Work-in-Progress—Learning about Virtual Worlds in Virtual Worlds: How Remote Learning in a Pandemic Can Inform Future Teaching

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***Abstract*—In response to the COVID-19 pandemic, many university classes shifted to remote learning. In some cases, this requirement intersected in productive ways with course content, especially when the class subject matter included virtual environments. This paper describes teacher and student experiences in an upper-level communication course on virtual worlds at a large United States university. As regular lectures moved to video conferencing and asynchronous communication, "field trips" and guest lectures became opportunities for students and teachers to connect remotely using desktops and headsets. We discuss how this will inform the design of future courses that combine face-to-face and virtual instruction.**

***Index Terms*—XR, distance learning, COVID-19, virtual learning, virtual reality**

I. Introduction

Leveraging the unique qualities of augmented, mixed, and virtual reality (XR) for education has been the subject of research and development for decades [1], [2]. Besides promoting XR's advantages for embodied learning [3] increasing engagement and interactivity [4], researchers have also discussed XR's utility for learning at a distance [5], [6]. However, despite the potential for connecting students and teachers who are separated by distance, much research on learning in XR takes place with students and teachers together in the physical classroom. In the recent pandemic, students and teachers in many university classrooms were suddenly separated at short notice. We discuss a case study of a class that already included immersive virtual reality experiences in its usual syllabus. As instruction became virtual, students and instructors connected using some of the environments they were studying and used the opportunity to reflect on class concepts.

The sudden shutdown of universities, in many cases, mid-semester, was an unprecedented event. However, this experience not only offers the opportunity to investigate how students learn in virtual environments in extraordinary circumstances; but also the opportunity to prepare for virtual teaching and learning in future semesters. This includes the challenge of accommodating students who are engaging via desktop equally with those who are using headsets [7], and negotiating these challenges during times that the teacher and students are not co-located.

As a first step toward these goals, we present student and teacher reflections on the semester and summarize the next steps in preparing for subsequent virtual experiences. We asked a series of questions. First, how did communicating in virtual worlds affect students' sense of presence with their instructor, and their sense of presence with their fellow students? Second, how did technical difficulties and at-home distractions affect the student and teacher experience? Third, how did learning *in* XR affect student learning *about* XR? We discuss student and instructor responses, and how these may inform future efforts in virtual learning.

The aim of this study was to collect preliminary data on students' experiences of learning in virtual environments when not co-located. The class in which these students were enrolled was an upper-level undergraduate course at a large United States university. The class title was "Communication in Virtual Worlds" and the course content emphasized embodied, immersive virtual reality. In-person instruction stopped in week eight and resumed after a three-week hiatus.

One of the last topics scheduled to be discussed in this class was education applications in XR. In order to inform this class discussion, students were asked to complete a survey after each virtual field trip, and then a final summary survey. Their responses to each survey contributed to the final in-class discussion on Zoom.

II. Methods

The class in which these students were enrolled was an upper-level undergraduate course at a large United States university.

A. Participants

The class was comprised of 24 undergraduates from classes across the university, including students from Business, Communication, Design and Environmental Analysis, Information

978-1-7348995-0-4/20/$31.00 ©2020 Immersive Learning Research Network
6th International Conference of the Immersive Learning Research Network (iLRN 2020)
Online, June 21-25, 2020.

Science and Computer Science. Most were upper-level undergraduates (juniors and seniors), although there were a few first-year students.

Students were given the option to consent to have their data saved, and also given the option to provide their contact information to be interviewed after the class was over. The instructor was not made aware whether or not students had consented to have their data saved until the semester was over, and students were not contacted to be interviewed until after the semester was over. Six of the 24 students consented to share their data.

After instruction became virtual, four weeks of instruction remained in the semester. Each week, students participated in one class session on Zoom, and visited one virtual world or environment as a "field trip". In these field trips, students discussed content as a class, listened to guest lecturers, or listened to the instructor. In total, they visited three different virtual worlds (Mozilla Hubs, Second Life, and Rumii). These were selected to be broadly accessible to students connecting via desktop computer, both Mac and PC, and headset.

The three virtual worlds used could be connected to by headset and desktop. Before leaving campus, a donation of equipment created the opportunity for students to borrow headsets (Oculus Go, https://www.oculus.com/go/) for the remainder of the semester. Of the 24 students, 6 elected to borrow a headset, and the rest joined class sessions via desktop.

In the first session, in Mozilla Hubs, the instructor led the class while wearing an HMD with hand controllers, while a graduate student recorded the class session. In subsequent sessions, the instructor recorded from their desktop in order to accommodate students who were not able to attend classes due to time zone issues.

