EDULEARN24 : 16th International Conference on Education and New Learning Technologies, Palma, Spain. 1-3 July, 2024

VIRTUAL REALITY IN A SYNCHRONOUS CLASSROOM: A STUDY OF LEARNERS' IMMERSIVE EXPERIENCE IN THE APPLICATION OF HIVE AND META QUEST 3

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Abstract

Virtual Reality (VR) is a contemporary immersive approach to classroom learning. It has gained more and more applications in the teaching and learning landscape such as training students in the medical, healthcare, and aviation sectors. A study found that virtual reality improved medical students' learning motivation and learning competency (Sattar et al., 2019). More and more literature has also studied different outcome variables of virtual reality applications. However, limited research examines the effectiveness of adopting different modalities when projecting 360 videos in VR settings. Given the increasing application of Hybrid Immersive Reality Environment (HiVE) in teaching and learning, and the improved functions and affordability of wireless head-mounted devices, such as Meta Quest 3, this study aimed to explore learners' immersive experience by comparing their sense of presence among these modalities. Presence is "defined as the subjective experience of being in one place or environment, even when one is physically situated in another" (Witmer & Singer, 1998, p. 225). In a synchronous classroom environment, business school undergraduate students in Hong Kong were surveyed using a questionnaire to examine their sensation of being there. The results provide implications for the effectiveness of the application of HiVE and Meta Quest 3 in immersive virtual environments. Instructors can better utilize different modalities to design and develop pedagogical models to achieve students' learning outcomes and promote active learning.

Keywords: Active learning, higher education, Hybrid Immersive Reality Environment, immersive experience, Meta Quest 3, undergraduate students, virtual reality.

1 INTRODUCTION

With breakthroughs in computational powers and display graphics, immersive virtual reality (IVR) has become more affordable and gained greater attention for educational purposes (Matovu et al., 2022). Virtual reality (VR) is the "use of software to generate realistic images, sounds, and other sensations that represent an immersive environment and simulate a user's physical presence in this environment" (PolyU, 2024). For example, using the real-time motion tracking capabilities of IVR allows learners to become more aware of their embodied movement in a virtual training context such as handling dangerous chemicals in a lab (e.g., Broyer el., 2020) or operating on ill patients (e.g., Lohre et al., 2020). An academic subject of Human Anatomy offered by the School of Nursing adopted head-mounted devices with medical imaging software to demonstrate and manipulate human body parts in a virtual environment. There are numerous benefits of this application such as expanding the scope of teaching content and cost reduction in replacing traditional anatomy teaching aid materials (PolyU, 2024). Furthermore, a study also found that virtual reality improved medical students' learning motivation and learning competency (Sattar et al., 2019). In recent years, more and more literature has also studied different outcome variables of virtual reality applications.

Apart from the application of virtual reality in the medical, healthcare, and aviation sectors, using this contemporary approach to management skills training is on the rise. Instructors can design teaching and learning activities by creating real-life scenarios, such as an ethical dilemma or organizational values, presented by 360 videos to replace the traditional role-play or video-watching activities. The assumption is that VR may entice students to a higher concentration of their minds and brains while participating in the activities. Their presence in the scene through their involvement and immersion may elicit a higher engagement level to learn abstract content, followed by facilitated discussion. The design goal of this type of immersion lies in whether students have a feeling of connectedness and "being there" with the meaningful content presented. To operationalize their immersive learning opportunity, students can experience it in multiple ways. However, it is unclear which approach is best for learners. In this study context, we chose the Hybrid Immersive Reality Environment (HiVE), a 6-sided Cave Automatic Virtual Environment (CAVE), and wireless head-mounted devices (Meta Quest 3) for comparison.

