Teachyverse: Collaborative E-Learning in Virtual Reality Lecture Halls

Karola Marky, Florian Müller, Markus Funk, Alexander Geiß, Sebastian Günther, Martin Schmitz, Jan Riemann, Max Mühlhäuser
Technische Universität Darmstadt
Darmstadt, Germany
{marky,mueller,funk,geiss,guenther,schmitz,riemann,max}@tk.tu-darmstadt.de

(a) **(b)** **(c)**

Figure 1: (a) A lecturer giving class in our Teachyverse environment, (b) photo of our in-the-field study with students attending a virtual lecture in Teachyverse, and (c) a group of students attending at the virtual lecture hall.

ABSTRACT

Over the last decades, E-learning has gained a lot of popularity and enabled students to learn in front of their computers using Internet-based learning systems rather than physically attending lectures. Those E-learning systems are different from traditional learning and do not fully immerse the student in the learning environment. Thus, we propose Teachyverse, an immersive VR lecture hall that combines e-learning, traditional learning, and remote collaboration. Teachyverse immerses the student in a virtual lecture hall. A proof-of-concept study shows that students perceive lectures in Teachyverse as fun and would like to use Teachyverse as a further E-Learning option.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**.

MuC '19, September 8–11, 2019, Hamburg, Germany

ACM ISBN 978-1-4503-7198-8/19/09…$15.00
https://doi.org/10.1145/3340764.3344917

KEYWORDS

Virtual Reality; Lecture halls; E-Learning; Virtual Lecture

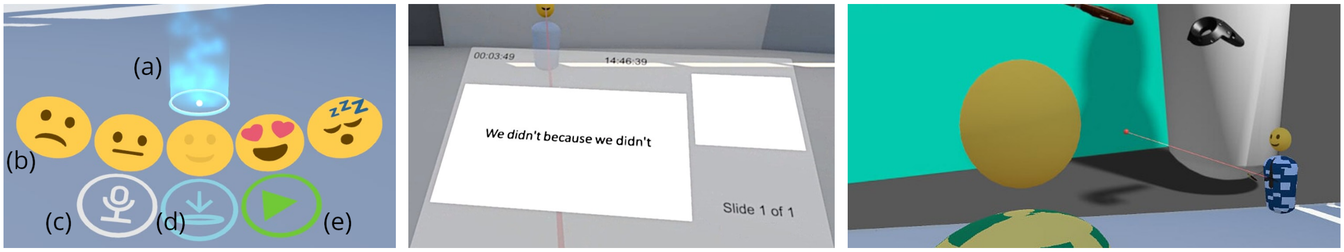
ACM Reference Format:
Karola Marky, Florian Müller, Markus Funk, Alexander Geiß, Sebastian Günther, Martin Schmitz, Jan Riemann, Max Mühlhäuser. 2019. Teachyverse: Collaborative E-Learning in Virtual Reality Lecture Halls. In *Mensch und Computer 2019 (MuC '19), September 8–11, 2019, Hamburg, Germany.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3340764.3344917

1 INTRODUCTION

E-learning has greatly advanced in the past years, thus computers, mobile devices, and digital learning materials have become an integral part of everyday learning life. For instance, in Australia and other countries with many rural and remote located areas, specialized schools offer an E-Learning over a distance through webcams[1].

Although E-Learning platforms have great advantages such as remote participation or collaboration, a majority of approaches targets students in front of computers or mobile devices on which they either read a text or watch a video. Therefore, the students are physically separated from their learning material. This separation could result in a lack of the student's attention and students could easily get distracted. Furthermore, the collaboration with other students is not

[1]https://www.education.wa.edu.au/distance-education, last accessed 04/01/2019



(a) **(b)** **(c)**

Figure 2: Subfigure (a) shows the available actions for the student: (a) teleport target, (b) different facial expressions, (c) mute/unmute, (d) select teleport, and (e) play/pause (in playback mode), Subfigure (b) depicts the lecturer's presentation view hovering in front including the current and next slide, as well as lecturer annotations and Subfigure (c) shows a lecturer giving class in front of students.

fostered, which introduces a gap to more traditional learning approaches such as lectures.

