JoTL Journal of Teaching and Learning in Higher Education

2024: Vol. 5, Nr 2
doi: 10.24834/jotl.5.1.1141

VIRTUAL REALITY IN ONLINE INSTRUCTION: A PILOT STUDY ON LEARNING EXPERIENCES

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Abstract

Online instruction has become increasingly common as an alternative to face-to-face instruction (Crawford-Ferre & Wiest, 2012; Maertens et al., 2016; Ananga & Biney, 2017). One benefit with online instruction is that it is more easily accessible for students who are not able to fully access the more traditional face-to-face instruction on campus. After the Covid-19 pandemic, online instruction has gained further ground (Zhu & Liu, 2020; Kerres & Buchner, 2022; Li et al., 2022). At the same time, we have seen a rapid increase in new educational technologies, including that of virtual reality (Ding & Li, 2022; Al-Ansi et al., 2023; Zhang et al., 2022). Studies show that virtual reality (VR) can make the learning process more engaging and interactive (Jackson & Fagan, 2000; Ardiny & Khanmirza, 2018; Roopa et al., 2021) and that it can increase reception levels and train collaborative skills (Isik-Ercan et al., 2010; Petersen et al., 2023). This paper raises the question of how the use of virtual reality in online instruction affects learning experiences. While the participants in the pilot study displayed a genuine enthusiasm for using VR in an online setting, results showed a lack of knowledge in how to use VR to improve student learning. One area of investigation was concentration. Here, results were inconclusive as 50 % of the participants in group 1 (G1) were unsure of whether VR improves concentration, while 50 % of the participants in group 2 (G2) claimed that the use of VR does improve their concentration level. Another area of investigation was understanding the topic. The participants from G1 gave higher ratings than those who performed the experiment in G2, which implies that the impact was not as great as expected. In fact, the participants in G2 found that the VR equipment shifted

focus from learning to other details in the visual medium. Another area was interactivity. Here, results indicated that VR technology has the didactic potential of engaging students and making them more interactive in the learning situation. The study concludes that while VR technology has the possibility of enhancing learning, a prerequisite is that both students and teachers have the skills and knowledge of how to use VR technology in a pedagogical setting; furthermore, a few technical modifications to the device itself are required.

Keywords: Online instruction, Online learning, Virtual reality, Immersive learning experiences

Sammanfattning

Undervisning online har blivit allt vanligare som ett alternativ till campusundervisning (Crawford-Ferre & Wiest, 2012; Maertens et al., 2016; Ananga & Biney, 2017). En fördel med undervisning online är att den är mer lättillgänglig för studenter som inte fullt ut har tillgång till den mer traditionella undervisningen på campus. Efter pandemin har undervisningen online vunnit ytterligare mark (Zhu & Liu, 2020; Kerres & Buchner, 2022; Li et al., 2022). Samtidigt har vi sett en snabb ökning av ny utbildningsteknologi, inklusive virtual reality, VR (Ding & Li, 2022; Al-Ansi et al., 2023; Zhang et al., 2022). Studier visar att VR kan göra inlärningsprocessen mer engagerande och interaktiv (Jackson & Fagan, 2000; Ardiny & Khanmirza, 2018; Roopa et al., 2021) och att den kan öka mottagningsnivåer och träna upp samarbetsförmåga (Isik-Ercan et al., 2010; Petersen et al., 2023). Denna pilotstudie väcker frågan om hur användningen av VR i onlineundervisning påverkar lärandeupplevelsen. Medan deltagarna i studien visar en genuin entusiasm för att använda VR i en onlinemiljö, visar resultaten på en brist på kunskap om hur man använder VR för att förbättra studenters lärande. Ett undersökningsområde är koncentration. Här visar resultaten att 50 % av deltagarna i grupp 1 G1 är osäkra på om VR förbättrar koncentrationen. och 50 % av deltagarna i grupp 2 G2 hävdar att användningen av VR förbättrar deras koncentrationsnivå. Ett annat undersökningsområde är att förstå ämnet. Här gav deltagarna från G1 högre betyg än de som utförde experimentet i G2, vilket innebär att påverkan inte var så hög som förväntat. Faktum är att deltagarna i G2 fann att VR-utrustningen flyttade fokus från lärande till den tekniska utrustningen. Ett annat område som studien tittar på är interaktivitet. Resultaten visar att VR har stor didaktisk potential när det gäller engagemang och samarbete i lärandesituationer. Studien drar slutsatsen att VR-teknik har möjlighet att förbättra lärande, men att det samtidigt är en nödvändig förutsättning att framför allt lärare har kunskap om hur VR-tekniken kan användas i en pedagogisk miljö.

