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Article abstract

Recent research in the field of virtual reality (VR) education is dominated by the application, experience, and effectiveness of high-immersive environments. However, high-immersive VR may not be accessible to all learners, with online distance learning students in particular unable to fully engage without being supplied with appropriate accessories. These field notes shed light on the role of low-immersive VR as a desktop tool for online distance learning students, exploring student experience of using 360° virtual spaces to undertake a summative assessment. Primary data collection in the form of an anonymous online survey was employed to gather feedback from postgraduate environmental management students who used low-immersive VR to undertake an environmental management system audit of a university campus. Quantitative results were analysed using descriptive statistics and qualitative responses using thematic analysis. Findings indicated that with guidance from the academic teaching staff and practice using the software, the majority of students felt both prepared and happy to undertake a summative assessment using VR spaces. Skills development and an appreciation of the effectiveness of the assessment approach were also highlighted as positive outcomes reinforcing findings from literature on the value of VR to improve learning outcomes particularly with practical tasks. Limitations of the assessment content and software were however noted by students, but both could be resolved with adaptations to the tool. It is hoped this research will be valuable to online education providers to demonstrate the value of using low-immersive VR within their programmes.

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Using Low-immersive Virtual Reality in Online Learning: Field Notes from Environmental Management Education

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Abstract

Recent research in the field of virtual reality (VR) education is dominated by the application, experience, and effectiveness of high-immersive environments. However, high-immersive VR may not be accessible to all learners, with online distance learning students in particular unable to fully engage without being supplied with appropriate accessories. These field notes shed light on the role of low-immersive VR as a desktop tool for online distance learning students, exploring student experience of using 360° virtual spaces to undertake a summative assessment. Primary data collection in the form of an anonymous online survey was employed to gather feedback from postgraduate environmental management students who used low-immersive VR to undertake an environmental management system audit of a university campus. Quantitative results were analysed using descriptive statistics and qualitative responses using thematic analysis. Findings indicated that with guidance from the academic teaching staff and practice using the software, the majority of students felt both prepared and happy to undertake a summative assessment using VR spaces. Skills development and an appreciation of the effectiveness of the assessment approach were also highlighted as positive outcomes reinforcing findings from literature on the value of VR to improve learning outcomes particularly with practical tasks. Limitations of the assessment content and software were however noted by students, but both could be resolved with adaptations to the tool. It is hoped this research will be valuable to online education providers to demonstrate the value of using low-immersive VR within their programmes.

Keywords: virtual reality (VR), low-immersive, online learning, student experience, environmental management education

Introduction

The use of virtual reality (VR) technologies in education is increasing (Makransky & Petersen, 2019; Radianti et al., 2020), a growth which can be attributed to its value in enhancing both “learners’ cognitive skills” and their learning outcomes (Merchant et al., 2014). Indeed, Taçgın (2020) emphasised the value of VR learning environments, highlighting their scope for enhanced outcomes when compared to traditional learning techniques, as well as the benefits they afford in both active participation and experimental learning. VR technologies create “realistic learning contexts” (Wu et al., 2020, p. 1991) that can be either high-immersive or low-immersive (sometimes referred to non-immersive or desktop). The difference between the two is the extent to which users feel the environment and thus “the concept of spatial presence” (Ventura et al., 2019, p. 2). High-immersive VR uses a head mounted display to facilitate engagement and presence through panoramic video technology, whereas participants are observers in low-immersive VR and use a device such as a computer to access the virtual space (Repetto et al., 2018; Ventura et al., 2019). There are conflicting results on whether high or low immersion technologies achieve better learning outcomes for users. Makransky et al. (2019) for instance found that whilst “students felt a greater sense of presence when they used the high immersion VR [...] they actually learned less compared to the low-immersion version of the simulation on a desktop computer” (p. 233), though Webster (2015) found that higher immersion technologies increased learning outcomes.

