Geography Education in a Collaborative Virtual Environment: A Qualitative Study on Geography Teachers

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Abstract: The presented study aspires to utilize the gradually validated immense potential of collaborative immersive virtual environments (CIVEs) in higher education when designing and conducting geography lessons. These particular lessons focused on hypsography. A Research through Design approach and relevant qualitative methodology were used as we engaged two groups of domain experts (experienced geography teachers) to validate both the learning scenarios and the virtual environment we used. The lessons were administered via eDIVE—a novel platform for collaborative learning and teaching in virtual reality of our own design. The teachers underwent a hypsography virtual lesson and were randomly divided into two groups to be compared, which differed in the level of structure given to the lesson (one group received detailed instructions on what task they were to solve, while the other was given a free hand in exploring the environment and activities it afforded). The teachers’ experiences were then summarized in a post-lesson reflection and a subsequent focus group following the tasks. The participants’ expertise allowed insights to be gained into their first-hand experience as students, as well as their expert view of the lesson from an educational point of view. Virtual reality’s implementation into teaching practice was the key topic of the discussion.

Keywords: collaborative immersive virtual environments; hypsography; contour lines; guided and unguided; eDIVE; education; research through design; head-mounted display; virtual reality

1. Introduction

Technologies in education transform the processes by which education can take place and allow some topics to be taught more effectively [1–5], in a more fun way [6,7] or more interactively [8,9]. One of the technologies being discussed concerning new ways of working with education and new educational practices is immersive virtual environments (IVEs) [1,10,11]. Technology can serve as a tool to emphasize the constructivist elements of teaching [12,13], including collaboration, the ability to form one’s views and opinions on a particular issue [10,14,15], and the development of active learning. Working in virtual environments aims to support constructivist approaches that could otherwise be applied to a limited range of topics or would be difficult to employ.
Technology itself is not a universal solution to teaching [16]. It is necessary to look for ways to create a suitable educational environment and activities that enable students to develop their knowledge. It could be said that concerning immersive virtual environments, we are now challenged to find a way to properly carry out this educational transformation and to utilize the available research outputs to design necessary methodological recommendations and procedures. At present, sufficient empirical experience is still lacking [11,17].

Although the literature shows the gradually expanding possibilities of using immersive virtual environments in education [10,18] at various levels of schools [19,20], that does not mean that immersive virtual environments are being unconditionally accepted or easily applied to the school environment [21]. However, this technology undoubtedly enables the expansion of educational opportunities [22]. Research of virtual environments in education also specifically focuses on geography and understanding its complex natural phenomena [23–25]. The potential benefits of immersive technologies can be found, for example, in the study of Philips et al. [26], who examined the usage of immersive 3D geovisualization. The findings showed a range of benefits (improved understanding of the study area, higher interactivity with the data and enhanced motivation) and suggested that an immersive 3D visualization can increase learning effectiveness in higher education.

Within the constructivist paradigm in which we operate, the approach to any means of guidance during education in an IVE varies. Some authors, e.g., Meyer et al. [21], insist that pre-training in the form of introducing the topic of the following virtual reality (VR) lesson is essential for maximizing the educational effect. Chen et al. [27] defined a guided approach as one with additional navigating tools in the IVE (e.g., maps or arrows). In our study, we chose to distinguish between what we called guided lessons, in which the participants were introduced to the virtual environment and their task was explained to them (e.g., marking points on the map that fulfil certain criteria with flags) and unguided lessons, in which the participants were only taught to control the VR, but not given explanations about anything else concerning the environment, stimuli, or tools available). In this sense, the study tended to be closer to evaluating the features of minimally invasive education as perceived by Mitra [28].

This study’s novel approach is thus focused on the effect of having the application and task explained beforehand (guided lesson) on the understanding of a given topic within the context of the application design. Based on our previous teaching and research experience mentioned below (e.g., [29]), hypsography-related tasks were selected for the experimental lessons in the IVE.