Presence in VR and Synchronous Classroom

Both modalities offer learners an immersive experience in virtual reality. The experience can be examined using the concept of presence which is "defined as the subjective experience of being in one place or environment, even when one is physically situated in another" (Witmer & Singer, 1998, p. 225). To experience presence, the human state of both involvement and immersion is necessary. Involvement is "a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events" (Witmer & Singer, 1998, p. 227). In this study context, students received stimuli when they were listening to group presentations and watching 360 videos simulating themselves as a new joiner of the company on an orientation day. Their presence in the video scene in the VR settings and classroom may be affected by factors such as the head-mounted device being too heavy or the dizziness issue. On the other hand, if their involvement is high, they will be interacting with the environment described as a psychological state of being "enveloped by" or included in it. Very often, a helmet-mounted device is instrumental in providing this feeling of isolation, thereby, the learner will perceive oneself as moving inside or interacting in the simulated environment with a higher sense of presence (Witmer & Singer, 1998). Previous literature surveyed people after "fly-through" experiences suggested that their feelings of "being there" were correlated with comfort, presentation quality, and location information (Barfield & Weghorst, 1993). Although there are many factors underlie the concept of presence, such as sensory, distraction, or realism factors, this study did not intend to delve into the in-depth level of presence, but rather focused on their general involvement and immersive experience in two different modalities.

Given the increasing application of HiVE in teaching and learning, and the improved functions and affordability of wireless head-mounted devices, this study is a pilot test to explore learner immersive experience by examining their presence and engagement level among these two modalities. The results help instructors to better utilize different modalities to design and develop pedagogical models to achieve student learning outcomes and promote active learning.

2 METHODOLOGY

The methodology for this study involved a quantitative research design, with a sample of final-year Business school undergraduate students in Hong Kong. Forty-one students were studying in the academic year of 2023/24 in the subject of training and development. One of the key lecture contents is about the differences between traditional and technology-based (TB) training methods. To help students gain a more in-depth understanding of how TB training methods can enhance trainees' transfer of learning as compared to conventional approach, students were formed into project groups to develop an immersive learning experience presented in two different virtual reality modalities for further comparison. The project context of the immersive learning experience is about organizational culture in an employee orientation program. Therefore, students developed 360 videos that captured the spherical view of scenes in Hong Kong and the organizations.

At the end of the semester, each student group presented their orientation program to the whole class. Half of the class, around 20 students, presented their 360 videos projecting scenes of Hong Kong from the 6-sided CAVE, i.e., HiVE. Another half of the class watched the real-time presentation through Zoom and viewed the videos on Meta Quest 3 simultaneously at an Immersive Lab next door. Both groups of students are learning at the same time virtually facilitated by the instructor via this video conferencing tool. Students were required to evaluate each presentation and to fill in a survey. The survey was conducted immediately after they participated in the immersive experience ensuring that their vivid memory of their "sense of being there" was guaranteed.

The purpose of the survey was to investigate which modalities provide a better learning experience for the students in this form of synchronous classroom arrangement. There are 30 questions in the survey encompassing four key project components namely, HiVE, Meta Quest 3, video-making using 360 camera, and video-editing using the software of Adobe Premiere Pro. Students were asked about their agreement level with the statements using a five-point Likert scale, namely 1 = "strongly disagree", 2 = "disagree", 3 = "neutral", 4 = "agree", and 5 = "strongly agree". Open-ended comments about their project experience and reflection on whether immersive virtual reality can be applied in corporate training were obtained. Data were analyzed using the software of IBM SPSS Statistics version 27. Mean differences between the application of HiVE and Meta Quest 3 in the synchronous classroom were analyzed using paired samples statistics. Qualitative data in the open-ended questions were used to probe for a deeper understanding of students' views.

3 RESULTS

The survey was conducted in April 2024. The valid response rate is 95%. In general, among them, 95% of respondents "agree/strongly agree" that this project is useful to achieve the subject learning outcomes; 5% remained neutral.

> "It is because the project allows me to know how immersive learning can be applied in real-life training" (Student #37).
>
> "It is because the hands-on opportunities in the project provide us a brand-new experience to really get to use the technology and explore about it" (Student #39).

