PRACTICAL USE OF OFF-THE-SHELF VIRTUAL REALITY FOR DISTANCE EDUCATION - A LOOK AT THE FEASIBILITY OF

PRACTICAL USE OF OFF-THE-SHELF VIRTUAL REALITY FOR DISTANCE EDUCATION - A LOOK AT THE FEASIBILITY OF NON-EXPERT USE

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Abstract

As the potential value of online learning and distance education becomes increasingly clear (considering, e.g., global health and climate change) we are motivated to push for practical use of emerging technologies at an accelerated pace, to further facilitate rich and flexible distance education. While the pedagogical value of lectures has been often questioned, it remains a common method of instruction, making them relevant to investigate within digitalisation. Virtual Reality (VR) affords valuable embodied experiences and is currently at a point where it is within reach for non-experts, but may require considerable additional effort.

By focusing on the use of off-the-shelf hardware and software to give virtual lectures, a larger number of educators can start experimenting within their comfort zone. The purpose of the current paper is to contribute to the acceleration of this process by describing challenges encountered in such an attempt to quickly employ readily available VR technology to give a lecture in VR. Is it possible for educators without previous expertise in VR to start using this technology now? What factors can be considered to make the experience positive to both educators and students?

The setup of the VR lecture in this case study had the lecturer entering a virtual environment remotely (from another city) using the free VR application Bigscreen with students and three observing co-teachers entering the same environment being co-located in one physical room. The study was performed as an action research intervention, and the results were documented with ethnographic observations and a focus group.

Some issues encountered may be avoided or minimized by raising awareness beforehand and additional preparation. Based on the present study, technical and ethical recommendations are given for which issues should be prioritized and how they may be dealt with, regardless of the educators' level of expertise, to be able to successfully conduct a VR lecture.

Keywords: virtual reality, non-expert use, lectures

1 INTRODUCTION

Recent developments, such as the Corona pandemic (short-term) and the need to decrease the carbon footprint of traveling (long-term), make it increasingly obvious that online learning and distance education can be a very valuable tool. At the same time, widespread implementation of video based online learning make the limitations of established formats clear and present. In this context, we are motivated to push for practical use of emerging technologies at an accelerated pace, to further facilitate rich and flexible distance education. Still, the changes forced into the classic educational system need to be executed quickly, and time and resources available for integration of new technology is always limited. While the pedagogical value of lectures has been often questioned, it remains a common method of instruction and by taking the online distribution of lectures as a starting point the transition may be made especially relevant for a majority of educators.

Virtual Reality (VR) affords valuable embodied experiences and has been highly valued for its potential for training and learning for decades, even as actual use in education has been limited to specific contexts such as military training. VR is currently at a point where it is within reach for non-experts, but there are still many potential stumbling blocks. The purpose of the current paper is to contribute to accelerate the adoption of VR by describing initial challenges when starting to experiment with VR, and discussing possible ways to address such challenges. The choice of off-the-shelf hardware and software to give virtual lectures is meant to focus on scenarios that are feasible and within the comfort zone of a large number of educators. Is it possible for educators without previous expertise in VR to start using

Figure 1: Lecture in Virtual Reality

this technology now? What factors can be considered to make the experience positive to both educators and students?

The setup of the VR lecture in this case study had the lecturer entering a virtual environment remotely (from another city) using the free VR application Bigscreen with students and three observing co-teachers entering the same environment being co-located in one physical room. The lecturer used the Oculus Rift S headset and a VR-capable laptop while the students used the simpler Oculus Go headsets. A predetermined view of the lecturer in the VR-environment was also shown via a projector, as a general fallback. The study was performed as an action research intervention, and the results were documented with ethnographic observations and a focus group.

The long-term goal is to contribute to the understanding of how teaching and learning in VR would work practically in a pedagogical context. Also, a development of better online learning and distance education systems could promote less travelling, leading to improved environmental sustainability of universities and other schools.