Nyckelord: Onlineundervisning, Lärande online, Immersiva lärandeupplevelser

Introduction

Online instruction provides accessibility and flexibility and can be useful in providing learning opportunities for those who cannot otherwise access educational institutions (Ilgaz & Gulbahar, 2017). In student preferences for online learning, the value of "learning anytime" goes hand in hand with individualized time management and individual responsibility (Luo et al., 2011; Ilgaz & Gulbahar, 2017). In recent years, many reputed institutions have started offering courses online as a complement to more traditional campus courses (Caruth & Caruth, 2013). With the onset of the Covid-19 pandemic and the increasing demand for online learning, online instruction has expanded even further (Zhu & Liu, 2020; Kerres & Buchner, 2022; Li et al., 2022). Besides further expanding educational accessibility, this trend has led to an increasing demand for new technologies and tools used to facilitate online learning. While online learning encompasses a myriad of opportunities, there are also known drawbacks. Some of the major challenges faced by students in online learning include digital fatigue and lack of social presence (Enomoto, 2016). As self-cognition and the learning environment are closely related to learning concentration, student concentration levels in online learning have become a concern (Xinran, 2020; Lee et al., 2022). In this study we examine learning experiences when using VR in an online setting. It seeks to complement studies that show that VR technology can make learning more engaging and interactive (Ardiny & Khanmirza, 2018) and that visualization can help increase reception levels (Isak-Ercan et al., 2010). Although small in scope, the study aims to shed light on matters related to understanding the topic and to give insights into concentration when using VR in an online learning setting.

Key terms

Online learning

Online learning, also referred to as distance learning or distance education, can be described as instruction between a teacher and students separated by physical distance, where communication is accomplished by one or more technological media (Simonson et al., 2019). While some researchers support the interchangeable use of the terms online learning, distance learning, e-learning, and distance education, it is important to acknowledge their differences as well as the fact that they have taken on various meanings and different definitions over time (Saykili, 2018). One difference is that distance learning and online learning are often referred to as ability to learn at a distance or online, while distance education is more often referred to as an activity (Moore et al., 2011; Saykili, 2018). For the sake of simplicity, however, we will use the terms interchangeably, albeit preferring online learning. While doing so we nevertheless acknowledge that their specific characteristics are of central importance when designing and evaluating similar learning environments.

Online learning has a history of access beginning in the 1980s, whereas another term, referred to as e-learning, does not have its origins fully disclosed (Harasim, 2006; Jonassen et al, 2008). During this period, there were significant changes in how learning occurred and was communicated (Jonassen et al., 2008). In its early stages, distance education was described as an industrialized form of teaching and learning (Peters, 2005). From this perspective, it is a method of imparting knowledge, skills and attitudes that is rationalized by the application of division of labor and organizational principles as well as by the extensive use of technical media (Keagan, 1980). Given these characteristics, high-quality teaching material can be reproduced and reach a great number of students simultaneously, regardless of place

(Keagan, 1980). Once considered as a non-conventional approach and delivery method compared to campus-based education, online instruction has now become a mainstream form of education (Saykili, 2018).

Virtual Reality (VR)

Virtual reality is not a new technology. The core of VR existed already in the early 1960s, and a systematic discussion of VR was firmly established by the early 1990s (Ding & Li, 2022). It is only in recent years, however, that we have seen a surge in the development of VR technological devices along with the emergence of affordable VR headsets. As a result, VR has spread in educational settings, with teachers and researchers paying attention to it for instructional purposes (Huang et al., 2019).

Virtual reality has been defined as a model of the real world that is maintained in real time (Boyd & Koles, 2019) and which can be defined by its use of complex technology to form synthetic stimulation to replace real-world sensory information (Ding & Li, 2022). The user can both hear and feel the virtual reality at the same time as s/he can manipulate it directly and realistically. The user is in that sense *immersed* in the virtual reality. Boyd & Koles (2019) describe virtual reality as formed by interactions between individuals or groups that take place based on an online contact – a contact without physical presence. It should be noted, however, that the development of modern technologies facilitates communication and subsequent interaction of individuals or groups in virtual reality without the need for the participants to be congregated in a particular place at the same time.

