Computers & Education: X Reality 3 (2023) 100039

Contents lists available at ScienceDirect

Computers & Education: X Reality

journal homepage: www.journals.elsevier.com/computers-and-education-x-reality

Appraising occupational therapy students' perceptions of virtual reality as a pedagogical innovation

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ARTICLE INFO

Keywords:
Virtual reality
Curriculum development
Medical education
Occupational therapy

ABSTRACT

Virtual reality (VR) offers a forum for a person to immerse themselves in an artificial world. Despite the emergence of VR as a teaching tool, a strong base to understand the pedagogical impact of VR within post-secondary education is absent. Furthermore, there is minimal literature on how VR can be used pedagogically with medical and rehabilitation professional students. This pilot research project sought to answer "how do students perceive that VR should be used within occupational therapy curricula after trialling a variety of educational modules?" Study participants were Masters of Occupational Therapy Students who trialed four different educational modules using four different technological solutions. After each trial they completed a questionnaire specific to the learning and then completed an overall survey about how VR should be considered for future use in the curriculum. Findings showcased that students preferred a higher level of immersion and interaction. They showed less preference for the lower technological and less immersive learning opportunities. Students shared that they would welcome VR solutions to learn about assessment, anatomy and musculoskeletal function, neuroanatomy and neurological foundations and for cases as a preparation for clinical fieldwork experiences. Future research is required to evaluate the impact of a larger scale roll out of specific learning approaches.

1. Introduction

Virtual reality (VR) is a computer-generated simulation of a three-dimensional image or environment that a person can interact with in a seemingly real or physical way. VR allows us to immerse ourselves in an artificial world; this world can be an entirely imaginary universe or a reproduction of the real world. Immersion is achieved using special electronic equipment, such as a helmet with a screen inside, goggles, or gloves fitted with sensors (Bertrand et al., 2018; Elmqaddem, 2019). VR using conventional technology, such as computer screens, is considered non-immersive as it allows the user to recognise the outside world. Societal trends in VR have been profound, with the emergence of a $20B a year gaming and entertainment industry (Babb et al., 2013). Similarly, VR has caught the attention of educators and educational researchers as an innovative experiential learning approach (Radianti et al., 2020).

Despite the emergence of interest in VR as a teaching tool, we currently do not have a sizable evidence base to understand the pedagogical impact of VR within post-secondary education (Khan et al., 2018; Radianti et al., 2020). While a few preliminary evaluations have identified that VR enhances student engagement and comprehension of complex concepts, many studies have failed to demonstrate strong evidence that VR has an advantage over traditional teaching methods (Liu et al., 2017). Additionally, authors share challenges with VR, such as cost, integration within educational systems, user acceptance and cognitive overload (Liu et al., 2017; Moro et al., 2017; Radianti et al., 2020). Despite these mixed findings, educational researchers express that VR has potential and promise as a pedagogical tool, but acknowledge that further research is required (Kim et al., 2021; Radianti et al., 2020).

Specific to medical education, researchers have sought to understand how VR can be used to educate learners on topics such as gastrointestinal endoscopy (Khan et al., 2018), anatomy education (Moro et al., 2017) or cardiopulmonary resuscitation (Wong et al., 2018). Findings from these studies suggest the lack of haptic input prevents VR from

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https://doi.org/10.1016/j.cexr.2023.100039
Received 20 July 2023; Received in revised form 1 September 2023; Accepted 9 September 2023

being used as a tool to develop hands-on skills (Khan et al., 2018; Moro et al., 2017; Wong et al., 2018). However the evidence suggests that with a blended learning approach, the immersive nature of VR can potentially build foundational anatomy knowledge, develop clinical reasoning skills, construct compassion for the patient experience and prepare students for clinical placements with real patients (Radianti et al., 2020; Wong et al., 2018).

Within the field of rehabilitation, there is a dearth of literature on how VR can be used pedagogically with rehabilitation professional students and existing literature is limited to descriptive case studies and student's perception of VR solutions (Bennett et al., 2017). Without a significant evidentiary base, it is difficult to conceptualize and develop a plan for integrating VR into the curriculum or how to establish the appropriate blended learning approach. Additionally, it is challenging to present a business case for acquiring new technology and software without a strong evidentiary base on which to justify new expenses.

As educators and researchers, we are drawn to the potential of VR as an innovative experiential learning medium. However, prior to designing larger scale integration, and associated evaluations, an exploratory approach is required to evaluate the feasibility and benefit of integrating VR into the curriculum. Therefore, this pilot research project sought to a) acquire and create VR experiential learning modules and b) pilot them with students to explore their perceptions of VR as a teaching tool. Specifically, we sought to answer, "how do students perceive that VR should be used within occupational therapy curricula after trialling a variety of educational modules?"