Three objectives of this study are as follows:

1. To discuss, with domain experts—geography teachers—the advantages and drawbacks of using a collaborative immersive virtual environment in their school practice based on the experience with the platform eDIVE;
2. To analyze in more detail the domain experts’ views on the suitability of the (un)guided lessons for students and the possible effect it may have on students’ learning;
3. To gain feedback for the improvement and development of CIVEs such as on the eDIVE platform and instructional modules.

2. Materials and Methods

2.1. Research Methods and Techniques

We decided to take a qualitative approach due to the limited number of participants available and the need to understand the topic thoroughly. In addition, one of the advantages of such an approach is the emergence of unanticipated topics. The Research through Design (RtD) approach that we used allows conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge [30] (p. 166). The intention of RtD is to generate new knowledge by “making things and placing them into the world” [30] (p. 177). The central role in the knowledge-generating process is held by a CIVE prototype and its development and active use that enables interactions that were not possible before. Prototypes can give direction to research
by creating new situations to investigate and revealing design patterns, inducing discussion with different stakeholders, or uncovering new phenomena and challenges in the design. Enabling interaction between persons and VR software in this experiment can generate new and valuable findings. When we focus on user experience (UX) findings, of the CIVE, the research moves from the level of application design to the level of lesson/course design, where VR is merely implemented to enhance teaching.

Several data collection techniques were used during the experiment. We used the reflection technique where participants were supposed to cooperate, formulate their ideas and thoughts, and present them in a structured way as answers to questions we asked. Participants—the domain experts—were then interviewed in a focus group. The focus group minimized the researchers’ influence, who only moderated the discussions or brought up the topics omitted by participants through subtle hints. The targets of the focus group were to obtain experts’ evaluation of the educational potential of a CIVE and to detect practical challenges and issues regarding teaching in a virtual environment. Each step of the data collection process (reflection, focus group, experience in the CIVE) was audio-recorded. Transcription of the audio recordings of the reflection and focus group was used as a base for qualitative analysis. Additionally, the experience in the CIVE was both audio- and video-recorded to create a complete picture and to confirm or confront the testimony of teachers during the follow-up reflection and focus group. Simultaneously, at least three researchers were present with each group to observe the participants’ behavior and interactions. These data provide the researchers with objective complementary information and captures participants’ unconscious and nonverbal reactions and behavior.

2.2. Apparatus and Research Environment

The currently presented experiment followed up on the original study and drew from the original experimental CIVE application for geography education [29]. However, a brand new software solution was used in this study—the above-mentioned eDIVE platform [31]—which allows for efficient real-time collaboration. The application is built as a shared virtual room for multiple users, who can be physically split into more than one physical room. The head-mounted displays (HMDs) enable them to communicate and collaborate in a virtual environment. Users can freely move around the room and explore the content from different angles and sides or use teleporting when the physical space is limited. Multiple users are displayed as simple avatars without legs and with HMDs and controllers that they are holding. The main element of the virtual space is a table with a map in the center of the room (Figure 1). The default visualization is a 2D map of terrain that can be altered to two other different terrains by clicking the buttons next to the map.

The study took place at the Department of Geography at Masaryk University in Brno, the Czech Republic, mostly in two separate rooms, one for each group. In total, ten users out of the domain experts pool volunteered for the study. Three researchers and five participants were present in each room during the various steps of the experiment (see Section 2.4 Procedure). During step 4, Collaboration in CIVE, participants were placed into more rooms so that there was a maximum of two participants in each room to provide enough space for movement in the virtual environments and to prevent echoes in the virtual environment. Each participant was equipped with an Oculus Quest 2 HMD (Qualcomm® Snapdragon™ XR2 Platform, Adreno 650 graphic unit, 6 GB RAM) and two controllers. In each room, there was also a computer (Predator) to record the collaboration task in the CIVE, a device provided for presenting the reflection results, and a JABRA speakerphone to audio-record the focus group.
For the purposes of this study, one task was performed—the so-called Mirror Signals [29]. Participants were placed into a virtual environment in front of a table with a map and two fixed flags marking start point (A) and endpoint (B). Five more flags were prepared next to the map (numbered 1, 2, 3, 4, 5) that could be picked up and transferred to it. The aim was to connect start point A with endpoint B using the extra flags while maintaining direct visibility from the start point to the endpoint—in such a way that mirror signals can be transmitted. The intention of the task was to use as few additional flags as possible. Figure 2 illustrates examples of right and wrong startpoint-endpoint connections.