VR technology consists of a virtual environment generator and a human-machine interface (Liu et al., 2019). As an output device of the system, the virtual environment generator includes a head-mounted display, stereo glasses, and naked-eye 3D used to create a multidimensional virtual environment that gives users a sense of immersion. The human-machine interface consists of a sensing device and a tracking device, according to Liu et al., 2019. The user manipulates the virtual environment through the human-machine interface, and the virtual environment can also provide real-time feedback to the user through this human-machine interface, realizing the interaction between the user and the virtual world. Ding & Li (2022) argue that VR can provide students with teaching aids that are closer to real-life rich and diverse personalized learning environments. This statement is supported by Ryan (2015), who argues that although the application of VR technology in education is not new, the development of VR technology in visualization and interaction in recent years has made educational application of the technology more attractive, especially in higher education.

Compared with traditional education, the vast majority of studies show that the use of VR for educational purposes has had positive effects: firstly, affecting student behavior, which in turn affects learning results; secondly, by affecting students' cognition; and thirdly, by affecting students' learning (Ding & Li, 2022; Lin & Yu, 2023; Qureshi et al., 2023; Timotheou et al., 2023). The advantages discussed can be divided into three categories of concentration: immersion, interactivity, and imagination (Ding & Li, 2022). While immersion helps build a realistic virtual environment, the concept of interactivity suggests that when students perform operations in VR, the environment will give them corresponding feedback, which can deepen students' impression of the classroom and enable them to master knowledge more efficiently (Ding & Li, 2022). This means that students may gain a deeper understanding of related issues according to their own senses, cognitive methods, and cognitive ability in the simulated VR

environment. This, in turn, can expand innovative thinking and effectively enhance student creativity and imagination (Ryan, 2015; Ding & Li, 2022).

Aim and Research Objectives

The main aim of this study is to explore the effects of using VR in an online learning environment. We have limited our scope to understanding learning experiences. To achieve this, a research question was formulated as follows: *How does the use of virtual reality affect learning experiences in an online setting?* In exploring this question, we focus on aspects of concentration, understanding the topic, and interaction.

Method

To gather empirical data, we composed a survey (questionnaire) and performed experiments. Participants were divided into two groups: one group consisting of fourteen (14) participants (subsequently referred to as G1) and one group consisting of four (4) participants (subsequently referred to as G2). The participants in G1 were asked to answer only the survey, whereas the participants in G2 were asked to participate in an experiment before filling in the survey. The purpose of this set-up was to use G2 to validate and compare results with G1. Both sets of participants consisted of teachers and students. G2 was composed of two (2) teachers and two (2) students, whereas this distribution was unknown for G1 as the survey was sent to many, and the identity of the respondents was anonymous. Only participants with VR experience were asked to participate in the study. This helped in getting insightful answers from G1, and in G2 we wanted to avoid the uneasiness and other effects of using VR for the first time, which may have impacted the results.

The experiment and survey were designed to study the effects of VR on the learning experience and to understand the users' perspectives. For the experiment, we chose a video on climate change. Two different teaching methods were chosen: a video illustration (representing the traditional teaching method)[1], and a 360° video in a VR format[2]. Zoom and Meta Horizon Workrooms, a virtual classroom in VR, were used as a medium to communicate with the participants in a simulated distance environment. In the first part of the experiment, the participant was presented with a video illustration on the selected topic of climate change. After that, a topic from the selected area of study was presented in a VR setting. The experiment was followed by a survey with both qualitative and quantitative questions. The online learning environment was simulated at Blekinge Institute of Technology (BTH) in the spring semester of 2023. During experiments, the participants and organizers of the experiments were separated from each other and placed in different rooms.

[1] https://www.youtube.com/watch?v=dIsjcG7hTmo and https://www.youtube.com/watch?v=eZZSzq3WvSs

[2] https://climate.nasa.gov/explore/earth-360/ and https://www.youtube.com/watch?v=G0N7WFl6lbE

Participants

Voluntary participation of the students and teaching faculty at BTH was sought for the study. Information about the study and the need for volunteers was spread by word of mouth and e-mail. Information about the purpose of the study, the nature of the experiment, and how responses would be handled was provided. Participants were given a consent form along with safety instructions[3] for using the VR device, which they needed to read and sign before conducting the experiments. A total of 14 respondents answered only the survey and 4 participants (2 teachers and 2 students) took part in the experiment before answering the survey. All responses from the survey were handled in a manner which secured participants' confidentiality.

Experiments

Only the participants in G2 took part in the experiments. The first part of the experiment was done in Zoom. Two 2D videos related to the area of climate change were selected. An introduction about the experiment was given before we proceeded by playing the selected videos. This was followed by a brief interaction on Zoom where the general experience of the participant was discussed. The next step was conducting the experiments using the VR headset. The Oculus Quest 2 VR headset from Meta was used in the VR part of the experiment along with Meta Horizon Workrooms and YouTube VR. An initial overview was given in Meta Horizon Workrooms, where both the participant and instructor entered as avatars. This was followed by viewing two 360° videos on YouTube VR. Finally, a short interaction was performed in Meta Horizon Workrooms, which concluded the experimentation element.