Virtual Reality (VR) systems have been widely used in educational contexts, such as medical [5] or industrial training [6]. Immersive VR reduces distraction and connects the students to their learning materials and other students in a virtual environment. While VR enables new possibilities in immersive environments, learning in such scenarios is still underexplored.

In this paper, we present Teachyverse: A concept that enables E-learning by immersing the students in a virtual lecture hall. Students and lecturers are represented by 3D avatars and can chat with each other by real-time audio transmission. Lectures can be live-streamed or recorded. We conducted an initial proof-of-concept study by evaluating our Teachyverse concept during a regular lecture (see fig. 1a, 1b). The positive feedback of the students showed the high potential of a virtual lecture hall as a novel method to participate in classes. Therefore, VR systems, such as Teachyverse, are promising in bridging the gap between E-Learning and traditional learning.

2 RELATED WORK

Virtual Learning Environments (VLEs) are environments that are specifically designed for learning. VLEs are used in vocational training for specific tasks in which reality-based training cannot be applied due to various reasons such as cost, physical danger or physical limitations [3], but a first-person perspective that is needed to allow the construction of knowledge [9]. Since Virtual Reality removes the need for a symbolic user interface, it enables students to learn concepts and to solve problems in a non-symbolical way [11].

Collaboration is one of the most important parts of an educational environment as it promotes social interaction where students work together (e.g., CocoVerse [7]). During the development of collaborative VLEs it is important to enable visual, gestural, and verbal interaction through the usage of an avatar [10]. Virtual space enables persons to adopt their points of view while other users can still see where the person looks or points [1]. This goes along with the idea that virtual worlds can be a shared experience as well as an individual experience [2].

3 CONCEPT AND PROTOTYPE

We present our concept of a Virtual Reality lecture hall called *Teachyverse*. It allows students and lecturers to meet for a lecture in VR. The lecture can be held remotely, so there is no need for being in the same physical space. A simple avatar represents each person attending with a stylized face as depicted in Figure 1c. The student can select the facial expression of the avatar from five predetermined expressions: sad, indifferent, happy, loving, and sleeping (cf. Figure 2a (b)). These should enable other students and in particular the lecturer to make a rough assessment of the interest and presence of the persons. Real-time audio transmission enables the natural communication between students and between the lecturer and students. If enabled by the lecturer, each student can move around by teleporting themselves, based on locomotion techniques investigated in previous work [4]. Otherwise, a random position in the lecture hall will be assigned after entering the virtual space through a user menu on the ground as depicted in Figure 2a.

The virtual lecture hall is equipped with a large presentation screen showing the current slides. Further, the lecturer can add annotations and custom drawings on it using a brush tool, and can also wipe them with an eraser tool (cf. Figure 2c). The annotations and drawings are displayed to the students on the large presentation screen. The lecturer has full control of the presentation with a virtual presenter that allows switching slides, laser pointing and provides control

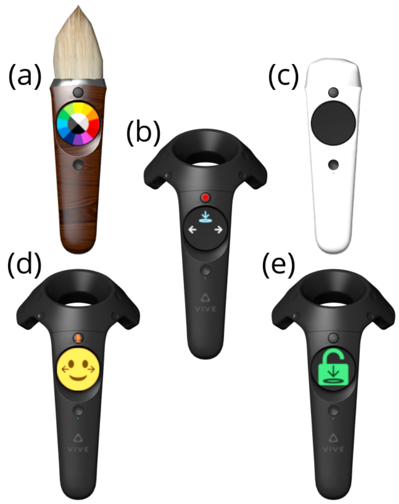


Figure 3: Available tools for the lecturer: (a) annotation brush, (b) presenter and teleport, (c) eraser, (d) facial expression, and (e) enable/disable student teleport.

over lecture recordings. All lecturer tools can be toggled by squeezing the controller and are depicted in Figure 3.

To support the lecturer as in traditional learning environments, an additional presenter view is always visible in front of the lecturer at waist level as depicted in Figure 2b. Also, to allow questions and discussions during a live lecture, both, the lecturer and the learners, can use an internal speech communication system. However, to limit unwanted noise during the lecture, the lecturer can mute all student communication.

Besides live lectures over a distance, Teachyverse also supports a recording of lectures with playback control. This contains all shown slides, as well as all movements and verbal communication of the participating students. Lecture recordings can be paused, rewind, and repeated, similar to traditional video recordings.