2. Materials and methods

A pilot study mixed methods e-survey design was used to determine student perceptions of VR as a teaching tool in the occupational therapy curriculum after trialling four different VR educational modules. One questionnaire was completed after trialling each educational module and then an overall survey about VR in occupational therapy curriculum was completed after all four VR modules were trialled. This study was approved by the University of Toronto's Research Ethics Board on October 13th, 2022 with protocol #43467.

2.1. Virtual reality module creation

Our intention was to test both pedagogical content and virtual reality software to secure an understanding of both feasibility and benefit of a variety of VR approaches. To achieve this goal, the research team investigated, created, and acquired a series of educational VR modules. After consultation with VR experts, software creators and fellow researchers, we secured four separate VR educational modules for this research project. These were chosen for convenience, feasibility, and long-term potential. Specifically, the VR modules were:

1. An anatomy learning module about the spatial relationship between upper limb bones, muscles/tendons, and nerves in the carpal tunnel of the wrist using the Microsoft (MS) HoloLens 2 headset.
2. An immersive and interactive case scenario in which students conducted a hospital-based assessment of a patient with a recent mental health diagnosis. This interactive video used the Ubisim software (UbiSimVR, 2023) and students interacted with the video by wearing an Oculus Headset and using hand controls.
3. A 360-video enabled YouTube video that teaches students empathy for the COVID 19 patient experience by allowing students to experience bedside care from the perspective of the patient. The students watched this video on an android phone while using a Cardboard headset.
4. A 360 video that teaches students about the research planning process in a team environment. The students viewed this meeting on their laptops with interactive on 360 enabled YouTube features.

2.1.1. Virtual reality modifications

Further to the 360 COVID-19 related video, this was previously developed by one member of the research team (Thomson et al., 2023). During this preliminary study, participants were able to use their own phones in conjunction with the cardboard headsets. For this present study, the participants were not involved in the previous study; therefore, this was a new experience. In the days leading up to data collection, the research team discovered that Apple iPhones no longer supported the 360 YouTube videos that allowed viewers to interact with their environment by turning their heads from right to left or looking up and down. Therefore, we had to quickly pivot and acquire older android phones to support this VR video and data collection. This quick modification allowed us to continue with still using the third module.

2.2. Participants and recruitment

The potential participants in this study were students in the Masters of Occupational Therapy (MScOT) program at the University of Toronto. To limit persuasion, recruitment and communication came from a member of the research team who was not actively involved with teaching the students at the time of recruitment. Participants were recruited via email. Potential participants were informed that there was no obligation to participate in the study and that participation would have no impact on their academic standing. Participants were offered the opportunity to ask questions as they signed up to attend the VR research study in one of two timeslots. On the day of testing, participants were provided another orientation to the research and engaged in informed consent verbally and in writing.

2.3. Data collection

All participants attended one of the two 3-h VR education module testing sessions. Participants were invited to test each of the four VR modules and complete the Virtual Module Questionnaire (Appendix A). This questionnaire was completed by all participants immediately after trialling each module; such that participants who completed all four modules would have completed four questionnaires regarding their perceptions of the experiential learning and the VR technology used.

The Virtual Module Questionnaire was developed by the research team based on questions from the UTAUT Questionnaire (Shen et al., 2019), the Extended Technology Acceptance Model questionnaire (Fussell & Truong, 2021), Student Satisfaction and Self-Confidence in Learning Scale (SSSCL) (Unver et al., 2017) and Satisfaction with Simulation Experience (SSE) (Levett-Jones et al., 2011) Scales (Hanshaw & Dickerson, 2020) (Appendix A). All these questionnaires informed a list of fifteen statements for the participants to rank on a five-point Likert scale from Strongly Disagree to Strongly Agree after using the VR educational module. One final open-ended question asked students for any additional feedback. All data were collected via MSForms.

After participants trialed all four VR educational modules, they were invited to complete the Virtual Reality in Medical Education survey that asked them to reflect on where they would have benefitted from these pedagogical innovations within their educational program. These questions were all open ended (Appendix B).

2.4. Data analysis

All data were downloaded from MSForms and combined into two excel files to prepare for descriptive statistical analysis. All ordinal data (e.g., Agree, Strongly Agree) was changed to numerical ratings for analysis. If the participant ranked the statement as 'Strongly Disagree', this was translated into a score of one and if they ranked as 'Strongly Agree', this was translated as a five. The quantitative data were then analyzed using descriptive statistics. Conventional content analysis followed by thematic analysis was used for the open-ended text box answers for the last question on the individual module survey and the final questionnaire (Hsieh & Shannon, 2005). Specifically, two members of the research team reviewed the findings and discuss the dominate themes within the data, which are reported within the findings.