Survey

As stated before, the first set of participants only answered the survey, while the second set answered the survey after performing the experiment. Two different survey forms with the same questions (see Table 1, Appendix) were created and used to collect the responses from these two groups separately. The survey consisted of both quantitative and qualitative questions. After completing the experiment, insights into the participants' perspectives regarding taking part were also obtained in the discussions.

Results and discussion

In this section, we analyze the results of the survey answered by the 14 participants in G1 as well as the validation group of 4 participants in G2. 100% of the participants from both groups had previous knowledge of VR, in line with our expectations. Although we included both quantitative and qualitative measures in our study, we realize that the questionnaire contains many Yes/No questions, and that there is an underlying positive inclination towards VR. As this may have affected our results, it has been considered in our analysis.

[3] https://www.meta.com/be/en/legal/quest/health-and-safety-warnings/

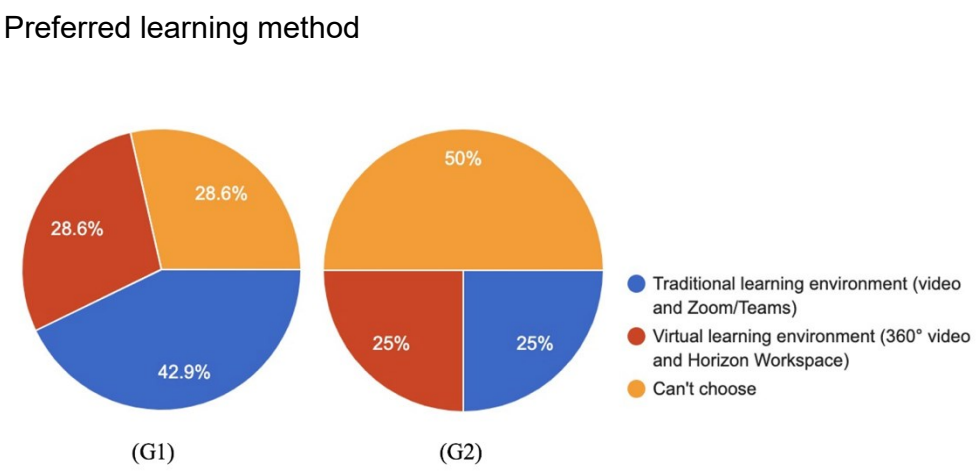


Fig. 1 Learning method preferences for different participants of each group.

From Figure 1, we can see that a high percentage of the participants (42.9 %) from G1 preferred a traditional learning environment, whereas in G2, 50 % could not choose one method over the other. A few of the participants in G1 stated that they had not used VR in a learning situation. Yet, their qualitative responses highlighted the positive aspects of VR, focusing primarily on matters of immersivity and versatility. The participants believed that VR allows for deeper learning experiences, higher levels of concentration, and a sense of social presence. But in their answers, they also raised issues concerning the fact that VR technology is not fully ready for pedagogical use. Participants in G1 also asserted that online learning through platforms such as Zoom is quite enough to engage students in learning. Based on their prior experience, some participants in G1 also stated that VR can be quite exhausting to use. In G2, 50% of participants claimed that they lost concentration when using VR since the 360°effects made them focus on the immersion into the virtual reality itself rather than listening to the information provided. However, participants did prefer the interactions in VR Horizon Workrooms over Zoom. Most participants preferred a combination of both traditional and virtual learning environments. At the same time, they thought that VR was more suitable for entertainment. In general, participants described VR technology as refreshing although it occasionally gave them a headache.

