2D Virtual Learning Environments for Tertiary Education

Gerhard Hube, Kevin Pfeffel, Nicholas H. Müller
Faculty of Economics and Business Administration and
Faculty of Computer Science and Business Information Systems
University of Applied Sciences Würzburg-Schweinfurt
Würzburg, Germany
e-mail: gerhard.hube@fhws.de
e-mail: kevin.pfeffel@fhws.de
e-mail: nicholas.mueller@fhws.de

Abstract — **In the last two years, university teaching has been strongly influenced by online formats, mainly by video conference systems. Beyond that, there are also some practical examples for the use of immersive environments in higher education, mainly focused on the usage of virtual reality (VR) or augmented reality (AR) environments. However, this study aims to see if immersive 2D environments are also holistically suitable for teaching in terms of presence, participation, collaboration and active learning for higher education, as they can offer advantages over video conferencing systems, but are not as costly as VR and AR solutions. A Master's program at the University of Applied Sciences Würzburg-Schweinfurt was chosen for the study. The selected course was held completely in an immersive 2D environment over one semester. Accompanying the course, subjects were asked to complete the Online Learning Environment Survey (OLLES) questionnaire weekly for analysis. In addition, qualitative interviews were conducted with the subjects afterwards. Thereby a descriptive analysis of the questionnaires takes place. All dimensions of the OLLES questionnaire achieve high to very high values. In doing so, the interviews provide insights into the reasons for the ratings. From a purely descriptive point of view, it can therefore be assumed that the used immersive 2D environment is holistically suitable as a learning environment in the tertiary sector.**

Keywords - Virtual Learning Environments; Online Teaching; Tertiary Education; 2D Environments; Desktop virtual reality

I. INTRODUCTION

This contribution is based on the IARIA conference contribution "Suitability of Immersive 2D Environments for Tertiary Education using the Gather Environment as an Example" published in June 2022 [1]. University teaching has been heavily influenced by online teaching over the past two years as a result of the COVID 19 pandemic measures. Besides the isolated usage of VR or AR environments [2], primarily the classic video conferencing tools such as "zoom", "GoToWebinar" or "Cisco Webex" were used, according to their market shares [3]. All of the classic video conferencing tools use video and audio transmission in a simple representation of the participants on the screen of the end device. Due to the continuous and long lasting use of these systems, signs of fatigue and weariness could be observed, often referred to as "zoom fatigue" [4] [5] also and especially for university students within online courses [6]. Nevertheless, it can be assumed that online communications and events will continue to some extent after the COVID 19 pandemic [7]. Therefore, alternatives or additions to classic video conferencing systems such as VR should also be analyzed, in order to check their suitability, especially for online university lectures. A first pilot study showed higher spatial and social presence for VR group meetings in comparison with video conference systems [8]. In contrast to video conferencing systems, the representation of the participant in VR is integrated into a virtual world and allows to explore and interact within a dynamic virtual environment [9].

In this introduction, some definitions and explanations of the basic terms are given. These are VR and immersion, for example. Additionally, the status quo of VR in education, as well as virtual learning environments (VLE) will be discussed. Section 2 shows the related works for VR and VLE in higher education and especially in tertiary education. Section 3 presents the virtual learning environment gather.town and their specific software features, which are used in the study and also the measuring instrument OLLES [10] for analyzing the different dimensions. Section 4 resumes the results, which are then discussed in detail in Section 5 with some limitations. Section 6 forms the end of the paper and contains the conclusion with the main results and future studies.

A. VR/immersion

VR can be distinguished between immersive VR (I-VR) including additional devices like a head mounted display (HMD) and non-immersive VR on the screen of some end devices, also declared as desktop VR (D-VR) [11] [12] [13] [14]. Di Natale [15] proposes a tripartition. He differentiates at the poles between non-immersive systems such as desktop VR (D-VR) and immersive systems such as HMD or specially designed rooms with projected walls (CAVE). In between, he places semi-immersive systems such as AR or wide-field-displays. While the definition for VR seems to be clear in literature, the term of immersion is a multifaceted concept without clarification [2]. On the one side, immersion is viewed as a kind of objective characteristics in terms of technical systems and affordances [16] or a psychological subjective characterized by one's perception of presence and interaction [17]. While Bergstrom [18] defines immersion as an objective

property of the platform environment and presence as a subjective feeling, it seems that the term of immersion started to become synonymous with "presence" [19]. Despite the strict separation between non-immersive and immersive VR, recent studies tend to consider immersion as a kind of continuum from highly immersive or high-end for I-VR and low immersive or low-end for desktop VR systems (D-VR) [19] [20] [21]. This is probably because there can be some kind of immersion and spatial presence on desktop VR systems as well.

