of computer processing, improved network transmission rates, and decreasing costs of VR equipment have facilitated the widespread adoption of VR in education and teaching. Consequently, the effectiveness of VR implementation is gaining significant attention (Brown et al., 2020).

DOI: 10.4018/IJWLTT.334849 *Corresponding Author

A century ago, Dewey (1916) proposed that students should "learn by doing," i.e., gain experience in real learning environments and learn by doing real tasks. As a result, a large body of research has concluded that virtual reality provides rich stimuli, facilitates natural interactions and experiences, and improves student engagement in learning due to the three-dimensional perspective and immersive space that it provides. Despite the generally positive attitude of researchers toward virtual reality technology, the available research has focused more on the impact of virtual reality technology on learners' academic achievement and lacks research on the impact on learners' academic experience. Lähtevänoja et al. (2022) suggested that the impact on indirect learning outcomes (e.g., motivation and engagement in learning) should be added to future research.

The purpose of this study was to explore the impact of virtual reality technology on learners' engagement, rather than focusing on the impact on their academic achievement. In addition, a moderated analysis was conducted to explore inconsistent results. Therefore, the research questions were as follows:

1. How effective is VR technology on the overall learning engagement of learners compared to non-VR technology?
2. How effective is the impact of VR technology on various aspects of learners' cognitive engagement, emotional engagement, behavioral engagement, and social engagement?
3. What are the moderating effects of the qualities that have been studied, such as the type of immersion in VR technology, the stage of learners, etc.?

LITERATURE REVIEW

VR Technology Types and Characteristics

VR technology is an emerging technology that integrates several disciplines such as computer graphics technology, human-machine interface technology, sensing technology, simulation technology, and artificial intelligence (Yang et al., 2010). It enables human-computer interaction and access to multimodal information through devices that immerse the user in a 3D virtual environment to achieve physical and mental interaction and a realistic perceptual experience. According to the level of immersion, virtual reality technologies are divided into two categories: non-immersive VR and immersive VR. Non-immersive VR technology, also known as desktop computer virtual reality, generally means that users can interact with the virtual environment through a mouse, keyboard, game console, or touchscreen (Cabero Almenara & Fernández Robles, 2018). Immersive VR can be categorized into two main types: semi-immersive VR and fully immersive VR. Semi-immersive VR technology refers to systems that allow partial sensory immersion of the user in the digital environment. To achieve this, the relevant sensory inputs are enhanced or the way the user interacts with the virtual environment is improved, as in the case of Google Glass (Di Natale et al., 2020). Fully immersive virtual reality technologies enclose the user's visual, auditory, and other senses and provide input devices such as 3D mice, data gloves, spatial position trackers, and visual-auditory and other devices to fully immerse the user in a new virtual sensory space. This technology can be divided into two types: head-mounted display devices and cave automatic virtual environment (CAVE) (Passig et al., 2016; Meyer et al., 2019). Head-mounted display devices are where the user wears glasses consisting of two LCD screens through which the system monitors the orientation of the user's head and, in some cases, the user's position. CAVE is a projection-based virtual reality technology in which the user is isolated from the external physical environment and the audiovisual perception is fully integrated with the virtual environment and a highly immersive experience is obtained in the CAVE environment (Muhanna, 2015).