Interactions

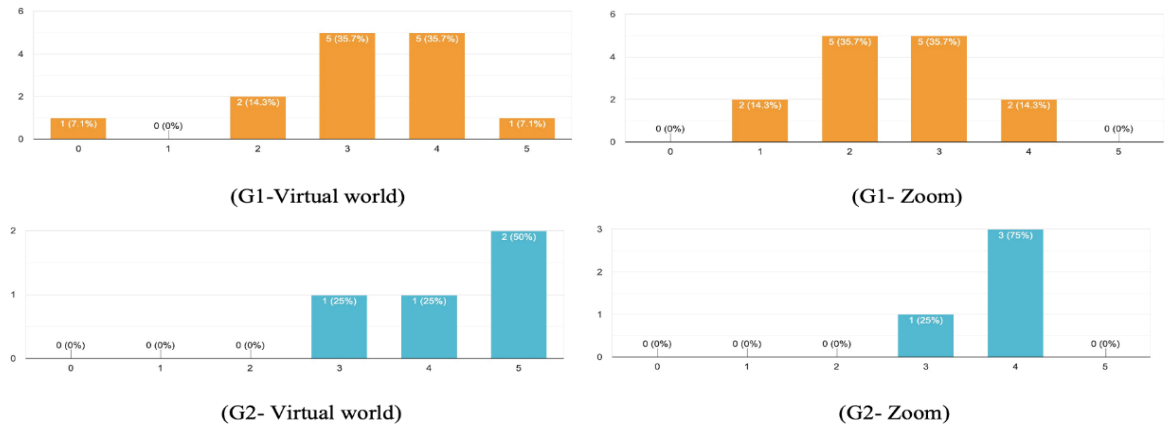


Fig. 2 Scores given to interaction in both the virtual world and zoom for both groups

In Figure 2, we can see that a high percentage of participants from both groups gave higher scores for interaction in the virtual reality compared with Zoom. It should also be noted that 50% of participants in G2 gave interaction in the virtual reality the highest rating of 'Yes'.

When asked if they preferred interacting in virtual reality over Zoom or Teams, 50% of the participants in both groups answered that they preferred interactions in virtual reality. None of the participants of G2 answered "No," whereas for G1 the figure was 14.3%, which shows that the experiments might have impacted their answers. Based on the overall responses, the participants expressed uncertainty concerning VR as an interactive distance learning method. One participant in G2 wished that more people had joined Horizon workrooms during the experiment for a more authentic virtual classroom environment.

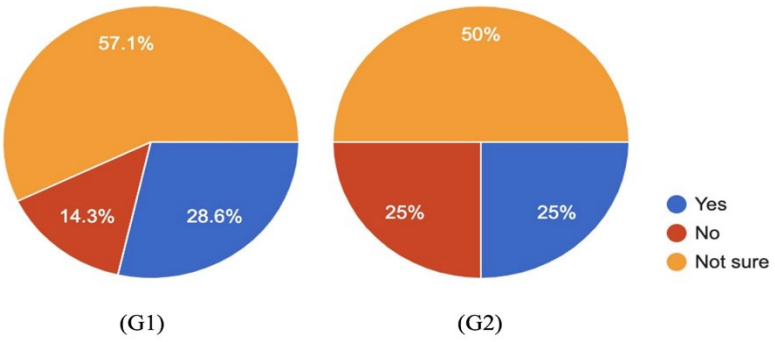


Fig. 3 Responses to the question whether it was easier to communicate in the virtual world compared to Zoom/Teams.

Figure 3 addresses the question of whether the participants experienced that it was easier to communicate in the virtual world compared to Zoom or Teams, or not. While the majority of the participants (57.1% of G1 and 50% of G2) expressed uncertainty, approximately 25 % of participants

from G2 thought that this was not the case. This may imply that VR is not more efficient than traditional means of communication in online learning. Comments given by participants in G1 show that it was easier for the teacher to see that the students raised their hands in VR compared with Zoom/Teams. Comments also highlighted that VR gave a possibility to express oneself in other ways than merely through words and pictures. It was also stated that VR is more anonymous. While some participants found anonymity to be positive, others felt the opposite. Participants in G2 pointed out that VR and Zoom/Teams are equally user-friendly, but it is difficult to use some tools (e.g. a hand tool to write) in VR.

Based on the responses of participants to whether they can sense another person's emotions better in the virtual world compared to Zoom/Teams, we can conclude that the general opinion was that emotions are not easily detected in VR. Only participants of G1 (28.6%) answered 'Yes' to this question. Both groups agreed that the virtual world's representation of emotions is not sophisticated and that seeing another person's face on Zoom/Teams provides better access to emotions.

Concentration and understanding

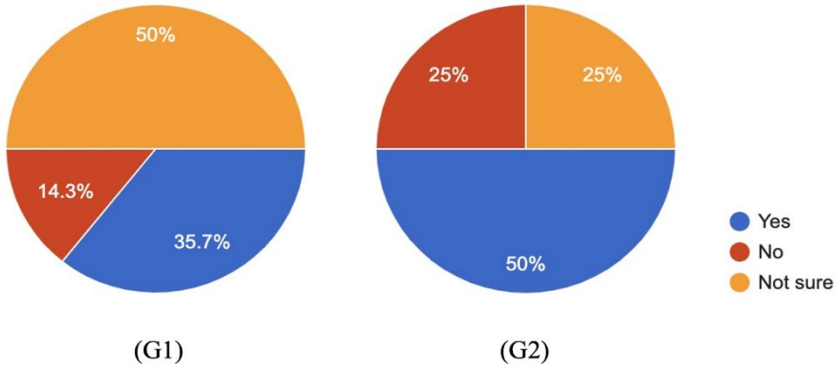


Fig. 4 Responses to the question whether VR improves concentration levels.

