The use of virtual reality for public health education with reference to Syrian refugee camps

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In this study we used Virtual Reality (VR) technology to provide an immersive interactive learning experience for undergraduate public health students in the UK and Lebanon. Students carried out a problem-based learning exercise around public health challenges faced by Syrian refugees in Lebanon. In the wider context of a Virtual Student Exchange programme small, mixed nationality groups were connected by Skype, WhatsApp and other technologies to research specific healthcare requirements for refugee camps (e.g. sanitation) and constructed an interview guide for the Lebanese students to use on a visit to a camp at the end of the programme. Lebanese students captured 360-degree videos to allow UK peers to 'join' them on their camp visit using VR. Findings from post-hoc video interviews focusing on the use of VR indicated that students felt closer to the subject of their research than before it was used. Participants' emotions were affected by what they saw in the camps, providing a broader cognitive experience in which sight, sound, and emotions were linked to the camps, deepening learning about the refugees' conditions. Faculty were able to move beyond the use of simple text-based scenarios, facilitating students' learning about a real-world situation that they would not have been able to access through other means. This approach has potential for wider use in education, providing virtual access to locations it can be difficult for learners to visit by other means.

Introduction

The use of interactive simulations in educational environments provides an effective approach to augment students' understanding of difficult concepts, as well as their practice of real-world skills in a safe, controlled environment. Traditional approaches to interactive simulations have focused on the use of text-based scenarios. By comparison, recent studies have shown the benefits of using Virtual Reality (VR) in classrooms to empower learners through increased interactivity, role-play, and more complex social interaction (Huang, Rauch, & Liaw, 2010). VR has been successful in mimicking complex social interactions through immersive, interactive experiences (de Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, & Poulovassilis, 2010).

VR has been used with positive results in a variety of disciplines such as engineering and architecture (Burnley, 2007; Doyle, Dodge, & Smith, 1998; Izard & Méndez, 2016). Reports indicate that training/teaching in VR is at least as effective as real-world training (Barrett, Stull, Hsu, & Hegarty, 2015; Harrington *et al.*, 2017; Khanal *et al.*, 2014; Stone, Watts, Zhong, & Wei, 2011) with the advantages that it is safer to make mistakes (Johnson,

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doi: 10.1255/vrar2018.ch8
Citation: H. Dawson, N. Alami, K. Bowen and D. Maddah, "The use of virtual reality for public health education with reference to Syrian refugee camps", in *Proceedings of the Virtual and Augmented Reality to Enhance Learning and Teaching in Higher Education Conference 2018*, Ed by J. Hudson and R. Kerton. IM Publications Open, Chichester, pp. 73–81 (2019). https://doi.org/10.1255/vrar2018.ch8

Print ISBN: 978-1-906715-30-4
Online ISBN: 978-1-906715-28-1

Levine, Smith, & Stone, 2010; Lorenzo, 2014), students find it engaging (Harrington *et al.*, 2017; Lee, Sergueeva, Catangui, & Kandaurova, 2017), motivating (Fonseca & Redondo, 2013; Redondo *et al.*, 2014) and it can provide greater information uptake through the provision of multiple learning resources in the spherical environment (Harrington *et al.*, 2017).

Public health and displaced people

The war in Syria has displaced 12.2 million people. The number displaced into countries surrounding Syria is 5.6 million. A significant proportion of these refugees have been provided with accommodation in refugee camps (UNHCR, 2018). Camps provide basic sanitation and shelter, but living conditions for residents of the camps are relatively poor. Providing further infrastructure to improve the health and well-being of the residents is problematic due to the temporary nature of the camps. Where conflict and displacement are prolonged (e.g. in Palestine) there is a necessity for more long-term infrastructure and healthcare systems to be put in place. This is problematic given the inherently temporary nature of the camps and the precariousness of political agreements to accommodate displaced people. Public health issues presented by refugee populations are complex, requiring lateral thinking and strong knowledge of the displaced population. Cultural barriers, funding access, restrictions on employment for refugees and political issues mean that traditional models of public health improvement have to be significantly adapted to provide results in these situation. (Hermans *et al.*, 2017; Jonassen *et al.*, 2018; Lutfy, Cookson, Talley, & Rochat, 2014; Saleh *et al.*, 2018). Health education and preventative solutions will require a bespoke approach, taking into account the environment and nature of the refugee population. Healthcare interventions will also have to be adapted from those used in a country's mainstream healthcare systems, where assumptions around access to infrastructure and cultural norms can be made.