B. Virtual learning environment (VLE)

Another keyword often used in connection with virtual learning is virtual learning environment (VLE). This term includes a wide range of systems like simple web pages, learning management systems like MOODLE but also three-dimensional learning environments like Second Life or OpenSim [22]. Reisoğlu [23], following Zuiker [24], defines the term "3D Virtual Learning Environment" (3DVLE) and describes it as platforms for virtual worlds with avatars as representatives and the ability to communicate via audio or text, such as Second Life or OpenSim. Other authors use the term of "immersive 3D virtual world" or "immersive 3D virtual environment" for similar systems to describe computer based simulated environments, in which users are able to immerse themselves through avatars [25] [26]. We will follow the wording of "immersive 3D/2D virtual environment" to describe desktop VR with different levels of immersion. If 3D-like representations are used in the desktop environment, we assign them to an immersive 3D desktop environment and, in the case of a two-dimensional representation, to an immersive 2D desktop environment. Within this paper we do not include learning management platforms (LMS) for distribution of contents, messages, notices and communication via forums and chats, like e.g., Moodle although they are included in the term of virtual learning environment (VLE) [27] [28]. We want to focus on low immersion desktop solutions that provide the ability to move, interact, collaborate and communicate in a kind of virtual environment using an avatar. The aim is to use them for online master lectures at universities.

In this paper, the related works are presented below. This is followed by the method section, in which the learning environment used is presented in detail. In addition, the measurement instruments used are explained. Afterwards the results are given. This is followed by a discussion of the results, the limitations of the study and finally the conclusion.

II. Related Work

In the following sections, the state-of-the-art, several studies on VLE in specific topics are discussed. But there is a research gap regarding the basic suitability of such virtual environments in higher education. In particular, usage in the tertiary education sector for the implementation of regular courses, and not just for individual specific and short learning units, does not seem to have been sufficiently analyzed.

A. VR in education

The high-end immersive VR seems to fascinate and inspire people in their first reaction, probably because of the high level of immersion and appearance [29] [30]. Especially in terms of education, there were several announcements about groundbreaking improvements by the usage of immersive VR, like increasing memory capacity or making better decisions [31]. Wu et al. [32] reported that I-VR-lectures are more effective than non-immersive environments and Gao [33] assumes better learning outcomes because I-VR is more engaging than traditional methods. A meta-study found that the majority of studies on immersive learning environments from 2014-2019 used AR or VR applications, although all forms of immersion in learning and education were explicitly included. Among other things, the study shows the need for more research on less immersive learning environments with higher narrative and greater challenge [2]. Although the level of immersion in desktop VR systems is not as intense as fully immersive VR technologies, it is not the case that higher immersion and presence directly lead to better learning performance [20]. Johnson-Glenberg [19] discovered that the main effect for better learning is not the level of immersion between 2D or 3D virtual environment but the level of embodiment. The study compared the learning outcomes between groups learning with a low immersion platform on a desktop and a high immersive platform with an HMD (I-VR). The low embodied I-VR group performed significantly worse than the desktop group with high level embodying. Radianti [34] states that immersive VR technologies are particularly used in education, even if their level of maturity still seems questionable and there are several research gaps. Hamilton [14] found in his literature review that in most I-VR studies between 2013 and 2019, there was a significant benefit of using I-VR in education. However, he also restricts that most studies used short interventions and were mainly focused on scientific topics such as biology or physics. Additionally, there are still limitations while using immersive VR. Besides higher costs for immersive VR, above all cyber sickness in terms of e.g., headache, blurred vision or dizziness are effects of using HMD technologies [35]. This is one reason why such systems should be used only for a limited span of time [36]. Due to this and considering the specific requirements and accommodations for university lectures, desktop VR applications appear to be more suitable for online education [10] [21] [37].

B. Immersive VR (I-VR) in higher education

There are several studies on the impact of mainly immersive VR (I-VR) in higher education. Chien et al. [38] stated that a VR environment increases the motivation and critical thinking skills. Tepe [39] concluded that a VR environment increases performance and professional skill development. Other studies also showed several positive effects on the academic success and motivation [40] [41]. Wen-Yu Lee [42] discovered higher scores in science concepts for sixth-grade students learning with I-VR systems in comparison to students without the help of immersive systems. In the field of higher education, a meta-study analyzed studies on desktop-based virtual environments,

games and simulations in particular. They concluded that these virtual tools could be effective in improving learning outcomes [13]. Mystakidis et al. [43] conducted a literature review analyzing the outcomes of distant learning and their effect on various criteria of "deep and meaningful learning" such as cognitive, social or affective aspects for K-12 high school students. As a result, positive outcomes were found, especially in terms of performance, satisfaction, cooperation and motivation. Although it is also emphasized that insufficient didactic quality cannot be compensated by online formats. In a metastudy on the effects of immersive VR on students' academic performance, Akgün [44] concluded that there are many positive effects on students' abilities, such as an increase in motivation and other positive contributions to learning. Despite these positive results, the study also determined that there are still technical and health problems to be solved.

