An exploratory student-centred approach to immersive virtual reality: Reflections and future directions

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Advancements in immersive virtual reality (VR) have encouraged educators to start looking for ways to leverage the potentials of this technology. This concise paper reports the preliminary findings of a study where VR was used in an educational setting. A small group of teachers and students explored free VR apps and investigated their usefulness for learning. Through this activity, they not only compiled a list of VR apps that could potentially be used by teachers but also co-investigated the benefits and challenges of implementing VR-powered activities. The study was backed up by student app reviews, teacher observations, and focus group interviews. The results revealed that students found VR engaging and stimulating and successfully explored the educational values of multiple apps; however, they experienced some degree of cybersickness. As a response to this concern, the next phase of the study will focus on desktop VR and learner-generated content.

Keywords: virtual reality, immersive VR, desktop VR, student-centred approach.

Introduction

Immersive virtual reality (VR) is a technology that places users, represented as avatars, in a 3D simulated environment and through real-time motion tracking and rendering creates an immersive embodied experience. In general, VR can be accessed on PCs (also known as Desktop VR or Web VR), VR headsets or goggles that are more technically called head-mounted displays (HMDs), and VR cubicles or CAVEs (Cave Automatic Virtual Environments). What marks the difference across these three means of accessing VR is the degree of immersion; that is the extent to which a VR system can remove outside-world interference, and VR powered by HMDs and CAVEs is often regarded as high immersion (Makransky & Petersen, 2021).

Desktop VR in the form of 3D virtual environments has been used for a few decades, and reviews of past research have identified best practices in instructional design as well as learning affordances associated with the use of these environments (e.g., Dalgarno & Lee, 2010; De Freitas & Veletsianos, 2010; Reisoğlu et al., 2017). Recently, HMD-based VR has been a topic of interest for many educational researchers since these devices have improved tracking and higher fidelity and are increasingly coming down in price. Most HMDs available on the consumer market consist of a headset that shuts off a user's view of the outside world and hand controllers that facilitate various actions in VR such as continuous movement and teleport (the latter signifying a sudden movement from one spot to another leading to a change of perspective), content sharing (e.g., adding audio-visual media or 3D models to an existing environment) and environment manipulation (e.g., grabbing an interactive object such as a cup or pen). Older HMD models were wired and had to be tethered to a high-end PC to function; however, newer models such as those by Oculus and Pico are wireless and allow users to enter VR environments either in a stationary position (seated) or within the boundaries of a self-specified area and are thus more likely to be adopted by educational institutions at a large scale in the years to come.

Given the COVID-19 global pandemic and the urgent shift to online education, implementing VR-enhanced learning could potentially leverage affordances reported in the literature such as increased engagement and motivation (Allcoat & von Mühlenen, 2018; Huang et al., 2021) and mitigate the risks of travel-based study-abroad programs (Liu & Shirley, 2021). Several meta-review studies have been conducted on the incorporation of VR using HMDs. For instance, Wu et al. (2020) evaluated the impact of VR on learning performance by synthesising results from past research and calculating a pooled effect size that showed improved results for VR compared to non-immersive approaches. Radianti et al. (2020) summarised previous findings in terms of the design elements and learning theories informing VR-based learning and have evaluated the impact of VR on learning outcomes to suggest an agenda for future research. Finally, Hamilton et al. (2021) investigated the learning domains to which VR has been applied, the variables considered for outcome measurement, and the assessment instruments used to evaluate learning gains. These review studies reveal that VR learning is more frequently employed in STEM education compared to humanities and arts, and that despite early promising results there are still inconsistencies in research findings as to the effectiveness of VR in higher education and a lack of rigorous learning theories guiding research. In addition, most of these studies are short-span experimental studies that fail to captivate the impact of VR learning beyond a single-time exposure. As recommended by Radianti et al. (2020), it is sensible to start with a small scoping pilot study before turning an entire course into VR, even when sufficient funding and human resources are available. This is the same direction followed in this longitudinal student-centred study.