3. Results

A total of n = 23 MScOT students participated in this study. Of these students, n = 17 participants trialed and completed the questionnaire on the anatomy learning module using the HoloLens, n = 22 trialed the assessment of a patient using the Oculus headset and hand controls, n = 19 trialled the experience of being a patient with COVID-19 using the cardboard headset and n = 14 observed the 360-research planning video. For each of these trials, the students completed the Virtual Module Questionnaire to evaluate the respective VR module. Following the trial of all four VR educational modules, n = 14 participants completed the VR in Medical Education Survey.

3.1. Individual virtual reality learning modules

Based on the ranking of the fifteen statements about the VR educational modules, the participants ranked learning anatomy with the HoloLens with the most preference. Both the modules that included assessing a patient at hospital beside using an Oculus headset and the COVID experience wearing a cardboard headset with the phone had similar overall averages, however, the learning with the Oculus had a wider range of responses (Table 1).

Most notably, the average (mean ± SD) student ranking of the statement "The module helped me to recognise my clinical strengths and weaknesses" was low on the COVID experience with the cardboard headset (2.89 ± 0.94). However, for the statements, "The module makes learning more interesting" and "Learning with the module was fun" the participants ranked the anatomy learning with the Hololens more preferentially (4.88 ± 0.33 for both).

Conversely, students ranked learning modules using the Hololens and the Oculus with lower preference on the statements "I have the resources necessary to use the module" (2.75 ± 1.52 & 2.77 ± 1.63) and "I could complete an assignment using the if there was no one around to tell me what to do" (3.35 ± 1.17 & 3.32 ± 1.29).

The individual learning module questionnaires also had one final open-ended question about the participants' experience. These comments were consistent with the Likert ranking scores showing preference for learning with the Hololens and Oculus, coupled with the caution that students may not have the skills to fully engage with the learning without additional supports. With respect to using the Hololens to learn anatomy, one student shared:

> "1. Very fun and helpful in learning nerves, muscles and bone and see how they come together in 3D and 2. Definitely require skills training to learn how to use the software."

Similarly, in considering the experience with the Oculus headset to practice assessing a patient in a hospital bed, participants responses were polarized around really enjoying the learning and expressing uncertainty about adjusting to the technology.

> "This was a great way to learn how to conduct assessments. I can see myself using this to practice with patient interaction and complete assignments. I think a tutorial at the beginning … would be beneficial in how to maneuver controls."

Specific to the module that allowed students to explore empathy for the COVID 19 patient experience on a phone and cardboard headset, the participants shared slightly fewer positive reflections with engaging in this virtual reality experience. Some participants shared that they felt the cardboard headset was very uncomfortable, that they had a harder time hearing the audio and had experiences of dizziness and fatigue after the experience. Interestingly, participants engaging in the higher technological learning modules did not report these adverse reflections. Lastly, participants did not feel as engaged with the learning as the other slightly more interactive modules:

> "This module was interesting and I think it provided … insight into the patient perspective, however I'm unsure of the benefit that VR provides in something that is passive like this as compared to watching a video that is filmed from the perspective of you being the patient. It would have been nice to be able to take on an active role in this activity."

Lastly, in relation to the learning module where the students watched faculty engage in a discussion to plan a research project, on their laptop, using a 360 video, participants shared similar reflections to the other 360 video learning module. Participants shared mostly positive reflections that the learning was interesting and accessible, and they liked using the directional buttons to navigate around to room to view different people talking. Some participants shared that they found this

Table 1
Virtual module questionnaire responses – average scores with standard deviation.