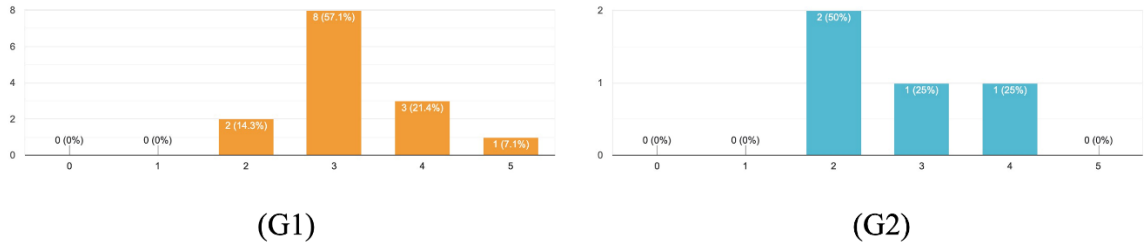
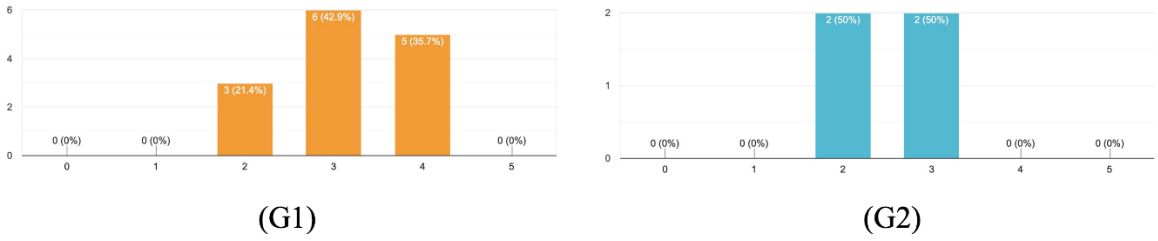


Fig. 5 Responses of rating the effectiveness of using VR for improved concentration.

From Figure 4 we can conclude that 50% of participants of G1 are uncertain whether VR improves their concentration. The same percentage (50%) from G2 are of the opinion that VR improved their concentration. It is worth pointing out that the majority of participants (57.1%) in G1 gave a score of 3,

whereas 50% of G2 gave a score of 2 (see Figure 5). Based on the qualitative responses of G2, it can be interpreted that even though the overall VR experience was engaging, the participants can deviate from the real motive due to the vast amount of information available to be explored. One reflection given by participants in G1 was that VR could be particularly useful for more introverted students. Because VR is more interactive, it could also promote student activity and higher concentration levels since students may be less distracted by matters outside the learning process.

Other reflections from the two groups were quite similar and yet somewhat contradictory. For instance, one reflection was that there is more distraction in VR due to the vast amount of information available in this virtual world. At the same time, you must concentrate more in VR, to the extent that it may give you a headache. Because of that, more breaks are necessary when using VR.

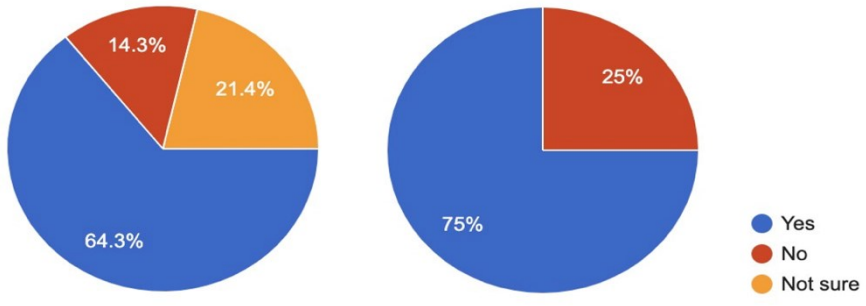


(G1) (G2)

Fig. 6 Responses of rating effectiveness of VR video experience in helping to understand the topic.

Most of the participants in G1, who did not participate in the experiment, believed that the VR video experience can help them in understanding the topic because of its proximity to real life. Interestingly, this opinion was not shared by participants in G2, who did participate in the experiment (see Figure 6).

Tiredness and eye strain



(G1) (G2)

Fig. 7 Responses of whether the participant feels tiredness after using the VR device.