Teachyverse is implemented in Unity with HTC Vive and Google Cardboard support. All communication is handled through a Client-Server architecture between the students/viewers and the lecturer. The slides of a lecture can be loaded from a PDF or Zip file and are distributed through a centralized file server. Further, to support other formats, we implemented a plugin system for more extensions. Lecture recordings are saved as incremental changes in a MessagePack[2] based format.

4 PROOF-OF-CONCEPT STUDY

We conducted a proof-of-concept study to evaluate Teachyverse in a realistic setting and to collect early user feedback. Therefore, we deployed our system in the context of the Human-Computer Interaction lecture at our computer science faculty.

Procedure

Thirty students attended the lecture in which the study took place. Before the lecture, we distributed the Teachyverse app to the students and gave them a brief introduction. During the lecture, all students were handed a Google Cardboard such that they could participate with their smartphones. Besides the 30 students that were present in the lecture hall, an additional three students attended remotely.

The lecture was about Augmented and Virtual Reality such that the students could have a hands-on experience. The presentation in Teachyverse took roughly 45 minutes, followed by an open discussion to gather direct feedback. We furthermore informed the students about the opportunity to fill in a questionnaire on Teachyverse using our institution's E-Learning platform.

Results

Ten of the students voluntarily filled in the questionnaires. They were on average 23.5 years old ($Min = 21$, $Max = 28$, $SD = 2.42$) and on average enrolled in the 5^{th} semester ($Min = 1$, $Max = 8$).

The students were asked from which place they would like to join Teachyverse lectures in multiple choice format. All students would like to use Teachyverse as an E-Learning platform from home, four students would use it in a public place on campus and six students would use it in a public place off campus. We also asked the students how they would like to use Teachyverse lectures. Six students would like to use them if they cannot attend lectures personally, four would like to use Teachyverse for exam preparation, four would like to use it as a substitute for lectures and two students would not use Teachyverse at all. We furthermore asked the students whether they prefer Teachyverse over video lecture recordings on a 5-point Likert scale. Five students preferred Teachyverse, while three students gave a neutral expression and one student did not prefer Teachyverse. At the end of the questionnaire, it was possible to give free-text comments and additional feedback. Five students wrote that they prefer Teachyverse recordings over traditional ones because it closely resembles the real lecture.

Two students mentioned a discomfort when wearing the Google Cardboard and that it is not possible to wear glasses underneath it. During the setup and also during the lecture the experimenter team observed several students, that had problems with the Google Cardboard. Two students stated that the lecture was great fun and they would welcome more complex presentations of learning materials, such as 3D figures.

[2]https://msgpack.org/

5 DISCUSSION

In our proof-of-concept study, we gave a lecture for 30 attending and three remotely connected students. Ten of them filled-out our questionnaire. The current prototype of Teachyverse is based on the usage of Google Cardboards and smartphones. As seen in the study results, this setup has to be adapted to enable more comfort for the students. Since commercially available Virtual Reality hardware rapidly becomes more comfortable and inexpensive, the expressed discomfort in the study will not be a problem for real-world deployment.

The study sample is not representative since the students were almost exclusively from the field of computer science and the majority of them was present in the lecture hall. Furthermore, communication features were not evaluated. Therefore, future studies should address these shortcomings.

The current version of Teachyverse integrates a communication system that is based on speech only. To support further communication, future studies should investigate the feasibility of speech and chat communication. Furthermore, students should be enabled to raise their hands in case they have questions. The privacy of the students should be considered in particular since the recordings of the lecture might result in a privacy violation by the VR device [12].

6 CONCLUSION AND OUTLOOK

In traditional E-Learning approaches, such as video recordings, the students are separated from the learning materials and could easily get distracted. The collaboration with other students and teaching staff is not fostered. We present the Teachyverse VR-E-Learning concept that connects students to their learning material by immersing them in VR. Our proof-of-concept study shows that lectures with our prototype Teachyverse were perceived as fun and students would like to use it as an E-Learning option. This shows the potential of Teachyverse for the improvement of E-Learning opportunities and everyday learning life.