When comparing the two modalities and the question "My engagement in the virtual environment experience at HiVE and using Meta Quest 3 at the Immersive Lab are the same" was asked, 43.6% replied, "disagree/strongly disagree". "Neutral" accounted for 10.3% while "agree/strongly agree" contributed 46.1%. Some qualitative comments about their feelings of physical presence are extracted from the survey as below:

Table 1. Qualitative comments on the immersive experience.

Comments on "the experience is the same"	**Comments on "the experience is not the same"**
"Both modalities enabled VR experience!" (Student #5)	"The video at HiVE provides a more immersive experience as the space is much bigger" (Student #18)
"In both settings, I can feel I am immersed in the videos" (Student #17)	"In HiVE, the images projected on the wall are not as sharp and detail as compared to Meta Quest. Using Meta Quest, I feel more like I am immersed as a real person experiencing the environment. However, I have dizziness when the video moved too fast" (Student #20)
"I use the Meta Quest at the Immersive Lab and feel that I am as engaged as in the HiVE Lab" (Student #25)	"I prefer using Meta Quest since I can see the ground better and it is more immersive" (Student #23)
"Since both of them allowed me to immerse, I feel that I am really in the environment in the videos" (Student #27)	"In HiVE, we watched the videos together as a group and are in a confined physical space. In the lab, we watch the videos on our own" (Student #26)
"It is because I can view the 360 videos in both settings" (Student #29)	"It is because the physical environment is totally different. In HiVE, I can be more engaged with the presenters and instructor/facilitators in the same physical space (Student #35)
"It is because I can view the videos in 360 degrees, both of them are very attractive" (Student #31)	"The activities in HiVE and Meta Quest are similar but the immersive experience in HiVE is stronger" (Student #38)

A paired-sample t-test was conducted to compare students (as a trainee/learner) engagement level in the virtual environment (i.e., 360 video content) in HiVE and not in HiVE conditions (i.e., using Meta Quest 3). There was a significant difference in the scores for HiVE (M=4.44, SD=0.502) and Meta Quest 3 condition (M=3.82, SD=0.854); $t(38)=3.782$, $p = 0.001$. These results suggest that students were engaged more in HiVE as compared to Meta Quest 3.

> "In HiVE, I feel like I can explore more of the video with a wider lens" (Student #10)
>
> "This is because, in HiVE, I feel more involved in the environment. The experience in HiVE is more immersive. When using Meta Quest 3, it is like only my eyes are involved in the 360 videos. The degree of my engagement in the Immersive Lab is lower" (Student #36)

Furthermore, another paired-sample t-test was conducted to compare if students are looking forward to engaging their project/video presentation in HiVE and not in HiVE conditions (i.e., using Meta Quest 3). There was a significant difference in the scores for HiVE (M=4.26, SD=0.549) and Meta Quest 3 condition (M=4.03, SD=0.707); t(38)=2.300, p = 0.027. Although these results suggested that students are more looking forward to using the learning space in HiVE, both of the mean values are above 4.0 indicating their positive responses.

> "This opportunity allows me to actualize my role as a digital native and rethink about how to embrace the future" (Student #33).
>
> "I think this project allows me to learn more about the cutting-edge technology" (Student #35)

4 CONCLUSIONS

The above results suggested that both modalities are well-received by students. They indicated their high level of involvement and immersion at HiVE and Immersive Lab using Meta Quest 3 when watching the scene presented in the orientation program.

In terms of the synchronous classroom arrangement, the majority of the students preferred HiVE as they can interact with the presenters and the instructors. It is suggested that connectedness between students at the HiVE and Immersive Lab could be strengthened to enhance more meaningful exchanges in the future.

With regard to the design perspective, for activities that require students to be isolated and work alone on tasks that require fine details, wireless head-mounted devices will be more effective. However, video quality will impact on viewers' dizziness; learners' profiles such as age group should be carefully considered. On the other hand, HiVE offers an open space in the immersive environment as well as a physical space for learners to interact in person. Activities that emphasize the concept of connectedness, such as group-based tasks, are appropriate. All in all, this pilot study opens doors for instructors to develop creative teaching and learning activities to complement students' VR experiences for active learning.

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