From Figure 7 we can see that the majority of the participants from both groups felt tired after using the VR device (the answers from G1 are based on their prior experience with VR). It should be noted, however, that none of the participants in G2 selected “Not sure.” This could be due to less experience

with using the device, which in turn shows that the participants who performed the experiment were more certain in their answers. The qualitative responses from both groups were similar. Some claimed that they felt dizzy and nauseous and that the device was heavy and uncomfortable.

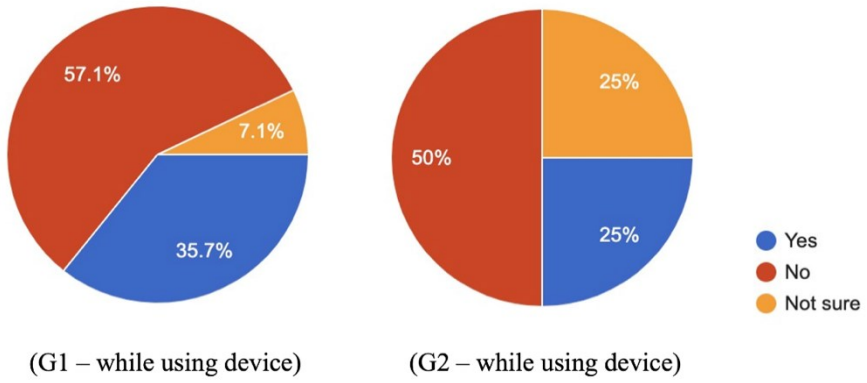


Fig. 8a Responses to the question whether the participant has any eye strain, while and after using the device.

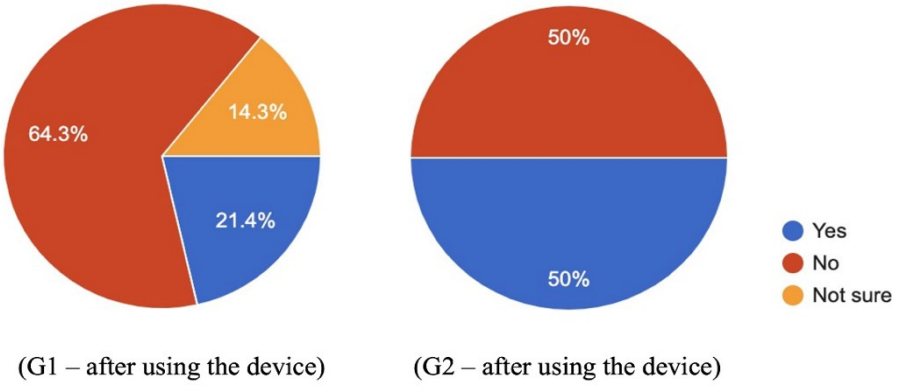


Fig. 8b Responses to the question whether the participant has any eye strain, while and after using the device.

Figures 8a and 8b show the statistics of whether the participant experienced eye strain while or after using the device. In the first case (while using the device), the majority said they did not feel any eye strain. While the majority of G1 did not experience any eye strain after using the device, G2 was more divided. The main reason for eye strain was blurry vision and the lack of the possibility of wearing their prescription glasses while using the device (due to the positioning of the device). A few participants pointed to the amount of time spent in the session as a possible source of eye strain.

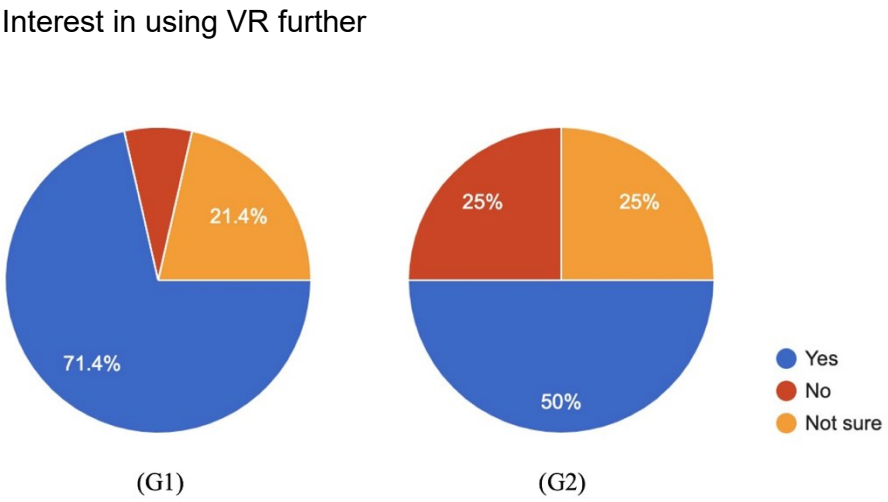


Fig. 9 Responses to the question whether the participants would like to use VR for extended self-study.