1) Mozilla Hubs: In this field trip, students visited a private room in Mozilla Hubs (https://hubs.mozilla.com). Students selected stock avatars but were required to use names, so they were not anonymous. They communicated by both chat and voice, but audio issues due to a high number of attendees meant that some students had to log into the environment multiple times. They listened to a short lecture on social presence and nonverbal behavior, and then broke out into small groups to discuss the interface.

Fig. 1. The first virtual world visited was Mozilla Hubs. The instructor is the blue robot in the back corner and the students are facing the instructor with their backs to the camera.

Fig. 2. The second virtual world visited was Second Life. The guest speaker is to the far left of the frame, in the top hat, and the students are facing her.

2) Second Life: In this field trip, students visited an academic lab in the non-immersive virtual world, Second Life (https://secondlife.com). Students again selected stock avatars but were required to use names, so they were not anonymous. Students communicated through both text and speech. They listened to a guest lecturer speak on accessibility in virtual worlds and viewed virtual environments that were built by blind users. Students navigated around the academic lab's island location, following the guest lecturer.

Fig. 3. Third virtual world visited: Rumii. The guest speaker is in the center of the frame, gesturing toward a student out of frame who is asking a question. The students are in a circle facing her. Videos were displayed on the wall behind the quest speaker.

3) Rumii: In this field trip, students were able to lightly customize their avatars. They used names associated with their real-life names. Students again communicated by both text and speech. They then visited two different virtual rooms, listened to a brief guest lecture, and watched a demo reel in Rumii (www.dogheadsimulations.com/rumii), a consumer virtual environment.

III. Data Collection and Preliminary Analysis

Data collection took place in several forms. First, students completed a brief survey after each excursion to a virtual world and a final summary survey. Their responses to each survey contributed to the final in-class discussion on Zoom. Second, the instructor took notes on their experience. Third, all classes were recorded (as required by the university to accommodate students in different time zones who could not attend the class synchronously). Two students agreed to be interviewed after the semester was over (these interviews are yet to be conducted). Finally, the instructor (an author on this paper) was also interviewed by another author on this paper.

IV. Discussion and Results

The following summary is taken from interviews with the instructor after each class, as well as student survey responses.

A. Felt Heard

Students stated that they felt "most heard" in either Zoom or Rumii. Of the three students who preferred Rumii, all had used headsets. One student who stated that they preferred Zoom mentioned, "This could change if I become more comfortable with the other platforms and find more ways to express myself through them."

B. Closeness to Instructor

Students stated that they felt most connected to the primary instructor in Zoom lectures. This may have been in part because guest lecturers were featured in each of the virtual worlds. "Well, our professor usually doesn't talk as much when we are in settings other than zoom because we have guest speaker and we can see her real face in zoom. So I would say zoom." However, some students answered this question in regards to their feelings of closeness with the guest lecturer, as discussed below.

C. Closeness to Other Students

Students stated that they felt most close to their fellow students in virtual worlds, with only one student selecting Zoom: "With zoom, most of my classmates didn't speak or have their videos on, so I didn't feel connected to them in any way. In the virtual environments, I saw their avatars moving and people were more willing to talk or chat, so it felt more authentic than Zoom."

D. Modes of Verbal and Non-verbal Communication

Although audio was available in all virtual environments, many students communicated through chat. This persisted through small group breakout interactions. The instructor reported prompting students to speak to one another to shift their primary mode of conversation from text to verbal, and saying it was akin to prompting students to turn on their cameras in Zoom.

Students and the instructor had to adjust to communicating non-verbal behaviors in online verbal environments. It was unclear whether students were paying attention even if their avatar was facing the instructor, although the ring of silent faces appeared extremely attentive. The instructor learned to pause longer for student responses after a question than they typically would in the classroom. This was because they could not rely on eye contact to elicit student responses. The instructor reported that engaging with the class was much easier in the one session in which she was able to use an HMD with hand tracking.

However, students demonstrated an interest in communicating non-verbal behavior, once they learned that it was possible. Students always faced their avatar toward the speaker and arranged themselves in a non-overlapping semicircle. Students also evolved gestures. For instance, an avatar can nod in Mozilla Hubs and Rumii by rotating the view of the avatar up and down via the keyboard, and students used this gesture on occasion, even though they had to consciously decide to nod and then take action. The instructor reported students using emojis and animations when available. As one student reported, it was "interesting, social rules still apply."

E. Class Challenges

Students reported technical issues as the biggest challenge for the course, with 6 separate mentions of problems with audio and lag. There were also technical difficulties associated with specific virtual environments. For example, one student complained "can't read people's names due to overlap or bad positioning." One student described trouble understanding "what my avatar was capable of doing in this environment." In addition, the instructor reported that the number of students in a given environment could sometimes impair performance.

Students faced a steep learning curve in using the equipment without having someone co-located to assist them. For instance, in the first virtual lecture, the instructor used approximately 25 minutes to transition students from Zoom to the virtual environment. The transition time reduced with subsequent classes to about 15 minutes. However, some students still preferred to participate via Zoom on the instructor's shared screen.