Literature indicates that a range of research has been undertaken on the use of VR in instructional design methods of education but with a specific focus on high-immersive environments (Pellas et al., 2021). Suh and Prophet (2018) also reported an increase in scholarly activity on immersive VR technologies. Makransky et al. (2019) emphasised that this enthusiasm and attention towards high-immersive VR could be attributed to a number of factors including continued investment in technologies, business analyses, and popular reports. Pellas et al. (2021) further accentuated that the widespread access to computing devices lends itself to the application of user-centered learning experiences. However, the application of high-immersive VR may not be accessible to all learners, with online distance students in particular unable to fully engage in this experience without being supplied with appropriate accessories. Indeed, whilst it should be noted that universities do provide students with access to the technology required to use more immersive VR environments, many accessories are only available to collect on loan from their respective libraries. Other options such as cardboard VR headsets do provide an affordable alternative to view more immersive content, however, they have limited interaction capabilities which Powell et al. (2016) reported was not “conducive to active exploration of a virtual space” (p. 5). These field notes will therefore develop current understanding of online student experiences of low-immersive VR, a desktop technology which could be valuable for students studying remotely who do not have direct access to the specialist and often expensive equipment required for high-immersive experiences and require more media interaction than that afforded by cardboard headsets.

VR can be used to make student learning more practice orientated (Radianti et al., 2020) and is particularly valuable within online learning as students can undertake “real life activities” within a virtual world (Huang & Liaw, 2018, p. 92). Wu et al., (2020) reinforced this value and specifically identified studies on environmental issues that included “higher-order competence development, require[d] the integration of multisensory channels and high intensity of interactions during learning” (p. 1992), which can be facilitated

through VR. These field notes specifically explore online postgraduate environmental management students' experience using low-immersive VR within a summative assessment.

Methods

In these field notes, VR refers to the use of 360° panoramic photographs as a form of low-immersive media whereby online learners manoeuvre the room through their personal computer devices. These 360° rooms were hosted on the Seekbeak® platform. The content was created by both academic and learning media staff at the University of Derby, a mid-sized university in the United Kingdom. Seekbeak® was chosen as it allowed a significant amount of customisation, and images could be privately embedded into existing university webpages. Interactive elements such as text, videos, and images were simple to include, and it had the potential to be scaled up to use more widely across the university if required. From an educational perspective, Seekbeak® has accessibility features built in so that there were text options for students with either sight impairments who used screen readers, and for those who had very old equipment or poor connection speeds. Conversely, it was simple for students with modern mobile phones and even headsets to click a button and look around the space immersively, using their device's built-in gyroscope rather than a mouse or touchpad: the platform worked for all students.

This form of low-immersive VR was used within a summative assessment for an online postgraduate environmental management course. Student users navigated the 360° spaces to perform a virtual environmental management system (EMS) audit of a university campus site. An EMS is a structured system used to manage an organisation's environmental performance and responsibilities, and to minimise or control the impact of its activities on the environment. An EMS audit is used to investigate and evaluate the effectiveness of the EMS and the organisation's compliance with systems, policies, and regulations. Figures 1 and 2 are examples of the Seekbeak® virtual rooms which were created using the university buildings. Each room included a link to a site plan of the building as well as interactive elements called "hotspots" which, when clicked, provided further details and photographs of an aspect of the room such as inside a cupboard. The students navigated these virtual spaces to audit the university rooms and review compliance with the university's environmental policy, other internal commitments, such as carbon management plans, relevant legislation, and the requirements of EMS standards.