2 BACKGROUND

Online learning and distance education are transforming in the use of new technology and breaking ground in new educational contexts. The last two decades we have seen the rise and maturing of desktop video conferencing (video meeting) technology and video recorded lectures in higher education. In traditional online learning systems the experience is typically asynchronous, using pre-recorded material, but may also include synchronous elements, like chat seminars [1]. Today, it is also possible to meet in Virtual Reality, and this can be used for online lectures, seminars, workshops and other learning activities were students and teachers meet across a geographical distance.

The emergence of off-the-shelf Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) systems in the 2000’s, has enabled the exploration of new learning experiences [2][3]. For example, Head-Mounted Display (HMD) systems have been used for educational purposes, both in classrooms and from home, in order to experience natural science phenomena or travel in time and space [4]. In VR, students can experience molecular visualizations and quantum physics in the smallest scale, astronomy in the largest scale, and also make study visits on virtual field trips [5]). Previous studies of collaborative VR [6] show that the choice of VR system as interface to the environment affects experience, co-presence, and collaboration between users, such that symmetrical VR settings are preferred. For the VR lecture presented in this paper both for teachers and students had entered the shared virtual environment using VR HMDs.

Desktop video conferencing (video meeting) technology and video recorded lectures are now mature and commonplace in higher education. A typical university teacher can be assumed to have access to the required hardware and starting a video meeting or video recording can commonly be done in a minute or two. If this technology works, why explore meetings and lectures in VR at all? Video meetings have their limitations, some of which are becoming more clear as we see wider use. If we assume that distance education and online meetings will become an increasingly important tool to facilitate sustainable health and environment, we should consider alternative solutions to minimize such limitations. Compared to video, VR is immersive and creates a shared, three-dimensional space, aspects that can be of considerable pedagogical value especially in domain areas where spatiality and temporality is connected to the learning outcomes (just as an illustration we can mention architecture, industrial design, video game level design, anatomy and therapeutic massage as examples of such domains).

If we want to push for enriched distance education and the use of VR we have to address the fact that VR does not have the same maturity that video meetings has. The availability of the technology is still very low; very few university teachers have access to a VR setup. What about ease of use? If a video meeting can be easily launched from any laptop in minutes, how does Virtual Reality compare? Our trial suggests that there are significant challenges, but also a perceivable path towards efficient and more user-friendly usages.

3 METHOD

The general framework for the method used is action research, where an interventionist action is planned, designed and performed, and the result is observed and evaluated [7]. In pedagogical research this method is often used in a live, actual learning scenario, and the trial we report on in this paper was performed as a part of a course at University of Gothenburg.

During the preparations for and during the actual learning activity the four involved researchers used participatory observation [8] [9] [10, p.83], documented via written notes. The learning activity was documented with photography, as well as a screencast and video capture of the lecturers physical and virtual situation. There were some limitations to participatory observation in this trial. The notes made were mostly descriptive and short due to the numerous interruptions induced by the technical support required.

Directly after the learning activity a short unstructured group interview and a simple paper based survey was done to gather impressions and insights from the students.

4 SETUP OF THE TRIAL

In this trial, a lecture was held in VR, for a small group of five students. The lecturer, the course examiner and the two co-teachers of the course were all involved in the learning activity, while observing the event. The topic of the lecture was VR, and the course subject is design and implementation of visualizations.

4.1 Summary of participants

Remote Lecturer: Holds a lecture remotely.

Examiner, Researcher 1: In VR, part of the class

Co-teacher, Researcher 2: In VR, as a teacher communicating with remote lecturer. Has control of the virtual camera view shown on the projection in the physical room.

Co-teacher, Researcher 3: Outside VR, observing the class. During the session, Researcher 3 had the task to observe the class from the outside. However, there was a number of technical and human issues that had to be solved from the outside.

Students: 5 students, in VR, microphones disconnected.

4.2 Course

This lecture was given in the context of a course in Visualisation in Architecture, Art and Design. The content of the lecture was an introduction to Virtual Reality and to different equipment and software available on the market.