Considering the insights from the literature and the above recommendation, the authors began co-exploring existing VR apps with a small group of student volunteers. The students were purposely recruited by the second author as they were all student assistants working part-time at his university. It was felt that as this was a first attempt to use VR with students the authors had to make sure they could closely monitor the student participants. English was the first language of two students out of five, whereas the remaining three spoke English as a second language. A mixture of Japanese and English was used as the means of communication among members. This concise paper reports on the preliminary findings of the student-centred research and outlines the lessons learned and suggests possible future directions. The study, although small in scale at this preliminary stage, is significant in that it can provide insights into the benefits and challenges of scaling up the project to real classrooms equipped with HMDS for all students. Four research questions were investigated:

1. *What are the perceptions of university students regarding VR?*
2. *What type of VR apps can students find and explore on their own?*
3. *What kind of learning affordances can VR environments provide for?*
4. *What pedagogical and logistical challenges can arise when incorporating VR into education?*

Study Setting and Procedure

Oculus Quest 2 HMDs were used in this study, and the two teachers and five students (four males and one female, four majoring in humanities and one in engineering) were each given one device with the Engage VR application pre-installed. Engage (https://engagevr.io) is a virtual communication platform where multiple users represented by avatars can share and collaborate within a range of spaces from lecture hall to coffee shop to moon base. Each virtual space is equipped with certain functionalities such as media sharing, session recording, 3D pen, whiteboards, and spatial audio. Although Engage is available on PCs and mobile devices alike, the HMD app was opted for to explore students' perceptions of and experiences with VR alongside the challenges encountered, with a view to inform potential classroom usability. All members except for one teacher accessed Engage using free accounts that were anonymised to protect students' privacy. A pre-questionnaire administered to the students before the start of the study revealed that most of them knew little about VR, had not experienced a virtual environment using HMDs, and had not created an avatar.

The seven participants met online over Engage at weekly intervals during a university term that lasted from April to June 2021 (Figure 1). The first VR session was partly dedicated to training students on using the HMDs and navigating Engage. The students were then asked to explore any free VR apps they could find. Given the educational orientation of this research, they were encouraged to look for apps connected to their academic discipline (economics, engineering, sociology, politics) or those they found of interest. Each time before meeting in VR, the students filled out a survey that asked them to review VR apps of their choice in terms of purpose, functionality, educational usage, difficulties, and so forth. Following that, each student presented the app(s) they found during the Engage meetings in reference to the aforementioned items. This weekly activity led to a list of VR apps with an educational focus recommended by the students.

This study utilises multiple sources of data: (1) online reviews of VR apps by the students, (2) teacher observations of the VR meetings, and (3) focus group interviews with the students. The data was analysed following the principles of 'exploratory practice' (Allwright, 2003; Hanks, 2017), where teacher and student participants worked together to gain a deeper understanding of the potential and constraints of VR for education. The data collected each week and the reflective journal kept by the teachers formed the basis of the upcoming tasks and activities and guided the ongoing process of exploratory practice as reported in this concise paper.

Figure 1. Weekly meetings in various VR locations in Engage (all names hidden to protect privacy)

Results

In this section, preliminary answers are given to the four research questions:

1. What are the perceptions of university students regarding the benefits and challenges of VR?
In general, the students had a positive attitude toward their experience with VR and thought of it as enjoyable and stimulating. VR experiences involving physical activities such as games were the most engaging and immersive for the students, but they perceived a lower 'sense of presence' (Slater & Sanchez-Vives, 2016) associated with VR activities that replicated the real world and involved minimum movement and interaction, such as listening to a talk in a virtual lecture hall. According to the participants, one of the benefits of VR was the ability to stay on task and avoid distractions thanks to being cut off from the surrounding environment. Another advantage of VR environments mentioned by the students (also applicable to Desktop VR) is the existence of avatars which can have a lower affective filter compared to face-to-face and video-chat interactions, and this may eventually lead to improvements in communication skills. Despite these benefits, all the participants suffered from some degree of physical discomfort caused by exposure to VR, otherwise known as 'cybersickness' (Rebenitsch & Owen, 2016). The participants, to some extent, felt dizzy or nauseous after using some VR apps. One other concern voiced by the students was the difficulty of wearing HMDs with glasses on, which led to increased pressure on the user's face and eyes, especially after prolonged use.

2. What type of VR apps can students find and explore on their own?
The students found and tried out a total of 18 VR apps from a variety of genres such as games, immersive documentaries, and social VR apps. They found it rather easy to find apps for entertainment, but it was more challenging to find those that were related to their academic discipline and interests. Apart from using VR apps as mere consumers, some students expressed their willingness to create their own VR content by using 360-degree images and videos, somewhat similar to the immersive documentary apps they had discovered.

3. What kind of learning affordances can iVR environments provide for?
Regarding the apps explored and reviewed by the students, they were asked to give presentations on their potential usage in educational settings during the final VR meeting hosted in Engage. Several suggestions were made, including the potential of some apps for empathy training, team building and collaboration, as well as content knowledge acquisition. This task in itself was a way to explore the potential of the Engage VR platform for use in formal educational settings since it has tools such as a 3D whiteboard or pen that are not accessible in a face-to-face classroom. Despite the positive opinions on the potential of VR for learning, concerns were raised regarding the physical discomfort caused by lengthy exposure to HMD-powered VR if it were to be adopted across all or most classes.