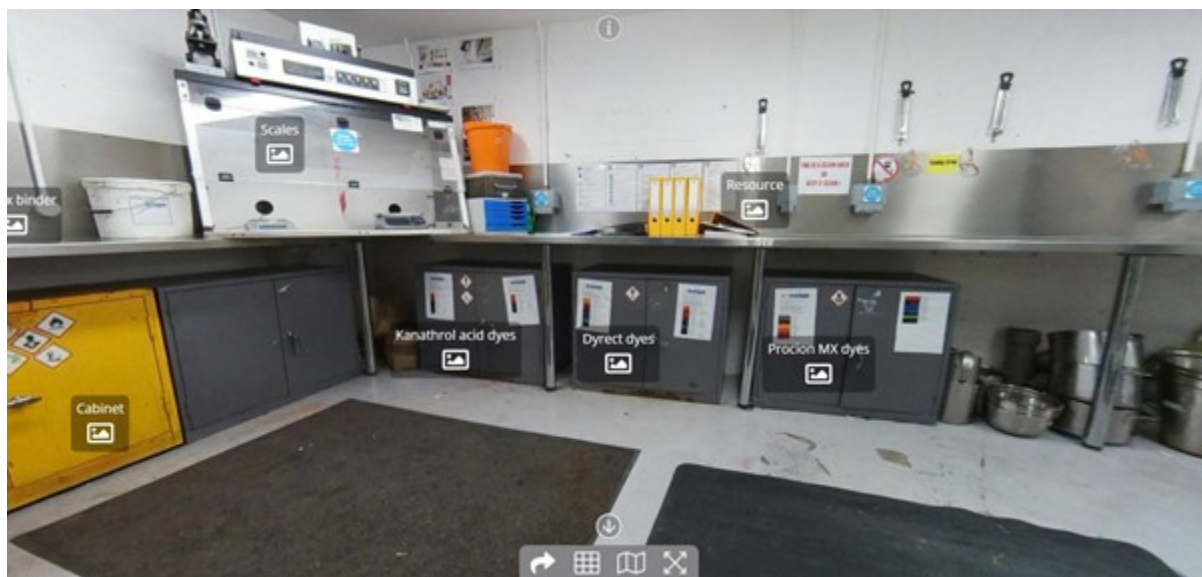
Figure 1

SeekBeak® 360° Room: Conference Room



Figure 2

Seekbeak® 360° Room: Washroom in the Art and Design Department



Students were provided with guidance on how to use the Seekbeak® software prior to their EMS audit assessment. Practice versions of virtual rooms were available on the university Virtual Learning Environment to explore the tool, and students were encouraged to discuss their thoughts with their peers and the academic teaching staff both synchronously in live online drop-in sessions and asynchronously using online discussion boards. Students were also given the opportunity to speak to the university's

environmental manager who undertakes the official EMS audit and to ask questions about the process and campus sites to help them complete their own audit assessment. This authentic and applied assessment was designed to allow students to develop key employability skills and apply their learning to a task they are likely to undertake in their prospective job roles (Villarroel et al., 2018). This is one of several applied and authentic assignments in the postgraduate environmental management programme within which this module sits, but it is the only assessment which includes VR. All students in the environmental management programme ($n = 75$) will complete this VR assessment as part of their core learning, but this module is also available to students of other programmes as an optional area of study. Further, it should be noted that students will also complete traditional assessment activities such as essays and reports within their studies to balance their workplace skills development with academic skills.

Data Collection and Analysis

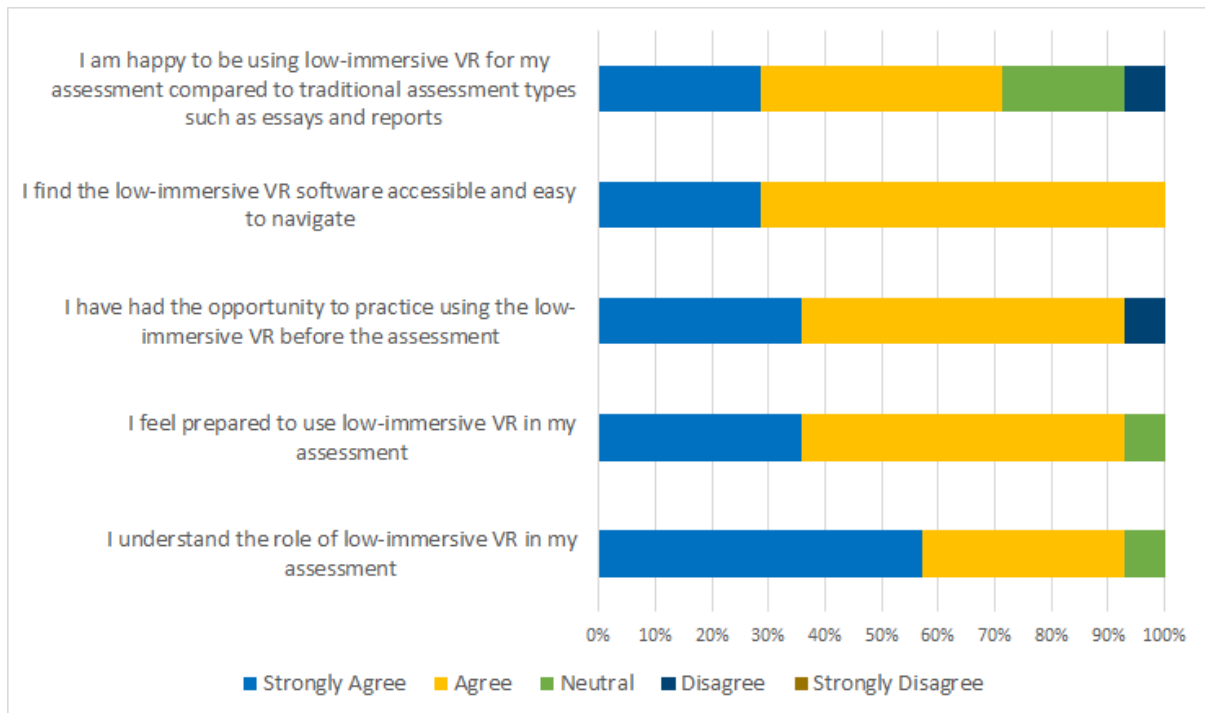
Participants for this study were recruited from among students studying a postgraduate environmental management online module which examined environmental assessment and management tools including EMS auditing. Primary data collection in the form of an anonymous online survey was employed to gather feedback from students whilst they undertook the summative audit assessment which included the use of low-immersive VR. The survey was hosted on Microsoft Forms, and the link to the survey was distributed during the module when students were completing the assessment. The survey link was open for students to complete for the remaining duration of the module (four weeks) until they submitted their summative assessment. The survey used a series of closed-ended questions with a 5-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree) to evaluate students' views of using low-immersive VR as well as a number of open-ended questions to allow expression of opinion. This approach was used by O'Connor et al. (2020) to assess student experience of 3D VR in radiography education. The quantitative results from the survey were analysed using descriptive statistics, and thematic analysis was used to analyse the qualitative responses. The lead author undertook the data analysis, and the results and themes were then discussed and reviewed by other members of the research team. The study was approved by the University of Derby Online Learning Ethics Committee.