We used two different methods of task instruction, and therefore, the participants were split into two groups we named “Alpha” and “Bravo.” The Alpha group was given more thorough, structured, and unambiguous guided instructions. On the contrary, the Bravo group was deliberately given a general task only, which would allow for a potentially more exploratory and creative way of problem-solving (Table 1).
Participants—the domain experts—volunteered to attend the collaborative, interactive part of a VR workshop during the Geography Summer School at Masaryk University in Brno in August 2021. Afterward, they underwent a six-step procedure: 1. A general VR introduction; 2. VR manipulation training; 3. Task description (different for each group based on its method); 4. Collaboration in CIVE; 5. Reflection instruction and presentation; 6. A semi-structured focus-group. The procedure for both groups took, on average, two hours.

The first step consisted of a general introduction to the IVE and its particular use in education and training and splitting participants into two groups of five people each. Next, we explained the comfort of wearing a VR HMD and the basic manipulation of the controllers to navigate themselves around the Oculus menu. Participants were then trained via the app Oculus Quest 2: The First Steps, to become familiar with the controllers and interact with the objects in a virtual environment. Then, they were asked to take off their HMD and one of the researchers gave short instructions on the experiment app on a
computer screen and delivered the task description. They were then split and moved to separate rooms to conduct the collaboration task in the VR. They were able to communicate together in a virtual environment via built-in speakers and microphones. After the VR simulation, participants moved back to the main research room. They were assigned two questions to answer. The questions were: 1. What can students learn from the app? 2. How could students work with the app? Then, they presented their reflection in a short PPT presentation. The final step of the procedure was the focus group. The focus group was semistructured and we asked the participants questions from the following areas set by priority interest: 1. The educational potential of the current teaching design (exploration using CIVE) from the teachers’ point of view; 2. Functions of the geographical task from experts’ point of view; 3. Adaptation of the scenario for real teaching—practical issues, challenges; 4. UX of an IVE app. Audio recordings of reflection presentations and the focus-group were captured by JABRA speakerphone and recorded by OBS Studio software. Finally, participants were rewarded with small gifts (headphones, flash discs, SD cards). A scheme of the experiment’s procedure is illustrated in Figure 3.

**Figure 3.** Research procedure.

2.5. Participants

A total number of 10 participants aged 27 to 55 volunteered for the study. Seven participants were men and three participants were women. They collaborated on geospatial tasks on the platform eDIVE in two research groups based on the type of instructions that they received. The research groups were established randomly with emphasis on a gender balance in each group. None of them had significantly experienced an IVE (apart from for gaming or entertainment purposes). The participants were all either elementary or high school Geography teachers (K12 Geography teachers), which makes them so-called domain experts [32]. They were asked in advance via an online questionnaire about their visual impairments and other possible medical limitations which could have made the VR experience significantly more uncomfortable. Participants were encouraged to report any cybersickness issues and were briefed on options to end participation at any moment if required. The training session in the VR app is illustrated on Figure 4.
Figure 4. Participants in classrooms.

3. Results

Practically no differences between opinions on the need for guidance for students in the CIVE in the guided and the unguided groups were found. The participants were able to differentiate between their own first-hand experience in the CIVE and the potential needs of the students, as they literally and repeatedly did; “I think that because we have the knowledge of the contour lines, it wasn’t entirely new for us and we were able to quickly orient ourselves. If we didn’t know anything about the contour lines, we would probably be guessing what these lines mean and what to do with them for a long time. And that would end in disappointment in the students.”

Several topics were discussed from the general use of an IVE in education, guided and unguided approaches to teaching in it, cooperative learning possibilities through the implementation process, software upgrade tips, and new scenarios for the current version of the instructional module used. It was also repeatedly stated that the approach to education would differ according to the age level of the students. The suggestions stated here are meant for high school students and primary school students. Lastly, the current situation in education and the means of employment of the IVE in the classes were discussed.