4.3 The lecture

The topic chosen for the VR lecture was *An Introduction to VR*. The reason for this was to highlight for the students the environment and context of the lecture, and to utilize the virtual environment as an illustration to the lecture itself. During the class, it was natural for the teacher to refer to the ”lecture room” as a virtual space, and himself as a virtual avatar, when describing VR technologies, devices, and

Figure 2: Photo of the lecture in Kuggen Medialab.

interfaces. All of this in analogy with a teacher in architecture that would hold a lecture about lecture halls in a lecture hall.

4.4 Physical rooms

The students and the three observers (examiner and two co-teachers) were located in Kuggen Medialab, at Lindholmen in Göteborg (Fig. 2). This is a media studio used for a wide variety of media production and exhibition, from visual effect shots and recorded lectures to VR productions. The room is about 30 square meters, with full control of light (no windows) and sound (semi-professional acoustic isolation and diffusion). There is a **HTC Vive** and an **Oculus Rift** set-up, and the latter was used in this trial. The Medialab is highly flexible and for this trial it was reshuffled with extra chairs to accommodate the five students and the three observers.

The Remote Lecturer used a room intended for recording educational videos at University West, in Trollhättan, Sweden. Using an **Oculus Rift S** headset and a VR-capable laptop (an Alienware laptop with a Nvidia RTX 2060 graphics card) it was easy to setup VR in this room, with privacy and additional options for recording video. The Rift S headset is one of several now available headsets with inside-out tracking, based on computer vision and cameras integrated into the headset. This means that no external equipment other than the actual headset and hand controllers is required, one simply connects one DisplayPort and one USB cable to the laptop. This ability to easily bring a full featured VR system into any room in minutes is one example of capabilities now becoming widely available, making new rooms and solutions feasible and facilitating the integration of these technologies into practical learning activities now and in the near future.

4.5 Virtual room

We chose to use the free to use VR application **Bigscreen** to bring the lecture to the students in VR (Fig. 3), based on previous experience with the application. Bigscreen is a social application were users can co-exist in a virtual space, and see each other as stylized avatars. The view of the VR computers