Results

The survey was distributed to 42 level 7 postgraduate students and had a response rate of 33% ($n = 14$). Figure 3 highlights the quantitative outcomes of the survey.

Figure 3

Student Responses on Their Experiences Using the Low-Immersive VR



Results show 71% ($n = 10$) of the respondents agreed or strongly agreed that they were happy to be using the VR software in comparison to traditional academic assessments, and 100% of the students ($n = 14$) agreed or strongly agreed that they found the software easy to navigate. Whilst the majority of students (93%, $n = 13$) also agreed or strongly agreed that they felt prepared to use the software, understood its value in their assessment, and had the opportunity to practice, one student did not agree that they had had an opportunity to use the software prior to completing their summative assessment. This student however also reported that they strongly agreed they were prepared for the assessment, so their lack of practice time does not appear to have overly affected their wider view of the assessment. Another student also reported that they were not happy to be using the VR software in their assessment but had also either agreed or strongly agreed with the other statements shown in Figure 3 so, again, this did not adversely affect their preparation or understanding of the software.

Qualitative feedback from the survey has been collated into positive and negative views by theme as shown in tables 1 and 2.

Table 1

Positive Student Feedback

Theme	Example comment
New skills developed	<p>“The experience is new to me, but it has been a good learning experience where I am able to adapt to a future trend in EMS audit assessment. I am able to find evidence of compliance by making certain observations I have been trained to check and analyse.”</p> <p>“Excellent opportunity to test practical areas of environmental management and get used to industrial codes of practice such as standards, audits and very normal situations that we could work in.”</p> <p>“It supports an understanding of the bigger picture and use of tools—without it I think it would be very hard to understand a standard because the documents are very dry and must be applied in a practical setting to gain full knowledge and understanding of what it means for an organisation together with the processes needed to improve environmental standards.”</p>
Value of the assessment approach	<p>“It is an interesting way to assess rather than standard essays.”</p> <p>“I am very grateful for the practice and the sessions that we got to support our understanding of the context of the coursework.”</p> <p>“It is effective as a tool for assessment.”</p> <p>“I think it is an excellent opportunity to test practical areas of environmental management and get used to industrial codes of practice such as standards, audits and very normal situations that we could work in.”</p>

Table 2

Negative Student Feedback

Theme	Example comment
Limitations of the customised content	<p>“It is a useful tool generally but would be complemented by interviews and documents.”</p> <p>“It would be beneficial if there were some notes provided with the low-immersive VR. Just to add those details that can’t be told by VR alone, such as the lights in a room being on timers or not.”</p>
Limitations of the software	<p>“Google maps provides a slightly more immersive and flexible experience than Seekbeak®.”</p>

Students reported positive outcomes to include the new skills they had developed from using the software as well as the effectiveness of the assessment style. Negative observations centred on the absence of additional documentation which would have been beneficial to complete the audit assessment, with one student noting, “It is effective as a tool for assessment but should be combined with other sources of information and more data as well.” Another student compared the tool to other software which they perceived to be of better quality. Further reported benefits of the low-immersive VR assessment tool were the “opportunity [it facilitated] to communicate with colleagues and get to know each other” and the skills developed that could be mentioned in job applications. One student reported, “It is something that can be used to sell above other candidates.” Students also valued the opportunity to practice using the software: “I found the VR quite easily accessible and after the [assessment] workshop, I had a much better understanding of what was required of me.”