The use of virtual reality in medical and public health education

VR technology has been used successfully in medical education environments to support triage training (Jarvis & Freitas, 2009), learning of anatomy (Izard & Méndez, 2016) and general medical teaching through virtual classrooms (Hansen, 2008). Uses in public health are less well reported, but include disaster preparedness using a Massive Multiplayer Online Game platform and use of a Massive Multiplayer Virtual World to conduct meetings around disease prevention and control (Hansen, 2008). In the current study, we aim to investigate the effectiveness of VR technology in training public health students in the UK and Lebanon in the broader context of a Virtual Student Exchange programme, where students connect with peers in other countries using information technology and telecommunications tools such as Skype and WhatsApp.

The intervention used in this study took undergraduate students from public health degree programmes at a university in Wales and a partner university in Lebanon. Module content was matched across both programmes in the area of humanitarian aid. A problem-based learning exercise was then formulated to bring students from both programmes together through technology-enabled Virtual Student Exchange between February and May 2018.

Engagement of the students, group learning and intercultural awareness are enhanced by the use of a Virtual Exchange (Abrahamse *et al.*, 2015; Olsen, Zimmer, & Behr, 2006; Todhunter, Hallawell, & Pittaway, 2013). This intervention sought to investigate if VR could be used as part of the Virtual Exchange to satisfy the following objectives:

1. Provide learning opportunities where background/theoretical knowledge can be applied to real world issues through simulations, and scenario/problem based learning opportunities;
2. Deepen learning through the use of emotion and self-driven cognition of the subject matter;
3. Reduce the perceived distance between the UK based students and the Lebanese refugee camps they were learning about.

Methods

Participants

The participants selected for this study were six first year undergraduate students studying at a UK University (representing the whole cohort on the degree programme, all female, mature students, 4 of African heritage, age range 22–50 years) and eleven second year undergraduate students studying at a university in Lebanon (representing the whole cohort on the degree programme, two

male, nine female, age range 18–22 years). Participants were all studying Public Health at their universities, but the Virtual Student Exchange in which they took part formed the content of different modules from the degree courses in each country.

Participation in the Virtual Student Exchange activities was a requirement of the students' completion of their module. To gather data for research purposes participants were asked if they would be willing to take part in the research around the exchange. This involved providing informed consent, completing a questionnaire before the exchange and taking part in a video recorded interview after the exchange. Questions before the exchange focused on cultural attitudes (e.g. My perceptions of the Middle Easterners are formed from what I see from TV and news outlets produced in the West, with responses given on a Likert scale from strongly agree to strongly disagree). These were asked again and elaborated upon after the exchange, along with a series of specific questions on the use of 360-degree video during the exchange. This article will focus solely on the responses to questions after the exchange, which explored the use of VR through 360-degree video. Ethical approval for the research was obtained from the ethics panels of the participating institutions. All communication was carried out in English.

Procedure

Students from the UK and Lebanese universities linked classrooms using Cisco Jabber videoconferencing software. In the initial session they were joined by two academics, one from an American university interested in the virtual exchange and virtual reality aspects of the project and the other from the Lebanese university taking part in the exchange, to provide an introduction to the concept and practice of Virtual Student Exchange. Students were briefed on the programme of activities by the UK Instructor and guided through an icebreaker exercise by the Lebanese Instructor. They were then put into pre-assigned teams of three or four students, with all teams having members from the UK and Lebanon. Each team was given its own WhatsApp discussion group to get to know each other and work on their allocated tasks. The Lebanese Instructor monitored all discussion groups, providing support when it was requested.

A problem-based learning approach was used for the exchange, to teach the students about the public health issues associated with Syrian refugee camps in Lebanon. Each team was assigned one of the following areas to investigate:

- How does war affect the access of refugees to health care services?
- How does war affect the access of refugees to food and water?
- How does war affect the access of refugees to adequate water and sanitation systems?
- How does war affect the access of refugees to shelter?
- How does war affect the spread of communicable disease in refugee communities?

Students were given four weeks to carry out their research. During this time a second videoconference was used to discuss progress, with Instructors acting as facilitators, guiding the work of the teams. Students were also assisted by a recorded lecture by one of the camp staff part way through the four-week period, delivered in Arabic and translated using English subtitles by the Lebanese Instructor.