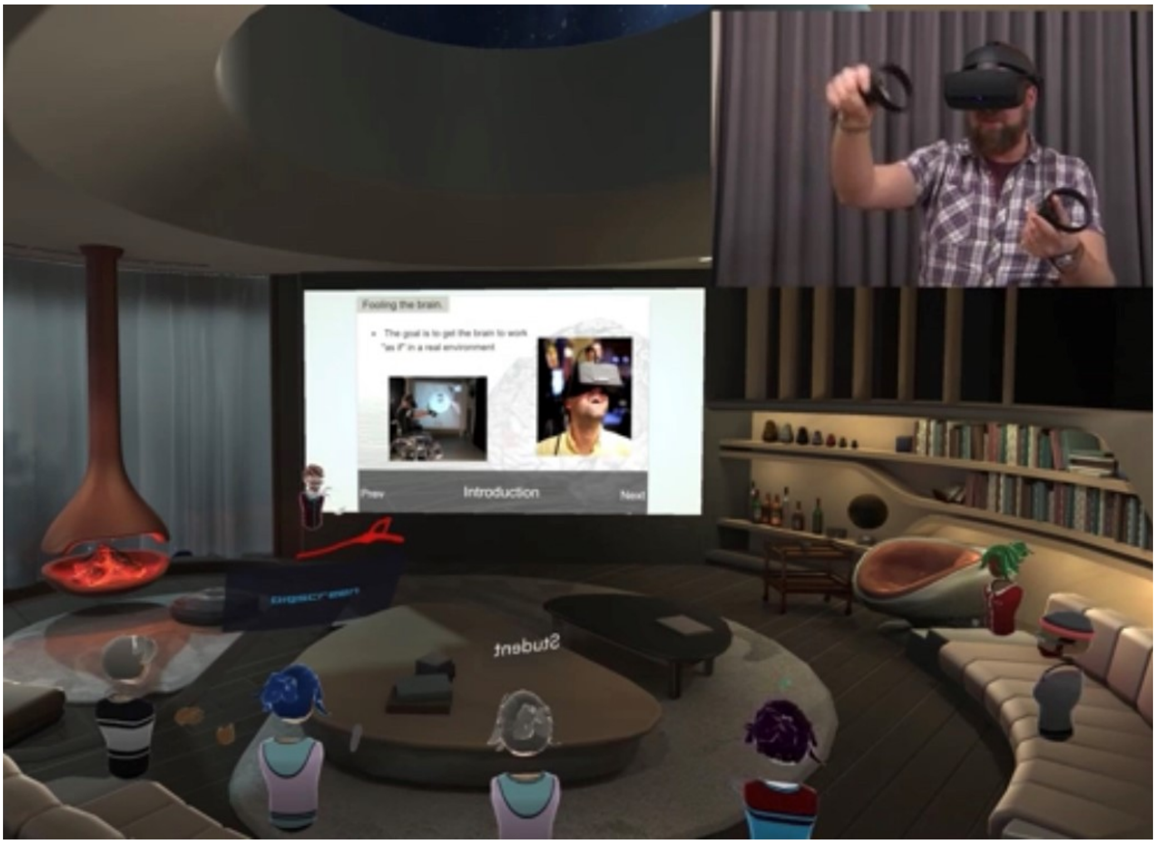

Figure 3: Capture of the virtual lecture room with overlaid capture of the lecturer (top right corner, not visible to participants).

desktop can be shown on a large screen inside Bigscreen, thus sharing anything visible on the computer screen. This enabled the lecturer to reuse an existing presentation prepared for lecturing with a projector, and rely on Bigscreen to share the desktop view of the presenter in VR. Some minor adaptations were made to the presentation to facilitate the use of hand controllers in VR to control all desired actions, where some would otherwise be typically executed using the keyboard (which is not in view in VR). The possibility to draw freely in 3D in Bigscreen was used to quickly sketch where the teachers physical computer and desk were in the real world, providing an easy assurance for the teacher that these would not be hit while gesturing and giving the students a sense of the teachers physical environment. Bigscreen also provides voice chat which was used to transmit the lecturers voice.

4.6 VR headsets and hand controls

Each student had their own Oculus Go headset, an inexpensive and simple headset with 3 degrees of freedom (ability to look around in all directions, but no tracking that allowed translation through the virtual environment). Each student had a Oculus Go hand controller, with 3 degrees of freedom (it can be used to point at different directions and make input selections, but does not allow tracking of hand positions, so gestures such as waving was not possible. The lecturer (in a Oculus Rift S) and one observer (in a Oculus Rift) had 6 degrees of freedom (DOF) on both headset and hand controllers. Thus, the teachers had 6 DOF while students had 3 DOF headsets, leaving the students more constrained in their motions in the environment. Both teachers and students could teleport in the environment, so the set-up was quite, but not fully, symmetrical.

As a complement to the individual Go headsets, there was also a projected image in the physical room showing the virtual lecture hall from the viewpoint of the observer in VR. This image was generated by positioning a virtual camera in the virtual environment (using a feature built into Bigscreen) and it was intended as a backup plan if the Oculus Go headsets didn't work. Audio was available from both the Oculus Go headsets and speakers from the Oculus Rift computer. The Oculus Go was borrowed from Visual Arena, a collaborative hub for the development and use of visualization.

5 RESULTS

5.1 Preparations before the lecture

Since this was the first time we arranged this set-up, we allowed extensive time for planning and testing. We had one planning meeting (about an hour) to plan the lecture and to familiarize ourselves with the application Bigscreen. We had half a day of testing when three of the headsets were brought in, and then on the day of the lecture we had half a day (four hours) of set-up time with all the head-sets borrowed. This was well needed time. The most important set-up problem was to get a working Internet connection for the Oculus Go headsets. We first tried to use a router that was dedicated to work with the headsets. However, there were severe technical problems of connecting the router to the Chalmers network, partly due to the strict security settings on the Chalmers LAN. Next we tried to connect the headsets via the wifi Eduroam, and eventually we managed to solve this. This meant that we needed unique login accounts on Eduroam for each individual headset. All in all, this was the procedure that needed to be done on each individual headset:

1. charge the headset
2. create unique Eduroam account
3. connect to Eduroam
4. download Bigscreen
5. launch Bigscreen
6. create unique Bigscreen account
7. log-in to Bigscreen with a unique account
8. join the correct Bigscreen room

5.2 During the lecture

The lecture occurred on Monday the 25th of November 2019.