F. Class Benefits

Considerable work on learning in XR has highlighted increased engagement as a benefit [8]. Students also reported this: "All in all, though, I found it to be incredibly interesting and engaging. I was actually surprised by how well I was able to stay engaged even though it felt like a video game at times." In contrast, several students identified their experience in Zoom as "More easily distracted. Easier to zone out if cameras were off." Thus, immersive systems can possibly reduce the risk of reduced student engagement when learning remotely.

Several students stated that the overall experience helped with class concepts: "It allowed me to grasp the concepts more due to a hands-on learning mode" and "I also learned pros and cons of different remote learning techniques." The experience of visiting virtual worlds was inherently interesting for students: "It was incredibly interesting getting to explore Second Life. That world that is totally foreign to me...it was fantastic."

While the original version of the class featured several experiences in virtual worlds, using a variety of platforms under varying conditions brought home the real-world challenges of deploying this technology. Several students mentioned this in their feedback: "I understood better how it is a learning curve to enter" and "It showed me some of the issues that face accessibility to virtual reality. For people with an unreliable internet connection, they'd really struggle to keep up with learning in virtual environments."

G. Headset and Desktop Users

One issue was the potential disparity between students who were able to access a headset, and those who did not have one. In this study, three of the six students who consented to have their data used had also borrowed headsets, so their responses were over-represented. Some students were reluctant to borrow a headset at all. When asked if they wished that they had used a headset, one student said, "I'm not sure if it would have made it harder or easier for me to immerse in a new environment with distractions and adaption...However, at the brief amount and level that we used the platforms, I think it could have deterred me more."

However, several students mentioned that they would have found headset use advantageous if they had been able to pick them up before the campus closed. For example, "I think I would have felt more immersed in the virtual environments and therefore found it easier to pay attention in class and not be distracted." One student who had a headset and used it only once explained their actions as follows: "The biggest benefit [of joining via desktop] is the ability to easily see [the professor's] slides while also being able to take notes...I was unable to do this in the headset. However, after experiencing it, I greatly prefer the VR headset experience. It was not as difficult to use than I had anticipated."

H. Home Distractions

Four students reported some notable distractions in their environment in at least one session. Distractions included a friend or a family member either walking by, entering their room, or in close view, or making noise outside the room. However, it is likely that a subset of potential students will always be working from a somewhat distracting environment, and this will need to be taken into account in future classes.

V. Conclusion and Future Work

In this study, we explored students' experiences in virtual worlds. We found that students who responded to the survey were overall enthusiastic about the experience. However, there is also clearly response bias in our small sample.

One notable finding was students' reported desire for social connection, and how even minimal interactions in different types of virtual environments can promote the feeling of togetherness with classmates or teachers. Social closeness to classmates is an important aspect of the classroom that was particularly missed when separation was enforced. Breaking classes into smaller groups to facilitate interaction was one successful strategy.

Virtual field trips also offered the opportunity for guest lecturers to connect with the class from anywhere in the world, and participate in classes on an equal footing with the primary instructor. One key element of successful guest lecturers was their own familiarity with the virtual environments. Guest lecturers who were already very familiar with the control systems could deploy nonverbal behavior in aid of their teaching, and thus be more effective. As one student said, "I felt strangely closest to the guest speaker because I could "see" her for the first time and could sense her commandeering of the environment and personality. My focus was on her avatar's speech, motions, and guiding of the environment."

Technical challenges were a huge component of the student experience. Most of the suggestions on how to improve the virtual experience mentioned technical difficulties; for example, "Technical difficulties were amplified even greater in VR, as it required a stronger internet connection and when that is not had, the lag made it incredibly difficult to stick with the class." However, the ability to personally experience technical challenges also augmented student learning in some ways. For example, "It showed me some of the issues that face accessibility to virtual reality." While students are sometimes overly optimistic about deploying virtual worlds to real-life settings, these experiences provided them with a realistic view of the challenges without dampening their enthusiasm.

While virtual worlds may not be appropriate for all types of remote learning, this experience encouraged us to further incorporate experiential learning in virtual worlds even when it is possible for students and teachers to meet face-to-face. The experience of engaging with the technology and all its frustrations adds a welcome social aspect and makes class content especially salient. Future classes can build on these preliminary findings to better understand how to learn about virtual worlds in virtual environments.

Acknowledgments

The authors wish to thank Angel Hsing-Chi Hwang for her assistance in obtaining the images shown here. We also thank our guest lecturers, Dr. Donna Z. Davis, Dr. Becky Lane, and Dr. Ketaki Shriram. Finally we thank all the students in the class for their adaptability and patience during this challenging semester, and especially those who shared their comments.

This work was supported in part with Oculus Go donations from Facebook Technologies.

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