After four weeks each group had researched their area and completed an interview guide. The Lebanese students then used the interview guides on a visit to a camp in Bekaa Valley accommodating Syrian refugees. Interviews were conducted with residents and camp staff to gather information on practical and procedural aspects of public health activity around each team's designated research area.

Whilst at the camp, a Samsung Gear 2k 360-degree video camera was used by the Lebanese students to capture footage of the visit to show their UK peers. Students obtained informed consent from camp residents and then captured the 360-degree video footage. They then stitched and uploaded footage to a file-sharing site. The UK Instructor downloaded and edited the footage into a five-minute video using clips from a number of locations around the camp and inside one of the tents which was used as a family home.

The camp was relatively undeveloped, with basic facilities and a gravel ground covering. Accommodation was in tents formed from tarpaulins stretched across wooden frames. Each tent had a basic electrical supply and an external toilet. The edited video was given an opening and closing title and a narrative was added in sections, provided by the Lebanese Instructor.

Following a short academic break, the final videoconference session of the Virtual Exchange was held. This required the Lebanese students to present their team's findings on the public health issues, practicalities and

risk mitigation procedures used in their designated area of investigation. Presentations were given over a Skype connection between the lecture theatres in Lebanon and the UK, with students from both lecture theatres being able to see the presentations. Following questions and answers, the UK students were shown the 360-degree footage. All six UK students downloaded the Google Cardboard application. The edited camp footage was posted on YouTube then accessed through the students' smartphones using the YouTube application. The Google Cardboard plugin for YouTube was activated and the phones were inserted into a VR Box smartphone headset to view the footage. Students either stood or sat down to view the footage. Where students experienced discomfort from using the headset they were given the option of viewing the video on a laptop or tablet screen with headphones. Students were allowed to interact whilst they viewed the footage and were provided with technical assistance by the UK Instructor. Following the viewing each student was interviewed individually in a private room. Twenty-six questions were asked about the Virtual Student Exchange, intercultural experiences and the use of the VR footage. This article will focus only on the responses relevant to the use of VR. Interviews were video recorded using a Samsung 8 smartphone. Interviews lasted from 13 to 22 minutes.

The interviews were transcribed verbatim by the interviewer, using Express Scribe. Transcripts were analysed using Braun and Clarke's thematic analysis methodology (Braun & Clarke, 2006). Coding was carried out using the NVivo 11 software package. Following initial micro-level coding of all content, duplicate codes were removed and like codes aggregated under common themes. Themes were generated using an iterative approach, constantly comparing theme titles and content with the data.

Results and discussion

Capture and manipulation of 360-degree footage

The UK based students were unable to visit the camp with their Lebanese colleagues. In satisfying Objective 1 of study the exercise attempted to simulate the experience through the capture of 360 video and its viewing by the UK students. Satisfying Objectives 2 and 3 of the exercise would require an effective simulation of the visit to the refugee camp. Successful achievement of Objectives 2 and 3 requires consideration of the capture and editing of the footage. Problems with these stages could lead to reduction in the quality of the UK student's experience when viewing footage of the visit. The technical issues encountered require discussion, to highlight some of the problems encountered and how they can be addressed.

The Samsung Gear 2k 360-degree video camera was simple to use, allowing the students to capture footage relatively easily. Students were provided only limited guidance capturing 360-degree images and were generally unfamiliar with this style of photography. Consequently, a great deal of the footage was of poor quality. The camera was rotated, as an operator would do if they were taking two-dimensional footage with a traditional camera. Operators also moved the camera around quickly, moved it into locations where their body obscured the view and the camera was subjected to a great deal of shaking.

Before capturing 360 video footage a more extensive briefing should be given to new users on good filming practices, along with an opportunity to practice in a supervised environment. Seven points of good practice when capturing 360-degree video footage are suggested below:

1. Keep the camera stationary to reduce 'simulator sickness' (Rebenitsch & Owen, 2016);
2. Use a tripod where possible (remove the tripod head adjustment lever to prevent it obscuring the image);
3. Where the camera is hand-held it should be placed at eye level or on top of the head of the user (placing as much of the user as possible in the camera's 'blind spot') to aid the viewer's perception of being 'inside' the image;
4. If the camera is to be hand-held then the use of a handle mount for the camera will prevent the user's hand showing prominently in the image as it would do if holding the camera by its body;
5. Where a 'tour' of a site is required this can still be captured using a series of fixed filming points, with each location being within sight of the last to allow the viewer to recognize where they have moved to. This will avoid the necessity for moving around with the camera, reducing motion sickness for viewers;
6. Use a 4k camera where possible as despite the high resolution of 2k images, once they have been 'stretched' over the 360-degree sphere there is notable blurring, and,