Question/Module	Anatomy learning using the Hololens N = 17		Assessing a patient in hospital bed using Occulus Headset N = 22		Experience of COVID 19 viewed with cardboard headset & phone N = 19		360 Video about research planning on laptop N = 14		Total	
	AVG	SD	AVG	SD	AVG	SD	AVG	SD	AVG	SD
The module helped me to recognise my clinical strengths and weaknesses	4.00	0.94	3.82	0.80	2.89	0.94	3.29	0.73	3.51	0.95
The module developed my clinical reasoning skills	4.29	0.85	4.05	0.84	3.26	0.99	3.79	0.70	3.85	0.93
This was a valuable learning experience	4.82	0.39	4.41	0.50	3.68	1.00	4.00	0.68	4.24	0.80
My interaction with this module was clear and understandable	4.06	0.66	4.18	0.66	3.58	0.84	4.14	0.86	3.99	0.78
It would be easy for me to become skillful at using this module	4.18	1.01	4.36	0.85	3.95	0.78	4.79	0.43	4.29	0.85
The module makes learning more interesting	4.88	0.33	4.68	0.65	3.84	1.12	4.00	0.96	4.38	0.91
Learning with the module was fun	4.88	0.33	4.82	0.50	3.74	1.15	3.71	0.99	4.33	0.96
I have the resources necessary to use the module	2.76	1.52	2.77	1.63	3.21	1.23	4.57	0.51	3.24	1.49
I have the knowledge necessary to use the module	3.94	0.97	3.73	1.12	4.26	0.65	4.50	0.52	4.07	0.91
I could complete an assignment using the if there was no one around to tell me what to do	3.35	1.17	3.32	1.29	3.79	0.98	4.50	0.65	3.68	1.15
The module promoted my learning	4.65	0.61	4.14	0.71	3.79	0.92	4.21	0.43	4.18	0.76
The module was suitable to the way I learn	4.71	0.47	4.50	0.67	3.63	1.12	3.71	0.73	4.17	0.90
This module covered critical content necessary for my training as an occupational therapist	4.65	0.70	3.82	0.85	3.79	0.71	4.00	0.68	4.04	0.81
I felt apprehensive about using the module	2.12	1.22	2.05	0.95	2.32	1.16	1.71	0.91	2.07	1.07
I felt hesitant to use the module for fear of making mistakes I cannot correct	2.06	1.09	2.05	1.09	1.89	0.94	1.79	1.19	1.96	1.05
TOTAL AVERAGE	3.96	0.82	3.78	0.87	3.44	0.97	3.78	0.73	3.73	0.95

AVG = Average, SD=Standard deviation.

style of video better than a traditional recorded lecture, while others shared that the interactive features may not necessarily enhance learning.

> "Having some trouble determining where this module would be applicable and/or superior to the current virtual methods that we use … Perhaps may be useful if meetings are missed in some cases, but this one feels like more limited purpose uses than the others. Consideration for learning is that the need to move the camera around manually would affect ability to simultaneously take notes and move camera - I could see that I stop trying to move camera around due to difficulty doing both simultaneously if that situation arose."

3.2. Overall student perception of VR in medical education

The second portion of the data collection asked the participants for overall reflections of all four modules and how these might be used in the curriculum. Consistent with the findings from the individual module questionnaires, the final survey highlighted that participants strongly prefer learning modules that allow them to take an active role. Therefore, the learning that is both interactive and immersive, such as learning with the Oculus and Hololens, were identified as preferred learning modules.

> "I really enjoyed the modules where we got to take on an active role in the VR, rather than passively watching. When we got to engage with the world it was fun and enticed me to 'dig around' to figure out what needed to get done. I imagine that this desire is in part because it is new technology that I am not familiar with using, but also because I felt that I was actively contributing to the scenario which I enjoyed."

Interestingly, the participants shared more negative reflections about the lower technology VR situations, both due to the set up and the content.

> "I did not enjoy the cardboard + phone headset module. It could be due to user error, but I felt like I was going cross-eyed by the end of it. It was also a very sad scenario so that may contribute to the discomfort I felt in the module. I also wish there were instructions or labels on buttons in the beginning … to make it more intuitive to use."

Overall, the participants shared that the interactive and immersive nature brings value add to the learning experience. Students shared that the VR learning felt like a safe way to practice their clinical skills. Additionally, most students shared that they enjoyed learning the new technology.

> "… there is added value learning when using VR as a learning tool for anatomy and preparing for placements. The technology helps me better understand the anatomical structures and how those structure located relative to each other …. helps mimic the clinical environment and enable students practice assessment skills in the clinical contexts."

Lastly, when asked where VR could fit into the academic program, consistently students shared that they would love to use VR to learn about assessment, anatomy and musculoskeletal function, neuroanatomy and neurological foundations and for cases as a preparation for clinical fieldwork experiences.

4. Discussion

The current study examined MScOT students' perception of virtual reality as a pedagogical innovation with regards to four different learning modules that employed different technology and educational content. Overall, it was found that a key aspect of value for the VR modalities was the level of immersion or interaction. Immersion, with regards to VR, is more related to spatial immersion in which an individual perceives their presence in a nonphysical space (Radianti et al., 2020). Establishing this perception involves "immersing" the user into an environment with images, sounds, and other stimuli that resemble the real world. This allows the user to feel like they are "there" in that environment.