Since Teachyverse is currently limited to picture-based presentations, future work should investigate the interaction with 3D learning material and harvest further advantages of Virtual Learning Environments, such as freedom from physical space constraints. Further, the integration of haptic feedback [8] from the learning materials could enhance the learning experience.

ACKNOWLEDGMENTS

This work was supported by the German Federal Ministry of Education and Research (BMBF) SWC 2.0 "zDAiMR" 01|S17050.

REFERENCES

[1] Steve Benford, Chris Greenhalgh, Tom Rodden, and James Pycock. 2001. Collaborative Virtual Environments. *Commun. ACM* 44, 7 (2001), 79–85. https://doi.org/10.1145/379300.379322

[2] Meredith Bricken. 1991. Virtual Reality Learning Environments: Potentials and Challenges. *ACM SIGGRAPH Computer Graphics* 25, 3 (1991), 178–184. https://doi.org/10.1145/126640.126657

[3] Laura Freina and Michela Ott. 2015. A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives. In *The International Scientific Conference eLearning and Software for Education*, Vol. 1. "Carol I" National Defence University, 133.

[4] Markus Funk, Florian Müller, Marco Fendrich, Megan Shene, Moritz Kolvenbach, Niclas Dobbertin, Sebastian Günther, and Max Mühlhäuser. 2019. Assessing the Accuracy of Point & Teleport Locomotion with Orientation Indication for Virtual Reality using Curved Trajectories. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems.* https://doi.org/10.1145/3290605.3300377

[5] Anthony G. Gallagher, E Matt Ritter, Howard Champion, Gerald Higgins, Marvin P. Fried, Gerald Moses, C Daniel Smith, and Richard M. Satava. 2005. Virtual Reality Simulation for the Operating Room. *Annals of Surgery* 241, 2 (feb 2005), 364–372. https://doi.org/10.1097/01.sla.0000151982.85062.80

[6] Nirit Gavish, Teresa Gutiérrez, Sabine Webel, Jorge Rodríguez, Matteo Peveri, Uli Bockholt, and Franco Tecchia. 2015. Evaluating virtual reality and augmented reality training for industrial maintenance and assembly tasks. *Interactive Learning Environments* 23, 6 (2015), 778–798. https://doi.org/10.1080/10494820.2013.815221 arXiv:https://doi.org/10.1080/10494820.2013.815221

[7] Scott W. Greenwald, Wiley Corning, and Pattie Maes. 2017. Multi-User Framework for Collaboration and Co-Creation in Virtual Reality. In *Making a Difference: Prioritizing Equity and Access in CSCL: Volume 2*, B. K. Smith, M. Borge, E. Mercier, and K. Y. Lim (Eds.). International Society of the Learning Sciences, Philadelphia, PA, 879–880. http://hdl.handle.net/1721.1/108440

[8] Sebastian Günther, Florian Müller, Markus Funk, and Max Mühlhäuser. 2019. Slappyfications: Towards Ubiquitous Physical and Embodied Notifications. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19*. Glasgow, Scotland, UK. https://doi.org/10.1145/3290607.3311780

[9] Hsiu-Mei Huang, Ulrich Rauch, and Shu-Sheng Liaw. 2010. Investigating Learners' Attitudes Toward Virtual Reality Learning Environments: Based on a Constructivist Approach. *Computers & Education* 55, 3 (2010), 1171–1182. https://doi.org/10.1016/j.compedu.2010.05.014

[10] Maria Roussos, Andrew Johnson, Thomas Moher, Jason Leigh, Christina Vasilakis, and Craig Barnes. 1999. Learning and Building Together in an Immersive Virtual World. *Presence: Teleoperators and Virtual Environments* 8, 3 (1999), 247–263. https://doi.org/10.1162/105474699566215

[11] William Winn. 1993. A Conceptual Basis for Educational Applications of Virtual Reality. *Technical Publication R-93-9, Human Interface Technology Laboratory of the Washington Technology Center, Seattle: University of Washington* (1993). http://www.hitl.washington.edu/research/education/winn/winn-paper.html~

[12] Katrin Wolf, Karola Marky, and Markus Funk. 2018. We Should Start Thinking about Privacy Implications of Sonic Input in Everyday Augmented Reality!. In *Mensch und Computer 2018 - Workshopband*. Gesellschaft für Informatik e.V., 353–359.