4. What pedagogical and logistical challenges can arise when incorporating iVR into education?
From a pedagogical perspective, there are not as many VR apps created for educational purposes, and most of those available for download on standalone HMDs are not free. This scarcity is partly due to the fact that these devices are more often marketed for gaming and entertainment, and many more apps have been developed in that direction. In addition, VR app stores such as the Oculus Quest Store have quite high standards for allowing developers to make their apps available through those stores; as a result, the VR apps available on official online stores represent only a selection of what has been actually developed. This issue can limit the extent to which educators could adapt these technologies into their teaching practice.

From a logistical view, the financial problems of purchasing and managing HMDs for a class/school size of users can hinder individual teachers or institutions from implementing educational VR projects. Furthermore, as mentioned above, most legitimate educational apps are paid and some may need institutional accounts to make the most of their learning affordances. For instance, the Engage app used in the current study allows for on-demand content creation and persistent VR session creation only in the presence of an institutional account with high annual costs. Another concern is student privacy and user data collected by tech companies, in light of the fact that HMDs like the Quest 2 require all users to have personal Facebook accounts linked to their device. Given the positive and negative sides of this preliminary attempt at using VR in education, the discussion points and ideas for future directions have been summarised in the following section.

Discussion and Future Directions

Although still in an initial stage, there are several lessons learned and the pedagogical implications derived from this study could be of interest to other researchers and educators. First, in line with the findings of previous studies, the student participants generally felt engaged through exposure to VR and found it a rewarding addition that can encourage exploratory and self-directed learning. This observation can be partially attributed to the novelty of the experience, meaning that most students first welcome VR-enhanced learning, but once the novelty of the experience wears off and they familiarise themselves with VR, they may not be as engaged; thus, similar to what Alizadeh and Hawkinson (2021) have observed, it is important to make an informed decision regarding the type of activities to be carried out in VR and task timing. Second, teachers should actively and carefully monitor the amount of time students spend in virtual learning to ensure a healthy learning environment that does not impose physical discomfort to learners (Southgate, 2020). Third, it seems that VR can help learners to be more effective communicators in collaborative situations by representing them as avatars and thus lowering their communication apprehension, also reported by York et al. (2021) as well as Yoshimura and Borst (2020). Through supporting students to actively participate in discussion and to take part in creative activities such as learner-led content creation, VR seems to be a useful medium for enhancing higher order thinking and communication skills. Lastly, technological requirements should be taken into account when using VR with learners. A secure network environment is necessary for learners to access apps without experiencing connectivity issues.

These initial insights and field observations collected from the teacher and student participants have shaped the next stage of this ongoing research. For the second phase, the teacher researchers have already started experimenting with other apps that do not pose the technological and physical hurdles experienced in the initial phase of the study. In particular, they are interested in exploring desktop VR apps that allow for optimal levels of immersion and have educational value. To this end, they have started utilising Mozilla Hubs (https://hubs.mozilla.com/), a browser-based VR platform accessible on a range of devices from PCs to smartphones and HMDs. They plan to use Mozilla Hubs for showcasing student projects where each student creates their own Hubs room to explore and present an aspect of their academic field in VR. Unlike Engage where creating persistent spaces was a problem, in Mozilla Hubs it is possible to create private VR spaces and to occupy the space with various assets, such as images, videos, and 3D models. Once created, a VR room remains open unless closed by the creator and can be edited using a related online tool called Spoke (https://hubs.mozilla.com/spoke). So far, the students have learned the basics of the platform, and some have begun creating their own Hubs rooms (Figure 2). The major challenge most of them are struggling with is the high computational load on their computers after accessing Hubs which causes connectivity and audio problems.

Conclusion

This study is an initial attempt at using VR in an educational setting. Following an 'exploratory practice' approach, a group of two teachers and five students explored VR apps available for Quest 2 HMDs by reviewing and presenting on them during weekly meetings conducted on a VR platform called Engage. This joint activity helped the teachers to better understand students' views and perceptions of VR and resulted in compiling a list of VR apps that could have potential value for use in formal and informal learning contexts. During focus group discussions, the students shared what they believed to be the benefits and challenges associated with VR and warned against the physical discomfort HMDs could cause such as cybersickness. This co-investigation led to the next phase of the study, where the group has started using a cross-platform VR app called Mozilla Hubs (accessible on PCs and HMDs) to have the students introduce an aspect of their academic discipline.

Figure 2. Landing scenes of two student-created rooms in Mozilla Hubs

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