1. Perhaps the biggest issue during the lecture was with delayed audio. Each Oculus Go headset had it's own connection to the local network, and each headset had a slight delay of visuals and audio. This delay was different for different headsets, with approximately up to one second difference. The ear pieces on the Oculus Rift is not covered which means that the sound leaks out into the physical room. The effect was a mix of five different audio, all with slight delays compared to each other, which caused a very disturbing reverberation effect. This could have been solved by muting all Oculus Go headsets, and have audio only form the Oculus Rift computer speakers, then all audio would arrive at the same time. However, the issue was discovered first when the lecture had started, and fixing it would have taken quite some time.
2. As mentioned above, the viewpoint from the Oculus Rift was displayed on a projector screen as a backup for students if the Oculus Go headsets didn't work. Now and then during the lecture, students took of their headsets and actually followed the lecture on the screen. However, there was issues with this viewpoint. During the lecture, this camera got misplaced and switched to first person view which resulted in exposing how the researcher tried to tinker with the system. The students reacted to this with smiles. For the person using the Oculus Rift it was difficult to have an overview of how the viewpoint worked for the students, and this observer continuously had to pull of the headset to double check the experience in the physical room.
3. Out of the five students, two students removed their headsets after about 15 minutes, one due to claustrophobia, the other because of nausea. These two students never put on the headset again for the reminder of the lecture, however, they did follow along via the projected view of the virtual environment.
4. On a few occasions, the lecturer utilized the VR environment to illustrate and exemplify aspects of Virtual Reality. Whenever the lecturer would discuss the technical capability of the Oculus Go, the students still wearing the headset tried rotation and tilting.
5. Limited space and lack of physical awareness: The space available was quite limited, and while most students kept to their own seats, one of the researchers stood up and moved around. There is a lack of awareness of how close or far the other participants are, so there was a risk of collision. There had to exist interventions for the researcher not to come too close to the students.
6. The same user account on Bigscreen was being used on all headsets, and therefore, all students had the same name tag in the Virtual Reality environment. This caused some confusion but could not be solved during the lecture time.

5.3 After the lecture

Participants were handed out a short questionnaire after the experience. After filling in the questionnaire, an unstructured group interview was conducted by the researchers, who lead the discussion with general questions about the experience. The group interview with the students afterwards was brief and quite quickly ventured into more general questions such as privacy issues in VR, but the following two comments is worth to bring up.

- When prompted for remarks on what they remembered from the lecture one student stated that ”I was a bit distracted - I tried to concentrate, I felt like I was tense, I did not feel comfortable, even though I was physically comfortable. I felt tired when I took off the headset.”
- When prompted for sources of distraction several of the other students offered similar comments; ”Curiosity of looking around”, ”One of the persons moving around a lot (in the virtual environment)”, ”The vacuum cleaner was distracting” (the virtual lecture hall had an animated vacuum cleaner moving around), and ”In a VR room everything is equally important - compared to physical room where you filter things away. Lacking depth of field where you blur some zones in reality while in VR everything is sharp”

5.4 Post-lecture reflections and takeaways

Generally, the lecture was somewhat successful, but some points could clearly be improved or changed for better results. In a post-lecture reflection session we noted a number of improvements that can have been made.

5.4.1 Ethical and Accessibility

1. Offer a detailed introduction to the students of what will happen during the lecture. The introduction given was perhaps too short, and a number of important aspects were not mentioned.
2. Inform of the expected length of the lecture.
3. Clarify to the students that it is perfectly acceptable to remove the HMD at any point during the lecture and that a number of people do feel uncomfortable using them.
4. Make sure there is a functioning alternatives for the students to attend the lecture, even if they do not use VR.