C. Virtual learning environment (VLE) in higher education

In addition, studies with desktop VR in higher education detected better performance achieved in groups using desktop VR. However, dependent from the individual spatial ability [45], Reisoğlu [23] analyzed studies between 2000 and 2015 on 3D virtual learning environments (3DVLEs) and various aspects such as platforms used, research topics and achievements. He found that the Second Life platform was the most used platform and that studies on 3DVLEs peaked around 2012 for simulation and learning support. He concluded some overall positive emotional and cognitive achievements on presence, satisfaction, communication skills and engagement. Coffey [26] also analyzed the second life platform against a normal computer surface for comparing the impact on intercultural sensitivity and reveals significant gains with the usage of a virtual environment. Another study analyzed the effects of collaborative learning in virtual environments with the use of 3D avatars in a virtual learning environment (VLE). The results showed that regardless of a collaborative group or an individual group, learning improved, but participation in a collaborative group had a significant positive effect on academic achievement and satisfaction in higher education [46]. In a systematic literature review on "simulation games", it was discovered that better results in terms of declarative knowledge, procedural knowledge and knowledge retention could be achieved through the use of desktop-based immersive environments for the education of trainees [47].

D. VR/VLE in tertiary education:

One of the early publications on "desktop 3D learning environments" without the use of head-up displays in tertiary education comes from Charles Sturt University [48]. Here it is already pointed out that a desktop application is easier for the users and reduces physical and psychological stress compared to immersive virtual worlds with head-mounted displays. A combination of learning management system with Moodle and 3D desktop environment with OpenSim was used in a study to design and evaluate a VLE for teaching with undergraduate students. There were effects on learning skills and understanding of sociocultural aspects that have a strong impact on social interaction when students participate and collaborate in common tasks and activities [30]. Collaboration and interaction seemed to be a high demanded factor influencing VLE systems, either by students as well as academic staff [49]. A special form of 3D virtual learning environment is used for analyzing dental students' performance. When comparing stereoscopic 3D vision with passive circular polarized glasses to 2D vision on screen, significantly better results and higher appreciation for the 3D vision were found [50]. Another specific anatomy medical study about the role of stereopsis in virtual and mixed reality conducted that virtual and mixed reality is inferior to physical models [51].

Overall, there are several studies of desktop VR (D-VR) respectively VLE for specific topics, often computer science or medicine [35] [50] [51] [52]. These studies include various intensities of immersion, but still lack an evaluation of the overall and holistic suitability of 2D desktop learning environments for higher education, including the new immersive 2D environments that have appeared in the last three years.

There are many different forms of virtual learning environments that are used in one way or another. The difference between the individual environments lies especially in the level of immersion. Fig. 1 shows an overview of the different virtual learning environments and their classification on the level of immersion.

III. METHOD

In the following we present the immersive learning environment gather.town, in which the course took place and the measuring instrument OLLES, which was used for the assessment. In addition, qualitative interviews were

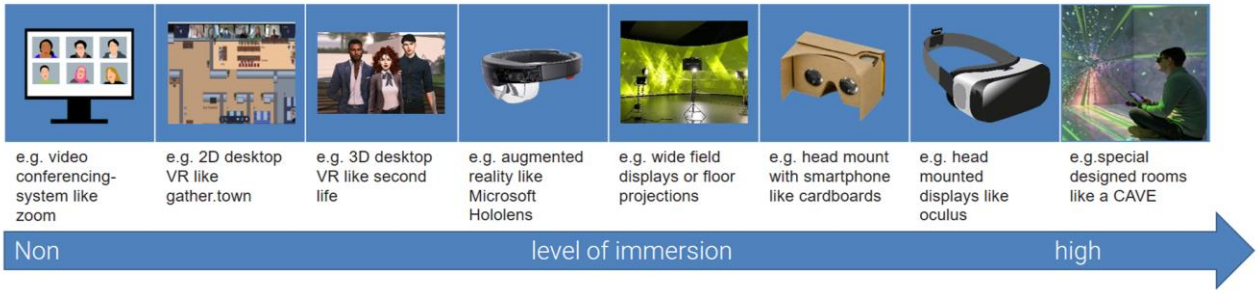

Figure 1. Overview of different virtual learning environments according to the level of immersion.

subsequently conducted with some of the subjects, which will also be presented here.

A. Immersive 2D environment gather.town

The software gather.town [53] was used as an immersive 2D environment. This is a web conferencing software, which allows to create a complete virtual replica of the teaching building. Within this virtual space, users can move around using avatars and interact with each other and their environment, similar to real life. If the avatars now walk around in the virtual environment and then meet each other at a certain distance, the camera and the microphone of the computers are automatically switched on, and the users have the opportunity to communicate. The graphical user interface is quite simple and it does not demand any special requirements to run on a variety of computers. In preparation, the entire real seminar building was recreated in the gather.town environment and the following virtual environment settings and software features were used:

1) Podium:

The podium is the classic teaching situation (see Fig. 2). Within the gather.town environment, all students and the tutor are in one large room. The tutor stands in front at the lectern, while the students take their places at the tables. All students can see, hear and of course communicate with each other via camera and microphone. It is possible to share the screen to provide lecture slides or other content to all participants in the plenum area. In this way, the tutor can use lecture slides in addition to a verbal execution of the learning topic, as they would be used in a real teaching situation.