In our study, participants enjoyed the use of the HoloLens for anatomy learning, as well as use of the Oculus headset in the interactive case scenario. Both were found to be "interesting, fun, and helpful" methods of learning and allowed students to take on an active role. As a high level of immersion is enabled with the HoloLens and the Oculus, participants may feel more engaged and maintain motivation to learn (Suh & Prophet, 2018). In the literature, head-mounted displays (HMDs) that allow for immersive VR (i.e., Oculus), were found to increase enjoyment of learning, improve concentration, and allow users to gain a level of control of their environments (Harrington et al., 2018; Wang et al., 2018).

A review by Jensen and Konradsen (2018) examined the use of HMDs and factors influencing immersion and presence on learning. Across all the studies examined, learner attitudes towards HMD technology were positive. Specifically, it was found that use of HMDs was useful for cognitive, psychomotor, and affective skills acquisition. Other than these situations, the HMDs showed no specific advantage compared to traditional methods and showed that it may even be counterproductive due to physical discomfort and technological difficulties (Jensen & Konradsen, 2018). Notably, participants in the current study also reported uncertainty about adjusting to the technology or having the necessary skills to learn the software.

With regards to the Google Cardboard headset, it was found that this immersive modality was not as engaging as the other modes of VR. This is inconsistent with findings in a previous study by Papachristos et al. (2017), which found no differences in immersion levels between Oculus and a cardboard VR. It must be noted that in the current study, Android phones, which are not traditionally used for cardboard VR were used. Not only may this have impacted the overall experience of participants, but it may also have affected the level of discomfort experienced by the participants, which is consistent with findings that the cardboard VR may be more demanding for the visual system of participants (Papachristos et al., 2017). In the VR literature, a common theme that has been raised is physical discomfort (i.e., nausea, motion sickness) experienced by users (Jensen & Konradsen, 2018; Radianti et al., 2020; Suh & Prophet, 2018).

Finally, there were mixed opinions about the 360 video, which is a non-immersive method of VR; some found it was more interesting and accessible, while others stated that it may not enhance learning as compared to a traditional video. This supports the idea that level of immersion is an important factor to consider in the use of VR. It also raises an important question to consider, which is the content available for VR use. Presently, most VR simulations available are designed for self-learning, meaning content is provided by the VR producers (Jensen & Konradsen, 2018). As the profession of occupational therapy places importance on the uniqueness of every person and follows a client-centered philosophy of practice, the use of VR for occupational therapy education may be more relevant if educators can create their own content, which is more promising with non-immersive VR methods like 360 videos (Grant et al., 2021). Overall, regardless of the mode of VR, the focus should not be on the technology, but rather the use of simulations to enable learning and provide opportunities to "learn by doing".

These findings contribute to the overall growing base of evidence that virtual reality has promise and potential as a pedagogical tool in medical education (Radianti et al., 2020; Wong et al., 2018). However future studies need to expand beyond pilot and conceptual (Radianti et al., 2020) and begin to measure effectiveness (Kim et al., 2021) and begin to test the hypothesis that this innovation is superior to traditional teaching methods.

4.1. Limitations

There are limitations that should be noted when considering the findings within this study. Most specifically is the small sample size. With a participant rate of approximately 20% the findings cannot be seen as representative of an entire class or student population. Further to this, there is significant response bias, as students who chose to participate in the study may have already had a strong interest or previous experience with VR technology. Additionally, this study embraced a mix of technology and pedagogies, and therefore we are not able to address impact on learning. Lastly, not all participants completed the final survey, those adding a confounding variable about the reliability of the conclusions.

5. Conclusions

This pilot research project sought to answer, "how do students perceive that VR should be used within occupational therapy curricula after trialling a variety of educational modules?" Findings showcased that students preferred a higher level of immersion and interaction, and that the lower technological and less immersive learning opportunities were viewed less positively. Students shared that they would welcome future VR educational solutions to learn about assessment, anatomy and musculoskeletal function, neuroanatomy and neurological foundations and for cases as a preparation for clinical fieldwork experiences. This work was undertaken to pilot a variety of technology and educational solutions to inform future innovations and evaluations. Future research is required to evaluate the impact of a larger scale roll out of specific learning approaches.

Statements on open data and ethics

The participants were protected by hiding their personal information in this study. They were voluntary and they knew that they could withdraw from the experiment at any time. The data can be provided upon requests by sending e-mails to the corresponding author.

Funding

This work was supported by the University of Toronto's Graduate Education Development Fund.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Andrea Duncan reports financial support was provided by University of Toronto, Canada.

Acknowledgements

We would like to acknowledge Rob Page for his support with the technological set up and quick response when the technology was not functioning at the last minute.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cexr.2023.100039.

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