3.1. CIVE, Its Advantages and Limitations in the Context of Education

The main topics that emerged from the focus groups were the attractiveness of the technology and its effect on the students, the prospect of gamification, easy visualization, place and phenomenon availability, and the effect of anonymity.

3.1.1. Attractiveness of the Technology as an Enhancer and a Distractor

Both groups expected that the novelty of the CIVE would lead to higher motivation in students. The guided group was more focused on the virtual environment in general—“... the remarkability and strangeness of the environment will motivate the students, it makes it interesting...”, “Happiness from the other reality, the uncanny feeling of teleportation and orientation ...”, “... it was unbelievable, as if I was holding someone’s hand in reality (during playing in the introductory app to the VR) ...”. The participants expected that the first few uses of the HMDs would not lead to much learning; the new environment will consume the students’ attention and they would not be able to concentrate on anything else, as was previously the case with nature walks and the Kahoot! application (a free application for teachers for making short quizzes; [33]).

This makes the attractiveness of the IVE slightly counterproductive as the main goal. However, they also expected that the novelty effect would eventually wear off. The same
had happened with the previously mentioned educational alternatives, which were, at the beginning, much fun for the students, but now just common practice during the lessons.

3.1.2. Gamification

The virtual environment resembles the classical video games environment and this association may increase the positive attitudes in the CIVE. One of the possibilities for using games in education was the use of quiz competitions among students with an announced winner at the end. Some participants suggested that letting the students play games in the IVE after school work would work to motivate them, but some were against it, saying that the VE should be motivation itself.

3.1.3. Immediate Visualization for Everyone

The biggest opportunity that the IVE was seen to offer among all participants was the potential to improve the internal visualization of complex topics. With proper visualization, students are able to see deeper connections, which further supports their understanding of a given topic.

A few of the hardest topics for 3D imagination in geography, according to the participants, are the weather fronts and planetary orbits. If the students were able to move the planets themselves to see what is happening, it would help them to understand how it works. In general, if the students could “touch” it, the participants regarded it as a more effective approach. Animations of those phenomena would also ease the teachers’ work, who would not have to draw by hand, which is, according to the participants, quite difficult.

With the 3D models, students could also easily learn how the relief restricts view and how the shape of reliefs differs from each angle.

Another perk of the IVE is the immediate visualized feedback. The participants suggested working in 2D mode, and once the task is finished, the teacher would switch to 3D and the students would better understand their mistakes in relation to the real world.

3.1.4. Places and Phenomenon Proximity

One of the undeniable advantages of the IVE is the possibility to go practically anywhere, a real or unreal place, in no time at all. The participants also reiterated this aspect. They liked the availability of not only distant locations, but also locations inaccessible due to the extreme weather—volcanoes, tectonic, or flooded karstic caves were mentioned. Another plus is that these places can be viewed with their actual proportions as well. In addition, a sort of time travel is available—students can see the formation of riverbeds, karsts, or mountains and compare them according to their age.

Another suggestion was to develop an app with places that students know near to their school. This way they could first theoretically work with it in the IVE and then apply their knowledge in the real world.

3.1.5. Highs and Lows of Anonymity

The option of anonymity in the CIVE was repeatedly mentioned as an advantage, even though it is possible to avoid the anonymity if desired. For the students that are normally too shy to engage with others, it might be easier to participate in anonymous environments. In addition, the traditional hierarchy of the class could be disturbed in the anonymous CIVE, so the students could switch roles with more ease. The effects of this could spill over into the “real world” classes, making the collective more connected.

The participants also feared that the names given in the CIVE could bring mockery to the class. This could be because their nicknames were truly random and somewhat funny, but the teachers would prepare the nicknames beforehand, and as the participants agreed, they saw no problem whatsoever with neutral names.
3.1.6. Cooperation in IVE

The importance of cooperative tasks for the students was discussed. These tasks allow them to create something and find out information themselves instead of just watching passively without participating. In a cooperative task, students would have to decide which role each of them will have, in order to smoothly and quickly solve the problem. Some participants suggested that the students should plan their cooperation in advance instead of during the task.