Figure 2. This is the podium. You can see a classic teaching situation in a shared space.

2) Workshops:

Workshops are smaller rooms that provide fewer seats than the large seminar rooms. Here, there are tables with seats and a whiteboard (see Fig. 3). Thus, the users have the possibility to do smaller group work. They can use the table for meetings via the camera, or the whiteboard for joint work or screen sharing for presentation.

3) Whiteboards:

The whiteboard (see Fig. 4) provides an opportunity for collaborative work. To do this, the whiteboard must first be activated. After that, all users who access the whiteboard at the same time can work together on it. This means that all users get write permissions and can interact with the whiteboard. In addition, a video and audio function for communication is available for the workgroup to discuss and exchange while working on the board.

4) Group discussion:

This is a room that is designed in such a way that a pro and a con side can sit opposite each other and participate in a group discussion by means of the camera (see Fig. 5). The whole setting is accompanied by possible viewers but would also be monitored by a jury that rules the discussion and evaluates the individual arguments.

Figure 3. Here you can see a small workshop room with several seats and a whiteboard in the room.

5) Break rooms:

In the break rooms, users can stay between the individual seminars and have the opportunity to play various card games at a game table, making music or watching videos (see Fig. 6). In another break room, users have the opportunity to get on a yoga mat. A 10-minute instructional video is then played so users can join in on the yoga session from home.

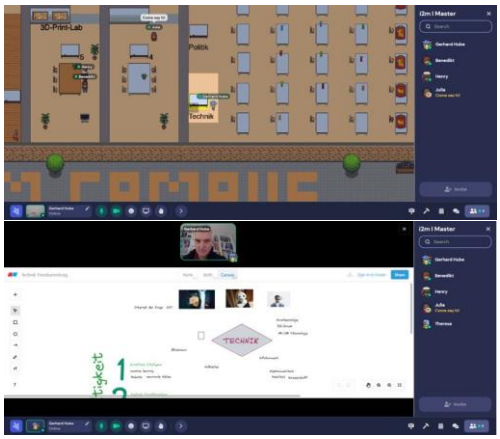

Figure 4. In the upper part of the picture, you can see the whiteboard placed in the room. Below you can see the view when using the interactive whiteboard.

6) Other Interactive Objects:

Within the environment, other interactive objects are stationed in the individual rooms or corridors. In the entrance area, for example, there is a blackboard, on which the timetable can be viewed. Next door, there is a tutorial that once again describes the functionality of the gather.town environment in a video. There is also a bookcase. If you use it, you get a web window within the gather.town environment,

which leads you to the online catalog of the university (see Fig. 7). There the literature search can be accomplished.

Figure 5. This is a group discussion room, where users sit across from each other in teams and a jury sits in the middle.

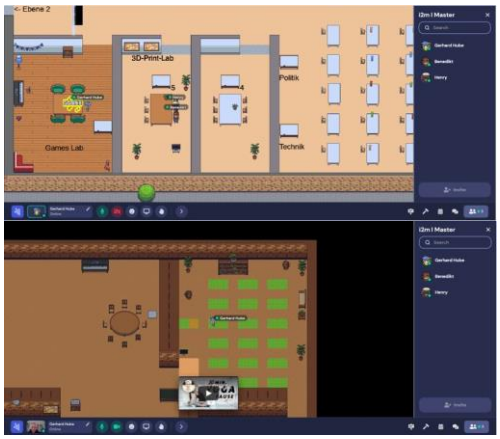

Figure 6. Here you can see the break rooms, where multiple users can gather and share interactive applications like a gaming table or a yoga room where a yoga tutorial is played as a video as soon as you step onto one of the green mats.

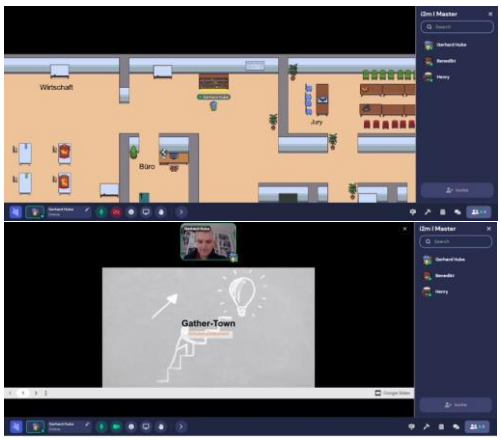

Figure 7. In the upper part of the picture, you can see a bookshelf, which stands freely in the room. Below is the view when you use the bookshelf. This is the online catalog of the university.

B. *Measuring instrument*

The OLLES questionnaire [10] in its modified 35-item form was used as the measurement instrument. The OLLES questionnaire is a web-based survey instrument for use in online learning environments in tertiary education. In this context, the OLLES questionnaire provides inferences about students' perceptions of interaction opportunities within an online environment in terms of economy and efficiency. The dimensions of the OLLES are Student Collaboration (SC), Computer Competence (CC), Active Learning (AL), Tutor Support (TS), Information Design and Appeal (IDA), Material Environment (ME) and Reflective Thinking (RT). In addition, questions about general computer use and Internet use were also recorded. All items were measured using a 5-point Likert scale.

