# “REVEALING - REalisation of Virtual rEality LearnING Environments (VRLEs) for Higher Education”

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## Research paper over VRLE and learning added value

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REVEALING is an Erasmus+ Strategic Partnership project coordinated by the University of Mainz with 5 partner organizations from 5 countries: Cyprus, Germany, Greece, Poland and Portugal. The project is cofunded by the European Commission.

# The design of virtual immersive learning environments and their acceptance and evaluation by students

(final draft)

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## 1 Introduction

As has been the case with society whenever advances in new technologies emerge, education is also rapidly taking off in new directions. These may substantially change the way learners learn and the way teachers teach, even if the nature and outcome of such changes are still being analysed (Beck et al., 2024). One such technology is virtual reality (VR), whose origins can be traced back to the 1960s when the first head-mounted displays were created. Then primarily used in military and industrial settings for training and simulation purposes, in the late 1980s and early 1990s, VR technology became more accessible to the public, and entertainment companies began to explore its potential as a medium for gaming and other interactive experiences. However, these lower-cost varieties were too cumbersome and underperforming, so it wasn't until the 2010s that VR technology truly began to take off with the introduction of devices that were not just accessible, but offered adequate performance and were not physically burdensome, such as the Oculus Rift, HTC Vive, and PlayStation VR.

Today, this category of VR devices became even more affordable and applicable, by combining low head weight, fast response rates and wireless operation. In this context they are being used in a wide range of educational settings. For example, VR simulations are used to teach medical students about anatomy and surgical procedures, while VR field trips are used to introduce students to new cultures and environments. VR technology is also being used to teach subjects such as science, engineering, and history in immersive and interactive ways (Beck et al., 2020). Donally (2018) underlines that virtual reality in education is transforming how we learn and teach, providing students with immersive and interactive experiences that engage and inspire.

The use of VR in education is still in its early stages, but its potential to transform the way we learn and teach is immense. However, the awareness of the nature and outcomes of that transformation – and hence informed educational orchestration of it – requires an acknowledgment of the educational actions, practices, and strategies that employ VR (Beck et al., 2024). Researchers underline not only the interactive aspect of applying VR but provide evidence for cognitive advantages, when that application occurs with a purposeful or serendipitous learning context: for instance, virtual reality enables educators to create authentic learning experiences that engage and inspire students, or establish in-context perceptions, leading to better retention and deeper understanding (Johnson & Nagel, 2016). Criticism on applying VR in the classroom has also emerged, such as concerns with social disengagement of learners, accessibility, or ergonomics.

Applications of virtual learning environments in education have played a major role in recent years, with a significant growth of accounts and research interest (Mystakidis et al., 2021). Many users are enthusiastic about engaging themselves in immersive learning environments and studies also confirm that the new forms of VR technology usually have a motivating effect on learners, at least initially (Checa & Bustillo, 2023; Mystakidis et al., 2021). There are two central questions regarding research into integrating virtual reality learning environments (VRLE) in an educational context: (1) How should such learning environments be instructionally designed so that they can promote learning? and (2) What learning outcomes can be demonstrated under what conditions (technology, context, and approach)?

Given the tight connection between technology use and educational actions, practices, and strategies, the EU-funded project "REVEALING"[1] explores the question of how virtual learning environments with VR headsets can be employed in academic teaching. To this end, the project partners from Greece, Poland, Portugal, Cyprus, and Germany developed several virtual learning environments, seeking to combine them with pedagogical approaches and rationales. Thus, a module handbook[2] was created for these learning spaces, in which their instructions design and technical set-up are combined and described in detail. A study was carried out to determine whether the developed instructional design principles were implemented adequately in these virtual learning environments and identify pathways for improvement. To this end, students from the participating universities were asked to explore the application in small groups, under the observations of researchers. They were then asked to report their experiences in an online questionnaire. The results are presented below.