7. Total edited recording length should be a maximum of six minutes to reduce viewer fatigue.

Footage was collected then shared using Google Drive and Microsoft's OneDrive. Some difficulties were encountered due to a lack of understanding of 'stitching' in some users of the camera software. Researchers were unable to help with this remotely, as Samsung Gear software requires a product key to operate it. Stitching using other tools provided poor quality results. Other 360-degree 4k cameras have free access to their software if image processing needs to be done by someone other than the camera operator. A user guide was developed to prevent a recurrence of this issue.

Editing of footage was carried out in Adobe Premier Pro, using basic editing and the recently added 360-degree film editing features. Better quality clips were edited into a film lasting approximately five minutes, with a voice-over from the Lebanese Instructor. The Instructor was chosen as they were able to provide an overview of all areas shown on the edited video and UK students were familiar with their voice from previous learning sessions. It may have further contributed to the authenticity of the experience if the Lebanese students themselves had provided the voice-over. This area was not explored in the interviews with UK students, but would merit investigation in future studies. The film was posted on YouTube for students to download.

Viewing of 360-degree footage

Objectives 2 and 3 required an effective viewing experience for the UK students. The original intention of the study had been to provide a viewing experience where the UK students felt as if they were part of the visit undertaken by their Lebanese teammates. All students possessed a smartphone capable of viewing the 360-degree footage as a virtual reality experience. Downloading the YouTube and Google Cardboard applications was quick, and Wi-Fi access in the lecture theatre did not impede viewing. In line with the findings of Christopoulos *et al.* (2018) a short orientation period was necessary to familiarize users with the software and controls prior to using the virtual environment for the intervention. Students started viewing the footage using VR Box smartphone headsets then moved on to 2.5D viewing (using a laptop or tablet screen to explore the footage; Lorenzo, 2014), when discomfort was experienced. One user experienced discomfort from the weight of the headset and strain on her eyes. The model of unit used for the viewing had moveable lenses. If these are adjusted incorrectly, it was found that they caused fatigue and eyestrain within five to ten minutes. It is likely that this was the cause of the ocular discomfort (this issue was used to determine the six-minute duration for footage detailed above). Smartphone battery life also limited the viewing of one student as processing requirements whilst downloading and viewing 360-degree footage are significant. All users complained of simulator sickness. This was thought to have a significant detrimental effect on the immersive element of the virtual reality experience, distracting viewers from the footage and reducing the emotional impact of the experience, affecting the achievement of Objectives 2 and 3 of the study.

Simulator sickness (otherwise known as motion sickness or cyber sickness) is thought to be attributable to the disparity in messages from the eyes when they perceive motion in the images and the inner ear, which senses that the subject is still stationary. It is a common issue and a significant limitation when using virtual reality footage (Juanes, Gómez, Peguero, Lagándara, & Ruisoto, 2015; Rebenitsch & Owen, 2016; Schnall, Hedge, & Weaver, 2012). To reduce the impact of simulator sickness it is suggested that the camera should move as little as possible when capturing footage.

Discomfort from headset viewers has been reported by other authors. It interferes with the effectiveness of the virtual experience by distracting the viewer from the content of the video (Juanes *et al.*, 2015; Wang *et al.*, 2017). The main difference between two-dimensional and 360-degree video is the potential for immersion of the subject within the footage, making the viewer feel like they have been transported into the virtual world. This is referred to as 'presence' or 'telepresence' (Slater, 2009). In this study, discomfort distracted viewers, reducing the sense of presence in the virtual world.