For the qualitative interviews, a separate questionnaire was developed, which can be viewed in full in the appendix. First, an introductory question was asked in order to lead the test persons into the interview situation in a relaxed manner and to check whether they could still remember the seminar well within the virtual learning environment gather.town. Building on this, at least one question was asked about each dimension of the OLLES to develop a deeper understanding of why one of the dimensions had performed well or poorly. In addition, the questions of the questionnaire still investigate whether the subjects prefer face-to-face classes, a virtual learning environment such as gather.town or classic video conferencing software such as Zoom and why this is so. Finally, the questionnaire examines whether the virtual learning environment gather.town was also used outside the actual seminar and, if so, for what other purposes and, questions are asked about the highlights and the low of the software used.

C. *Experimental procedure*

Even before the first seminar, all test persons were familiarized with the gather.town environment. Especially the basic functions were tested, so that everybody knows them and can use them independently. In addition, the OLLES questionnaire was introduced, since this was used in its original language English, but the test persons were not native English speakers.

There were a total of four measurement time points. The seminar duration was always from 8:15 am to 13:15 pm. From the start of the test, the seminar was always first held in the gather.town environment and at all four measurement times the entire questionnaire was completed online directly afterwards.

The qualitative interviews were collected with a time lag after the actual seminar, but they were conducted within gather.town. An appointment was made with a respondent within gather.town, where the interview was conducted and the audio track was recorded. The audio track was then transcribed, analyzed and interpreted.

D. *Sample*

All data were collected at the University of Applied Sciences Würzburg-Schweinfurt within the seminar “trend analysis and innovation assessment” of the master study

program “Innovation for small and medium Enterprises”. A total of 17 subjects participated in the study. However, there were not measured values from all subjects at all four measurement time points. From two subjects there were only three measured values and from four subjects there were only two measured values. This is still sufficient to form an arithmetic mean. Nevertheless, one subject was excluded from the final analysis because he produced outlier values on three dimensions. This leaves n = 16 valid subjects for the final analysis. The average age of the subjects is 24.44 years, with a minimum of 22 years and a maximum of 30 years. Of the n = 16 subjects, 7 are female and 9 are male.

Five randomly selected subjects were used for the qualitative interviews. Afterwards, it was checked to what extent the answers of the subjects overlapped or whether new insights could still be gained with further surveys, but a feeling of saturation set in. Therefore, n = 5 interviews were considered sufficient. Of the n = 5 subjects, 2 are female and 3 are male.

IV. RESULTS

The results section is divided into different areas. First, there is a purely descriptive part, in which the mean values of the OLLES questionnaire are considered. After that there is a statistical part, where the Wilcoxon signed-ranked test was used to find out if there are differences between different measuring times. Finally follows the part, in which the results of the qualitative interview are reported.

A. Analysis of the OLLES Questionnaire

In the case of computer use, it was found that all subjects use their computers daily or at least several times a week. In the case of Internet use, it was found that all subjects used the Internet on a daily basis.

When tested for normal distribution with respect to the dimensions of the OLLES, Student Collaboration (SC), Computer Competence (CC), Active Learning (AL), Tutor Support (TS), Information Design and Appeal (IDA), Material Environment (ME) and Reflective Thinking (RT), all were found to be normally distributed. Those descriptive values can be seen in Tab. 1.

Then, the Wilcoxon signed-ranked test was used to examine whether there were differences between the individual measurement points and thus whether there was a change in the evaluation with regard to the repetition of the use of the gather.town environment.

Since a normal distribution could not be determined for all variables, even after the exclusion of six subjects with partly missing values, the Wilcoxon test was used. Here, all requirements were met.

There were only significant differences between measurement time point 3 and measurement time point 4 for the dimensions Student Collaboration (Exact Wilcoxon Test: $z = -2.09$, $p = .037$, $n = 12$) and Material Environment (Exact Wilcoxon Test: $z = -2.41$, $p = .016$, $n = 12$). Otherwise, there were no other significant differences between measurement time points.

B. Analysis of the qualitative Interviews

A complete overview of the guideline interview can be found in the appendix and can be referred to for better understanding. Question 1 revealed that all subjects could still remember the seminar and the use of gather.town well to very well. Question 2 revealed that the majority perceived collaboration within gather.town as practical, fun, relaxed and easy. Group work in particular was rated very positively. The whiteboard function, on the other hand, was sometimes perceived negatively, as it did not always function correctly from a technical point of view. This was also confirmed by the query. All subjects found that there were sufficient opportunities for successful collaboration, although, as already mentioned, the whiteboard was sometimes replaced by external software in the form of Miro. Question 3 showed that although there were sometimes technical problems in using gather.town, the use itself was always understandable and simple and therefore it did not represent a technical hurdle. Question 4 showed that subjects found teaching within the gather.town environment motivating. Upon further inquiry, it turned out that this was due in particular to a higher degree of interactivity. For example, simply by moving or controlling one's own avatar. In addition, the virtual learning environment was also perceived as varied and interesting,