The teachers could theoretically imagine using the CIVE with the entire class (20–30 students), and at the beginning, they worked with this approach, but the problems of how to manage that soon emerged (see Section 3.3 Implementation).

One problem that may occur is with the easily manipulatable controllers and microphones in other avatars. Even if it was not anyone’s intention to mute their schoolmates, it may create chaos among students and even aversion toward the CIVE. Therefore, it would be best to let the students cooperate once they know how the controllers work and how to easily undo anything that they did not mean to do.

According to the participants, some form of misbehavior is to be expected. It is not only that students may not try to participate, but they might also try to disrupt the work of others. For example, deleting the whiteboard without consent, which happened during distance learning during the pandemic. However, the participants also stated that once the students got a cooperative task, they began to work straight away. Thus, the need for guidance can be applied here as well. It is good for the students to see the progress of their work immediately, for example, through written records of their work or procedures in the IVE.

The presentation of the final outcome of the students’ work is expected as well, during which the teachers can demonstrate other features available in the IVE that the students have not seen before—graphs or pictures.

The participants also suggested one form of explorative competitive collaboration in the IVE, meaning that students, divided into groups, would try their best to find out what to do and how. Once they made a mistake, another group would go in. However, as the groups would be aware of the mistakes of the previous groups, it would be highly unfair and demotivating for the first groups, which were designed to lose.

3.2. Guided versus Unguided Lessons

Interestingly, both groups perceived their activity in the CIVE as unguided and their potential lectures were planned accordingly. The general idea of a guided lesson was with a teacher in the IVE also participating in the lesson. The participants thought that without guidance, the students could get lost, especially when they have no previous knowledge of the given topic and do not understand the maps’ settings. The participants feared that this would destroy the positive effect of the CIVE for the students. Both groups of participants (guided and unguided) agreed that some sort of leadership from teachers is needed in the CIVE. The participants also agreed on the importance of students learning by themselves to facilitate retention. Usually, the order of guidance and exploration differed, and some participants also suggested including short theoretical lectures during the lessons (either in an IVE or in the real environment). One suggestion was to first let the students explore in the CIVE; then, the lecture would follow and the lesson would end again in the CIVE, but this time, the students would already understand the topic. Another approach would be to let the students into the CIVE after the lecture, and they would have to collectively solve some problems related to the topic to comprehend it more. The opposite approach was also suggested—first, the students would try to understand the topic themselves in the CIVE and, at the end of the lesson, the teacher would sum it up for them.

Many ways of guiding the students in the CIVE were named—apart from the teachers navigating them through it—and they could also receive instructions written in virtual notebooks.
The exploration need not be limited to in-app exploration; some participants suggested freedom in topic-related exploration. “When states or cities are discussed, they (students) can have a look at information that interests them and not at the things I’ll show them.”

It was proposed that the explorative options should be limited—the interval of the contour lines should be fixed, for example. This would mean less distraction during the exploration and students would concentrate solely on the main subject matter.

Concerns were raised about the suitability of unguided lessons for students (not only) with special needs. Some thought it could benefit these learners, as they have seen during the pandemic—once they were able to go at their own pace, their results drastically improved, but other students suddenly struggled.

3.3. Implementation

The main problem mentioned by participants regarding the use of the CIVE in schools was their support and maintenance. The IT departments are already supposed to take care of many things—tens of computers, the internet connection, school websites, etc. It seemed unlikely to them that the technicians would be willing to take care of a dozen HDMs (head-mounted displays) as well. They thought that schools would probably have to hire someone for a part-time job to take on that task. The schools seem to have enough resources for that (according to our participants), but the paperwork and hiring process remains a complication.

How to get some truly educational apps was also a topic. Currently, there are not that many available, and for the teachers, it would also be crucial to know the sources of the information provided in the app, which is not something that every developer would be willing to share.

Another problem was seen in the desirability, willingness, and general motivation in teachers to use the CIVE in their classes. As an example, they named the interactive whiteboards that are currently in every classroom, but scarcely used to their full potential. It is certainly a more demanding task to prepare lessons with the use of new technology, especially for the older generations, who tend to stick to the same education plan and techniques for years. However, our participants were not comprised of the youngest teacher generation only and yet they all were excited about the prospects of the CIVE. It is important for the teachers to see the purpose of the CIVE: “... there are complications and it’s up to the teachers’ activity, whether they want to use it or not. The purpose and knowledge, that I will gain the children’s interest, that it will be great and they’ll go home excited must prevail and then I’ll do it”.