The majority of participants from both groups (see Figure 9) stated that they would be interested in using VR for an extended self-study; the number may have been even greater if there had been fewer after-effects and if the device were more easily accessible. After-affects included tiredness (64.3% of G1, 75% of G2) after using the VR device and eye strain (21.4% of G1, 50% of G2).

As regards the questions pertaining to their interest in attending distance courses using VR and whether they think VR should be incorporated into distance education, 85.7% of G1 and 75% of G2 agreed, while the rest were not certain. No one gave a negative answer. This indicates that participants are positive with regards to introducing VR in an online learning setting. Some of the participants thought that it could be a good complement to traditional tools and that it could provide a real-life experience, while others expressed concern about costs and showed an interest in using the technology only for special purposes.

Conclusions

With the increasing demand for new technologies and tools used to facilitate online instruction, we will continue to see a surge of new ways of interactivity and engagement. Although small in scope, in this study we have shown how virtual reality can impact the learning experience in an online learning setting. We have done so by exploring questions concerning concentration, understanding the topic, and interactivity. While the participants in the study displayed a genuine enthusiasm for using VR in an online setting, results show a lack of knowledge in how to use VR to improve student learning and that the VR equipment shifted focus from learning to the technical aspect of the equipment. While VR technology has the didactic potential of engaging students and making them more interactive in the learning situation, thus increasing the possibility of collaboration and enhancing learning, a prerequisite is that both students and teachers have skills and knowledge of how to use VR technology as a pedagogical tool.

What we will see in the coming years is a rapidly developing VR technology which is not only more affordable (Harrington et al., 2018) but more user-friendly and that may reduce some of the technological challenges related to usability. In future work, it would be productive to investigate the ways in which VR technology can interrelate and grow in pedagogical settings with other emerging technologies, such as AR (Augmented Reality) and AI (Artificial Intelligence). A particular area of interest is how positive aspects such as social presence and concentration, in contrast to the described disadvantages of VR technology in education, can be strengthened and sustained in online learning with the use of these emerging technologies.

Acknowledgments

Devagiri, V. M.'s research is partly funded by the Knowledge Foundation, Sweden, through the Human-Centered Intelligent Realities (HINTS) Profile Project (contract 20220068).

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Appendix

Table 1 Questionnaire

S.no	**Question**	**Type of Answer**
1	Do you have previous experience of using VR?	Yes or No
2	Which is your preferred learning method in distance learning?	Traditional learning environment or Virtual learning environment or cannot choose
3	Why do you prefer the previously selected method (traditional or virtual environment) over the other?	Qualitative
4	How do you rate the student-teacher interaction in the virtual world?	Range
5	How do you rate the student-teacher interaction in Zoom/Teams?	Range
6	Would you prefer having interactions in the virtual world over having them in Zoom/Teams from the perspective of distance education?	Yes or No or Not Sure
*	Would you like to comment on anything concerning student-teacher interaction in VR compared to Zoom/Teams?	Qualitative

7	Is it easier to communicate in the virtual world compared to Zoom/Teams?	Yes or No or Not Sure
*	Would you like to comment on anything about your choice above?	Qualitative
8	Do you think you can sense the other person's emotions better in the virtual world compared to Zoom/Teams?	Yes or No or Not Sure
*	Would you like to comment on anything about your choice above?	Qualitative
9	Do you think using VR improves your concentration levels?	Yes or No or Not sure
10	How do you rate the effectiveness of using VR concerning the improvement of your concentration?	Range
*	Would you like to comment on anything concerning concentration impact?	Qualitative
11	How effective was the VR video experience in helping you understand the topic in comparison with the traditional video?	Range
12	Do you feel any sort of tiredness after using the VR device?	Yes or No or Not sure
*	If yes in the previous question, would you like to comment?	Qualitative
13	Do you feel any eye strain while using the device?	Yes or No or Not sure
14	Do you feel any eye strain after using the device?	Yes or No or not sure
*	Would you like to comment on anything regarding number 13 and/or 14?	Qualitative
15	Would you like to use the VR device for an extended self-study session on distance?	Yes or No or Not sure

16	Would you like to attend distance courses conducted in the virtual world?	Yes or No or Not sure
17	Do you think VR should be introduced in distance education?	Yes or No or Not sure
*	If you answered yes in the previous question, why and to what extent would you like to have it incorporated?	Qualitative

Range 0-5; 0 - Not effective and 5 – Highly effective