TABLE I. OLLES

Descriptive Analysis					
Dimension	***Mean Value***	***Standard Error of the Mean***	***Standard Deviation***	***Minimum Value***	***Maximum Value***
Student Collaboartion (SC)	3.76	0.11	0.42	3.10	4.60
Computer Competence (CC)	4.57	0.11	0.44	3.55	5.00
Active Learning (AL)	3.64	0.13	0.46	2.70	4.60
Tutor Support (TS)	4.10	0.12	0.55	3.20	4.80
Information Design and Appeal (IDA)	3.73	0.12	0.47	2.93	4.80
Material Environment (ME)	3.84	0.07	0.28	3.50	4.45
Reflective Thinking (RT)	3.19	0.16	0.62	2.25	4.10

since it is a diverse world. Question 5 and the related query revealed that the tutor's contact and accessibility was good, and enough opportunities were given for feedback and further questions were answered quickly. Question 6 revealed that the working slides as well as the sources were partly a bit outdated and would need optimization. An inconsistent design was also pointed out. Nevertheless, it was not perceived as particularly negative. On the other hand, the feedback showed that the gather.town environment was initially perceived as taking some getting used to, but after a period of getting used to it was evaluated with positive attributes such as entertaining, appealing and varied. In particular, the real proximity and thus easy navigation, as well as the possibilities for decorating and designing were mentioned positively. Nevertheless, a somewhat unprofessional impression remained. Question 7 showed that subjects rated their learning success within gather.town as good. This was also due in particular to the high level of interactivity, the richness of variety and the motivating aspect. Nevertheless, it was already apparent here that all test subjects prefer face-to-face teaching, but would prefer a virtual learning environment such as gather.town to classic video conferencing software such as Zoom. This was also confirmed in question 8, where all subjects preferred gather.town to Zoom. The most frequently mentioned point was the constant availability, since one could log in 24/7 within gather.town and did not have to send links by e-mail for a meeting. In addition, it was said that the exchange among each other worked better and there were several opportunities to collaborate. In addition, there are aspects like a higher individuality, a small gamification approach, higher activity and better design possibilities. One response should still be highlighted, as one respondent also made the point that the avatars created more closeness to fellow students than simple tiles. That this is a particularly important point was then shown in question 9, where all respondents answered that they prefer classroom teaching. In particular, the proximity to the person sitting next to them, the contact itself, but also the additional body language were cited as reasons. In addition, face-to-face teaching is more interactive, it is easier to work together and there are no connection problems. Question 10 then showed that the gather.town environment was also used by the subjects outside the actual seminar. Mainly for group work of other seminars, but also for private meetings such as vacation planning. The environment was also used for a Christmas party. Finally, question 11 and the two follow-up questions showed that the subjects particularly appreciated the fact that they did not have to register and could get started straight away. They also liked the conversation circle function, where you only took part in a conversation if you were within a certain radius. This gave a real-world feel. The usability beyond the seminar and the design options were also rated very positively. If something was rated as bad, it was mainly technical problems in the form of connection problems and the technical problems with the whiteboard function.

V. DISCUSSION

In the discussion section, the OLLES questionnaire scores are first discussed in relation to the findings from the qualitative interviews. Each dimension of the OLLES questionnaire is analyzed individually. Subsequently, the limitations of this study will be discussed.

A. Overall

Repeated measurement of user ratings of the gather.town environment showed that there was virtually no difference. Although a meta-study by Merchant et al. [13] found small effects in simulation studies in terms of number of sessions, these were measures of learning outcome and not an assessment of the immersive environment as in this study. Therefore, it can be assumed that a one-time survey after the first unit or even after the last unit is quite sufficient.

In the dimensions of computer use and Internet use, the subjects indicated that they use this on a daily basis. In addition, the gather.town environment and all basic functions were sufficiently explained before the start of the study. Thus, we assume that there were no poor ratings for the environment due to possible lack of technical skills.

All dimensions of the OLLES questionnaire reach high to very high scores. From a purely descriptive point of view, it can therefore be assumed that the gather.town environment is holistically suitable as a learning environment in the tertiary sector. Nevertheless, the individual dimensions will be examined below.

B. Student Collaboration (SC)

The Student Collaboration (SC) dimension asks in particular about the frequency of communication between students. This includes the question of help and feedback as well as the mutual exchange of information and resources. As already mentioned, studies have shown that collaboration [43] [46] [49] and communication [23] [49] have positive effects on users within a VLE. Therefore, this is an important factor for learning. It can be assumed that high values were achieved here in the evaluation, since gather.town provides enough possibilities, especially through the functions whiteboard, workshops, group discussion and informal encountering, that this can also be used profitably. This assumption can also be further supported in part by the interview results, since from the subjects' point of view, the simple and fast group work in particular was decisive for good collaboration. This could also be due to the fact that group formation is similar to a face-to-face event and the individual groups can then move individually to their own meeting rooms. Whiteboards in particular, on the other hand, had technical problems more often and thus certainly led to a point deduction in the rating. Nevertheless, it became apparent that there were enough possibilities for the test persons to collaborate successfully.