Another problem that emerged was with insufficient space during classes—there are too many students for any practical use of the HMDs—in these cases, the participants suggested students take turns in different activities during lessons and one station would be the CIVE activity. However, they also said that it would probably be too short and technical problems could shorten this time even more. This could also take more than a single lesson to realize, which may further complicate the schedule. One of the suggestions of how to compensate for this problem was to allow students to take the HMDs home. However, bureaucratically, it would be extremely difficult to establish everything according to the law and, moreover, the timetable would be tricky to form, due to the commuting students. The nicest solution was to use the HMDs in specialized courses only. Typically, there are fewer students enlisted in these courses and they are scheduled after the main classes, which means more room available (apart from empty classrooms, the gym was also suggested) and enough HMDs for each student to have one. This may limit the understanding of a topic among students in one class, but not everything is equally important for everyone; thus, some students may “give up” understanding contour lines in favor of understanding topology, etc. This may also help to solve the problem with the teachers’ lack of motivation to work with the VR. As the students choose these courses according to their interests, it is expected that their level of motivation is higher than those students in regular classes.
To work with highly motivated students under good conditions makes the time and complications involved in planning worth it.

The last problem that was addressed was the possibility of (motion) sickness in the IVE. Even in applications where motion is mostly unnecessary, the students might get sick and thus be unable to finish the lesson. To determine which students are able to go through it is again time-demanding even for a small group of students. One solution to this could be projecting the VE during classes. The teachers would be the ones using the HMDs and students would only watch them on a screen. This would eliminate the problems with IVE-induced sickness and also with the need to divide students. This would be a very VR-accessible way for all.

3.4. New Instructional Scenarios and Functionality Upgrade Suggestions

Following their experience in this particular CIVE, the participants came up with many software improvements for smoother class work and new scenarios applicable in the current version of the application.

3.4.1. Software Functionality Upgrade

The participants would appreciate labels in Czech on controllers and the available manuals (either written or map-dependent). In addition, they were missing a function that would export the students’ collective notes to cloud storage, where they would be downloadable. Both groups were missing measuring scales on the maps as well.

One suggestion for preventing students from misbehaving was to block them from the environment once they are inactive for some time, are far away from their classmates, or do not participate at all in the collaborative tasks. This solution will not be able to differentiate between intention and inability to properly orient in the IVE. This seems to create more problems than solutions, as there may be tasks where one of the premises is necessary for completion or some students get blocked without reason and then the teacher would have to deal with it and the time costs would be too high and the environment too rigid.

3.4.2. Instructional Task Suggestions

“We thought that it would be very cool if the students had the opportunity to plan a trip from place A to place B with minimal hill climbing or plan the easiest trail between two points.” Hike planning was suggested in both groups and, according to one participant, they do this in real summer excursions and often end up with horrible journeys, because it is completely up to their students to lead the way. “Where would be the ideal place to build a house?” or “Where is the best place to build a hydroelectric power station?” were also suggested tasks for the students to deal with.

4. Discussion

The research participants—domain experts in geography education—tested a CIVE module, designed for hypsography lessons. Within the qualitative study, they reflected on their personal experience in the role of students attending the educational scenario (with an either guided or unguided approach), but they mainly reflected on the possibilities and limitations of the eDIVE platform and of the educational module from their own expert perspective.

The use of a CIVE in education was altogether regarded as a good idea. The novelty and uniqueness of it were seen as a good means to motivate the students, even though it may be too distracting at the beginning. The option of anonymity holds a potential benefit for shy students that are not able to fully participate in the class in the real environment.