5.4.2 Technical

1. Avoid multiple users in tight physical spaces, due to audio feedback and to the lack of physical awareness each user has.
2. Guarantee fully charged batteries at the start of each session.
3. If possible, have a spare VR HMD available.
4. Include a list of common failures, such as overheating, and inform the students on what to do in the case of malfunction.
5. Assign the role of technical support to someone not holding the lecture, if there are participants who are not fully familiar with the equipment

5.4.3 Pedagogical

1. Take advantage of the given tools, try to connect as much as possible to the participants by relating to their use of the virtual environment, and VR equipment.
2. Encourage the users to explore the system before starting lectures, given them time to accommodate to the interface at hand.
3. Consider readability of the material in the lecture, make further use of images rather than text, as text may be difficult to read in VR.

6 DISCUSSION

In summary, the lecture needed extensive preparation and troubleshooting, but was eventually a success. Interestingly, it was not really the Virtual Reality technology itself that was challenging. On the contrary, both Vive and Oculus is quick to start, and the application Bigscreen is quite easy to launch and use, even if the user interface could have better usability. With some experience, launching a meeting in Bigscreen takes 3-4 minutes, approaching the one-minute launch of a typical video meeting application.

The major problem concerned the student headsets. These had to be borrowed, which required planning ahead. It was also a time-consuming process to set them up, especially solving the problem with connecting them to Internet. Finally, the audio reverberation experienced during the lecture was also an issue with the student headsets. Additionally, we need to consider that there were only five students in the Medialab. It is obvious that with a larger number of students, many of the headset issues would have escalated even more. Of course, these issues with the headsets came out of the set-up we chose; to have students in one physical location with headsets we provided. If we compare to the standard set-up of an online lecture, then each student is physically located on their own (at home, for example). Each student then takes care of their own equipment to experience the lecture (usually just a laptop with a screen and speakers). If we had chosen that option, the lecture had been impossible; none of the participating students owned or had easy access to a headset of their own.

The preparations for the lecture took about 12 person hours. With the experience we now have, we could probably redo the preparations in 2-3 hours. If we owned our own Oculus Go headsets, they could be permanently prepared, and then the preparation time could probably be cut down to an hour. Finally, it was clear from the comments from the students that the Virtual Reality environment itself, and the physical hardware in form of the headset, was distracting from the lecture due to a number of reasons. Even if the number of subjects was very low, these comments suggests that this might be a substantial issue in Virtual Reality lectures. One possible solution might be to let the students acclimatize to the environment before actual lectures are given. Further research would be needed to explore how long time would be needed for such acclimatization, and also explore how the design of the virtual room itself can support such acclimatization.

6.1 Alternative solutions

One alternative to Bigscreen that we have some inital familiarity with is Mozilla Hubs. Very briefly, **Mozilla Hubs** have a strong advantage in that it easily allows students to enter a virtual environment from their web browser, as spectators without VR equipment, but it also lacks some of the initial simplicity of Bigscreen from the lecturer's perspective. Simply presenting and interacting with your desktop screen in Bigscreen is a powerful solution to get access to your usual lecturing material. While Hubs has the possibility to share your desktop visually it does not allow you to interact with it while in VR, which makes the setup more complicated from the lecturer's perspective. Thus, the Bigscreen application chosen for this experiment currently has a strong position when it comes to providing an easy access point for educators.

7 CONCLUSION

Compared to established tools for distance education, such as video meetings, the preparation time was significantly longer but the VR setup with off-the-shelf VR hardware and software worked relatively well for the lecture itself. The primary problems encountered concerned the student headsets and the preparation of and interaction with the students in the physical room. In addition to practical issues with managing a larger number of headsets (there were 5 headsets for the students) there were significant problems in getting the audio to work well as well as technical problems with Internet access. During the lecture more behavioral and social issues came to the forefront, for example students being uncertain about how to behave in the unfamiliar environment. Out of five participating students, two experienced discomfort, but were uncertain about how to act and whether it was OK to take off their headsets or not. In summary, VR lectures require extensive preparation concerning both technology, social interaction and student understanding of the situation.

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