C. Computer Competence (CC)

The dimension Computer Competence (CC) asks in particular about the assessed competence of one's own computer and Internet use and also the ability to solve minor problems oneself. Since the highest values were achieved here, this further supports the assumption that all subjects had more than sufficient technical skills to use the gather.town environment to its full extent. This was also confirmed by the interviews. Although there were sometimes technical problems with the connection, there were no fundamental

problems in understanding how to use it. On the contrary, everything was very easy and intuitive to use.

D. Active Learning (AL)

The Active Learning (AL) dimension specifically asks about the motivation created, as well as the feedback received through the activities or the teaching unit within the environment itself. Again, various studies already showed that motivation [38] [40] [41] [43] [44] is a crucial factor in the use of VLE's. That there was increased motivation was confirmed by the interviews. The motivation arose primarily through increased interactivity. For the test persons, it was clearly more motivating to walk through the virtual environment by moving the avatar and not just to sit in front of the laptop. This also led to the environment being perceived as very varied. It was also mentioned here that a kind of fatigue nevertheless developed over a certain period of time. However, this was not evident in the Wilcoxon signed-ranked test, in which the individual values of the dimensions were compared across the individual measurement time points. Nevertheless, this could have led to a deduction of the score.

E. Tutor Support (TS)

The dimension Tutor Support (TS) asks in particular about the participation and accessibility of the tutor. In this respect, the response time to questions and feedback play an important role. Good communication [23] and interaction [49] lead to positively perceived VLEs. The second highest score was obtained for this dimension. This may be due to constant availability and timely communication, as the tutor himself was also always present and responsive within the environment. Therefore, from this perspective, the gather.town environment is well suited for interactive teaching. This assumption could also be confirmed by the interviews. All subjects felt that the tutor's accessibility was good and sometimes even saw advantages over a face-to-face lecture in the form of direct messages, which thus did not have to be put in front of all seminar participants. In addition, there was sufficient feedback and questions were also answered quickly.

F. Information Design and Appeal (IDA)

The dimension Information Design and Appeal (IDA) asks in particular how creative and original presented teaching materials are and whether graphics used are helpful and visually appealing. This mainly refers to the teaching slides presented as if they were in a presentation. Nevertheless, the colors and walking around within the environment can also have an impact on visual perception and lead to improved learning. In addition, there are the varied break rooms, so that there is also a fairly high rating here. The impression that the subjects evaluated not only the work materials per se, but also the design of the environment per se on this dimension was confirmed by the interviews. The work slides were perceived as outdated and somewhat confusing. The environment, on the other hand, took some getting used to at first, but after using it, the variety, the decoration and the discovery of little things were perceived as nice and fun. Perhaps this double assessment was due to the fact that, in this particular case, it was not always clear to the subjects what the individual question items referred to in this dimension. It could also play a role here that English is not the native language.

G. Material Environment (ME)

The dimension Material Environment (ME) asks in particular about the installation process and clarity in using the software. Since very high values were also achieved here, this further supports the point that all test subjects had more than sufficient technical skills to use the gather.town environment to its full extent. In addition, it can also be assumed that the environment is easy to learn and therefore has a high practical value. In general, it can be assumed that VLEs must be accessible and not have too many hurdles to ensure a successful learning environment. The interviews revealed that the usage was very understandable, simple and intuitive. Only the web interface was used, which is particularly easy to use.

H. Reflective Thinking (RT)

The dimension Reflective Thinking (RT) asks in particular how well subjects were able to learn within the online environment, but also for a comparison to a real classroom. Here, too, high scores were generated, but these are the lowest in comparison with the other dimensions. Nevertheless, it can be deduced that an online environment can be a sufficient substitute due to sufficient positively rated features, but real classrooms are still the most suitable form of teaching. This was also confirmed by the interviews. All subjects were motivated by the virtual learning environment and rated their learning success as good. Especially the interactivity and the richness of variety seemed to be conducive to learning. Nevertheless, all test persons also preferred face-to-face teaching. Probably the most crucial point that a virtual learning environment in the form of gather.town cannot copy is human proximity. The interviews showed that face-to-face teaching is primarily characterized by direct contact and closeness to the person sitting next to you, as well as to all other seminar participants. This again leads to more interactivity, better collaboration and simply closer togetherness among the test persons and thus also to a different feeling. However, since a virtual learning environment such as gather.town is always preferred to classic video conferencing software such as Zoom, it can be said that the closer the learning environment used resembles a real-world experience, the better it is accepted. This is also shown, for example, by the statement that a special highlight was the conversation function. You could walk towards other avatars and as soon as you were within a certain radius, the camera and microphone automatically started and you could start a conversation, while avatars outside the radius could not take part in the conversation. It was said here that this made the environment feel more real.