Effectiveness of the virtual experience

Presence has a circular relationship with the emotional reactions of viewers in virtual reality. Increased presence will increase the emotional response, which will in turn further increase the sense of presence (Riva *et al.*, 2007). Objectives 2 and 3 of this intervention were to increase the emotional response of UK students and decrease their perceived distance from the Syrian refugees being studied. Four of the participants reported a strong feeling of presence: 'I was in the refugee camp but I wasn't in the refugee camp you know. It was just a positive experience…'; 'You feel like you are in the midst of them, in that

present…' and 'I perceived it well because it was like we were there with them.' In line with the findings of Blanco-Fernandez *et al.* (2014), students reported being able to see the world of the subjects of the footage from their point of view:

> *I don't know the way they live, but with that video it make me feel maybe sense the way them they live because I see everything is there now, but if maybe it was a traditional one like I was saying, maybe I can't sense that but now with that video 360-degree it make you feel and you know really [*sic*].*

Diemer, Alpers, Peperkorn, Shiban, and Mühlberger (2015) reported that arousal caused by excitation of emotions was important in enhancing presence. The footage of living conditions in Syrian refugee camps conceptualized the situation in the camps effectively and elicited a more emotional reaction than would have been experienced using traditional two-dimensional video footage. This is likely to have contributed to the feeling of presence: 'It is something that is new to me which I know and er, and what they are going through is really for me is sad [*sic*]'.

Participants all commented on the honesty portrayed by 360-degree video footage. Constructivist learning was occurring through the use of virtual reality as participants used the footage and their own knowledge to form conclusions (Johnson *et al.*, 2010):

> *OK we hear like statistics and all that from the WHO. They are suffering from this and this and that we don't get to see virtual like what they are really going through and how they live and overcrowding and all that, and just to see with your own eyes and other things is a lot better than look at numbers all day, like this much suffered from what [*sic*].*

Individually and through discussion with other participants, the student group realized that the 360 footage offered an honesty in its portrayal of the camp that could not be achieved using 2D filming. The view is dictated by the camera operator in 2D footage, potentially preventing important parts of the site being captured. Participants felt that they had been given the freedom to look around the camp with their Lebanese peers and come to their own conclusions about what they were seeing:

> *It is something new but is good because, it is good because it is giving you an overall view. You can see the image the way you want and you can see every corner of the, what the image that they took. So you know everything that they can show. Like we can say like now when we are seeing they didn't like cover anything. If you, you enter like in the one of the shelter they show you every corner in different layout [*sic*].*

Self-driven cognition of the subject matter appeared to be occurring, in line with Objective 2 of the study.

Participants also commented on the ability to watch discussions between camp residents and their Lebanese peers. They were able to witness both verbal communication and body language as if they were a third party to the discussion and turn to look, when camp residents directed their attention to part of the surroundings.

All participants from the student group found the use of virtual reality and 360-degree film footage a positive experience, despite some reported viewer discomfort. They expressed a wish to use the technology again themselves and for the technology to be used with a wider audience. Participants thought that the 360-degree video had the potential to become more widely used in education. The medium has strong potential to provide simulated access to environments that would otherwise be impractical for students to visit. It can be used to metaphorically transport students to locations where they can apply their theoretical knowledge, without the need for physical travel. It provides the means to access environments where students would not be permitted to enter, such as dangerous locations, or those requiring special authorisations for visits. The use of 360-degree video also increases the emphasis on students to explore an environment themselves, as opposed to being shown specific areas of interest by their instructors, encouraging self-driven learning and improving observational skills.

Conclusion

The use of 360-degree video, either through a virtual reality headset viewer or through desktop/laptop/tablet screen viewing contributed towards the first study objective; to apply theoretical knowledge to a real world issue, through simulation and scenario/problem based learning. This objective could have been achieved without the use of this footage, but participants reported that the 360-degree footage enabled a greater awareness of

the living conditions of the refugees being investigated. This would allow a clearer understanding of the health issues they were investigating during the study.

Objective 2 was satisfied in that students reported that their emotions were affected by what they saw in the refugee camp. The use of 360-degree video aided the provision of a broader cognitive experience, with students reporting greater awareness of what was in the camps than would have been obtained through 2D video footage. The 360-degree footage linked sight, sound and emotions to the camps, deepening learning about the conditions there.

Objective 3 of the study was satisfied in that students felt closer to the refugee camp they were learning about. Participants reported being able to see the camp with their own eyes and feeling like they were in the camp whilst viewing footage.

Students were able to move beyond theoretical situations in their learning, supplementing their research of the literature with the virtual visit to the refugee camp, experienced in Virtual Reality alongside their Lebanese peers. All participants found the Virtual Exchange and the use of 360-degree film footage a new and positive experience.

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