Having fun while learning or being immersed in the activity while studying also corresponds to data from other research [16,34,35]. Research among teachers has shown that they believe that IVEs will lead to greater student motivation, supported by previous studies [17,21]. Anonymity in the CIVE has become a separate topic. Maloney et al. [36] pointed out that anonymity and the ability to decide with whom anonymity-breaking
information is shared can be crucial to the resulting educational process and should be considered in the design of the overall environment. Teachers who know the risks and benefits of an anonymous or partially anonymous environment also work with this ambivalence. However, this is a widely debated topic with unclear results [37–39].

The main educational potential of the IVE was stated as the ability to easily visualize complex phenomena and to bring the students anywhere in the world. The participants are aware that many of their students do not understand complex topics and only blindly repeat learned phrases. The IVE could help everyone better understand and reduce the gap between the most and least gifted students.

Specific possibilities are offered by using an IVE as a mediator of phenomena or new forms of experience. Some studies [10,14,16] highlighted the importance of IVEs for novices or less experienced individuals, which could be precisely related to compensating for a lack of imagination. The IVE offers the possibility of understanding the world in spatial contexts [17,35,40,41]. Other studies highlighted that IVEs can foster imagination, which can manifest itself in the creative process [42,43] or in the process of further thinking, for example, in science [35].

It was also agreed that there is a need for guidance in the CIVE. The suggested forms differed, but usually, the CIVE activity was interspersed in places with a theoretical lecture from the teacher. This shows the difference between the researchers’ expectation and teachers’ expectation of guidance level. The form of guidance given in the guided group was not sufficient for the participants to call guidance. Their idea of guidance was more similar to Chen et al.’s [27] but with more room for the students to explore, which is known to improve information retention [44]. The prospects of cooperative tasks during learning in the CIVE were mentioned and some concrete forms of it were suggested, as well as the use of gamification to motivate the students more. The cooperation was deemed important as it is important for the students to actively participate and see the outcome of their work to learn more efficiently.

Meyer et al. [21] pointed out the importance of pre-training, especially concerning the quality of the learning process and student distraction. Pre-training and/or guidance made learners focus on what is essential. Similar views can be seen in other studies [27,45–47]. Here, the research discourse coincides with teachers’ beliefs that a more fixed assignment is educationally advantageous. Gamification is seen in the literature as a critical element of IVE’s use in education [48,49]. Similarly, we can observe a positive acceptance of the connection between gamification and the determination process [5,50].

The biggest obstruction was seen in the implementation of the VR in schools, as it is not only logistically demanding to maintain the HMDs and schedule enough classrooms to use them in, but it is also hard to ensure the willingness of the teachers to use it. The common practice among teachers according to our participants is to practically ignore any new equipment. A solution to this may not be so easy to find, as this problem does not seem to be entirely age-related, but more motivation-related. There are too many problems that may occur during the lesson and, thus, teachers find this method not worth it. Were sufficient explanation about the full potential of the IVE in education and how to properly work with it given, the teachers would be more likely to incorporate it into their lessons. The participants proposed specific function-related adjustments so the eDIVE platform better meets the user requirements (e.g., ability to write notes). Furthermore, they created new scenarios for the existing module, which elevate the educational potential of the application without any need for changes to the functionality.

Reflections and suggestions of domain-experts gained in the Research through Design process are used in the development of the platform eDIVE and specific instructional modules.

Limitations

Given the type of this study, the sample size was still small. The results are likely to be culture-dependent, as not every country has a positive approach toward children with electronics or enough money to supply schools with the HMDs. Participants in this
study graduated from Czech universities and had been educated in the Czech education system; thus, it is possible that their perception and opinions on the IVE is different compared to other teachers from different cultural and educational backgrounds. In addition, the self-selection of participants may imply that these participants have a positive attitude to new teaching techniques and an overall more proactive approach toward their teaching improvement.

5. Conclusions and Future Outlook

The teachers reported great educational potential in using the CIVE during lessons. However, since both groups perceived their experience as unguided, the guided approach should have more structure in practice. Consideration to the needs of the class should be given when deciding on the amount of guidance to provide. The teachers stated many possible problems with the implementation of the technology. However, they also found a solution for every problem, so if interested, schools could find a way to make it work. Based on the findings from this qualitative study, we are preparing quantitative research on real students to shed more light on the suitability of IVEs for education.

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