I. Limitations

This study has some limitations, which are discussed below. The main limitation is that there is not yet a comparison group. The OLLES questionnaire is applied, resulting in a set of scores. These scores only reach their full significance when they are also put into relation. However, this limitation will be addressed by follow-up studies. At the time of publication, a second study had already been started.

This time two courses are running in parallel, with one course using the gather.town environment while the other course takes place in Zoom. Thus, in the follow-up study, the two teaching environments can be compared with each other, but also a comparison of the two gather.town courses can be carried out. This is interesting in that it cannot be assumed that very high scores will again be generated on the OLLES questionnaire. For instance, the scores in this study could be biased due to the effect that the test persons rate new and exciting interfaces better and this effect could wear out. It is also important to keep in mind that this study was conducted in the midst of the Corona pandemic and students had no choice but online teaching. This has changed again and there is also the option of real-world teaching again. This could result in the online teaching being rated significantly lower.

Another limitation is the small number of subjects, but this could not be implemented otherwise due to the small class size.

Furthermore, it should be noted that the qualitative interviews were only collected retrospectively for this study. This meant that there was a period of several months between the last teaching unit in gather.town and the survey of the qualitative interviews. Even though subjects reported that the complete teaching unit was well remembered for them, this remains a limitation. In the follow-up study, all data will be collected directly afterwards.

VI. Conclusion

This study was exploratory in nature with the primary goal of seeing if an immersive 2D environment is holistically suitable for teaching in terms of presence, participation, collaboration and active learning, and thus an enhancement over classic video transmission tools such as “zoom”, “GoToWebinar” or “Cisco Webex” and the like. As the main result of the study, the high scores of the OLLES questionnaire can be mentioned. In connection with the interviews, it can be said that an immersive 2D environment can be used holistically as a form of teaching and also has advantages over classic video transmission tools. As a practical implication, it can be deduced that the use of virtual learning environments in the tertiary sector, on the one hand, can be relatively easily deployed with existing software solutions and, on the other hand, are also well received and therefore offer added value for students. In future online seminars, instructors should therefore think carefully about what kind of learning environment they want to use.

Nevertheless, for now, only an overview of the use of an immersive 2D environment as a learning tool could be provided through this study. Group comparisons with other teaching formats could not yet be made. However, this is the next step in the research. At the time of publication, another survey has already started. Here the same teaching unit is being tested again in gather.town and at the same time another teaching unit is being tested in Zoom. Again, the OLLES questionnaire is used and additionally the Igroup Presence Questionnaire (IPQ). The IPQ is a scale for measuring the sense of presence experienced in a virtual environment (VE). The qualitative interviews will also be used again for data collection. Afterwards a comparison of the two forms of teaching can be made using t-tests.

The interviews further provided new insights. Here, it should be particularly emphasized that face-to-face teaching is always preferred. However, it also became apparent that an enriched virtual learning environment can lead to greater acceptance, more motivation and thus a better learning experience compared to classic video conferencing software. Therefore, in future experiments not only virtual 2D learning environments and classical videoconferencing software will be compared, but also an extension with a 3D virtual learning environment as well as I-VR environments is planned to be able to make a comparisons for this as well. Since it has been found that realism plays an important factor in the evaluation of virtual learning environments, this will also be used to explore, which factors contribute to a higher degree of realism. For example, the change from a 2D learning environment to a 3D learning environment with 3D avatars could be an improvement. This could best be explored by expanding the interview questions by asking more questions that specifically ask about a sense of reality. At the moment, there are many indications that hybrid forms of teaching and learning will be used in the future. However, the goal here should always be to provide the best possible teaching and learning experience for all involved.

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APPENDIX - GUIDELINE INTERVIEW

Question 1: You participated in the gather.town study, do you remember the virtual learning environment and the seminar well?

Question 2a: How did you feel about the collaboration within gather.town? Did you enjoy using the individual features like whiteboard, workshops and group discussions?

Question 2b: So there were enough opportunities for successful collaboration? Or were you still missing something specific?

Question 3: From the technical side, were there any ambiguities in using gather.town or was everything understandable from installation to use?

Question 4a: Did the teaching within gather.town motivate or demotivate you?

Question 4b: What do you think led you to be motivated / demotivated?

Question 5a: How did you feel about the tutor's contact/participation and accessibility?

Question 5b: Did you receive enough feedback and were questions also answered quickly?

Question 6a: Were the learning materials well prepared and understandable? This really only refers to the learning materials, i.e., mainly slides and materials or graphics?

Question 6b: Away from the learning materials how appealing or off-putting did you find the gather.town environment?

Question 7: How well or poorly do you rate your learning success within gather.town?

Question 8: You have also used video conferencing software such as Zoom. Which virtual learning environment would you prefer and why?

Question 9: Normally, teaching takes place in presence. Do you prefer face-to-face teaching or gather.town? Please give reasons for your decision.

Question 10: Have you used gather.town outside the actual seminar? And if so, why and for what?

Question 11a: Can you think of anything else you would like to say?

Question 11b: Was there anything that you found particularly good?

Question 11c: Was there anything that you found particularly bad?