Discussion

Recent research in the field of VR education is dominated by the application, experience, and effectiveness of high-immersive technology and whilst this is a valuable educational tool, it is not easily accessible to students studying online and at a distance from the university campus where the technology is typically located. These field notes therefore explore online student experiences with low-immersive VR which can be accessed remotely using desktop technology. The quantitative data collected highlights that the majority of students who participated in the survey reported a positive user experience. They were happy to use the low-immersive VR software, understood its role, had practised, and felt prepared when using the software and subsequently found it easy to use in their assessment.

Four key themes emerged from the qualitative data collected, and these were categorised as either positive or negative. Positive themes included the new skills developed and the perceived value of the assessment tool. This aligns with the benefits reported by Radianti et al. (2020), Wu et al. (2020), and Huang and Liaw (2018) who emphasised the value of undertaking realistic practice-orientated activities, such as an audit, in a virtual space. The student feedback on the effectiveness of the tool to support learning practical skills when compared to other assessment formats also aligned with the work of Taçgın (2020) and Merchant et al. (2014) who highlighted the potential of VR for enhancing learning outcomes and developing learner cognitive skills. A further interesting positive observation from the qualitative data was the student feedback that the VR assessment provided an opportunity for peer interaction, which took place during the practice discussions. This acknowledgement of an additional benefit beyond the aim of the assessment is particularly valuable given that online learning is generally undertaken independently and can therefore result in feelings of isolation. The negative themes from the qualitative data focused on the software used and the information included. These can be resolved by adding further material to the current content provided in the virtual spaces, thus facilitating an opportunity for the academic team to improve the task to develop the efficacy of the VR summative assessment. Specific actions include embedding further information into the virtual rooms via the “hotspots” tool, such as listing the chemicals stored in cupboards, outlining the local protocols for waste disposal, which can be room specific depending on the materials used, and providing links to the university environmental policy and internal plans and commitments. A limitation of virtual auditing is that assumptions can be made if there are insufficient facts and figures

provided. This additional detail will therefore support students to complete a more comprehensive and informed EMS audit in future iterations of this assessment.

This specific EMS audit assessment and the corresponding content of the VR rooms was designed exclusively for one online module. However, the significant customisation benefits of the Seekbeak® platform have meant that the 360° panoramic photographs taken to develop this activity have been adapted for use in other programmes within the university but with different content included. For example, an office has been reimaged to explore occupational health and a kitchen used to demonstrate aspects of environmental health, thereby demonstrating the significant flexibility and value of Seekbeak® and the virtual spaces.

Limitations

Whilst these field notes offer valuable knowledge on student experience using low-immersive VR in online environmental management education, two limitations should be noted. Firstly, the response rate for the survey was lower than anticipated, an outcome which could have resulted from the research being undertaken by the academic staff teaching the module. This may have therefore affected the representativeness of student perceptions and experiences reported. Secondly, and comparable with the limitations noted by O'Connor (2020), who undertook a similar study, the student perceptions obtained via this research are subjective. Further research should therefore explore student views and competence with the tool alongside their assessment output to determine if students who valued the experience delivered high quality outputs. It would also be beneficial for an independent researcher to collect data from students for pedagogic scholarly activity rather than the academic teaching staff. That said, the results from this survey were generally positive, and these field notes have conveyed practical knowledge that may be helpful to other universities wishing to implement low-immersive VR for students studying online.

Conclusion

VR technologies are a valuable tool for education, allowing users to enhance their learning outcomes and develop cognitive skills. Whilst technology in high-immersive experiences increases and has a valuable place within higher education, it is important to consider how this type of learning tool can be accessed by online students to ensure they are afforded equivalent benefits. Low-immersive VR presents an opportunity for online learners to experience this real-world learning within a virtual space, and they can easily access it remotely on their own devices. This investigation into student experience using low-immersive VR has reinforced the value of the tool to online learners and highlighted their positive view of the technology when used in a summative assessment testing a practical skill. It is hoped this research will be valuable to online education providers to demonstrate the value of using low-immersive VR within their programmes.

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