## 2 Theoretical Background

The question of how VRLEs need to be designed in order to stimulate learning can be considered from two perspectives: Firstly, it is about the design of such virtual immersive learning spaces. Which key design factors can be characterised as

[1] https://revealing-project.eu/

[2] https://revealing-project.eu/wp-content/uploads/2024/0ti/REVEALING-Manual.pdf

conducive to learning? Secondly, the perspective of the users must also be considered: How do they react to the designed learning spaces and which aspects are accepted by them and which motivate them? The aim of this study is to combine both perspectives and draw conclusions for the use of VRLEs in academic teaching. The procedure for answering the questions raised is as follows: The first step is to analyse the literature and the state of research on the design of virtual learning environments and their aspects that promote learning. Then, on this basis, virtual learning spaces were designed that take up central design principles. The third step is an empirical study on the acceptance and evaluation of the developed VRLEs by students.

### 2.1 How to conduct instructional design of VRLEs

With reference to Tahiri, Florian, and Hartmann (2022), the use of virtual space can support the understanding of spatial relationships, especially in three-dimensional spaces. By linking different virtual and physical tools in mathematics lessons, students can achieve their goal in new, additional or further ways than before. The article derives design principles from the psychomotor domain according to (Atkinson, 2013) to ensure intuitive operation of the tools by learners. The aim of the article is to design the application in such a way that it is easy to learn how to use the tools. The design principles are explained using examples and comparisons of existing planar and spatial geometry systems.

The authors explain the main design principles for a VRLE derived from the individual stages of the psychomotor domain:

1. Low-threshold access to tool use through imitation: Tools should be designed to be easy to understand and simple to use. One way to achieve this is to use imitation, i.e. the tools should be designed to resemble the real tools that the learners already know.

2. Support conceptualization: The application should support learners in understanding and internalizing the mathematical concepts and terms. For example, visual representations or explanations of the tools and construction steps can be used for this purpose.

3. Instructions for carrying out construction steps: The application should provide clear instructions on how to perform construction steps to help learners successfully complete the tasks.

4. Consistent and authentic operation of tools: The operation of tools should be consistent and authentic, i.e. it should resemble real tools and be designed consistently to avoid confusion and frustration for learners.

5. Continuous feedback when using the VRLE: The application should provide continuous feedback to learners to help them track their progress and correct their mistakes. This can be done, for example, through visual representations or acoustic signals.

These design principles should help to ensure that the application is intuitive and easy to understand, helping learners to understand and internalize the mathematical concepts and terms.

The authors Hartmann and Bannert (2022) from the Technical University of Munich have examined conceptual foundations and implications for future research. Immersive media are characterized by the fact that they represent spatial-situational or episodic information and can thus fully represent visual and verbal information of a situation. Learners can thus perceive spatial-situational stimuli directly without having to imagine them. Immersive media offer numerous design options and can represent interactive, problem-oriented and authentic situations that support learners in better understanding the context of relevant learning content and transferring it to new situations.

One difficulty with the theoretical version of learning with immersive media is that different aspects of a learning situation are often implemented together in one application, i.e. different features of the learning environment, such as interactivity or authenticity, are not examined separately or manipulated experimentally. Another important research question regarding the potential of immersive media to promote learning is the extent to which learners can mentally imagine spatial-situational information without having visually perceived this information in an immersive learning environment.

The implications for the practice of teaching and learning can be summarized in the following key questions:

- What media features characterize the immersive learning environment, and can the content be presented using comparable "traditional" media? What are the essential differences in the media presentation?

- What spatial-situational episodic content is presented in an immersive learning environment and what kind of mental model do learners form of this content?

- What additional semantic information is presented to learners and in what modality (e.g. verbal or visual) is it presented?

- What are the learning objectives of the immersive learning environment? What is the relationship between the representations presented in the immersive learning environment? How coherent is the spatial-situational and semantic information?

The results of the research show that immersive learning has the potential to promote learning processes but can also entail difficulties. It is therefore important to consider the above questions when designing learning environments and to clearly define the learning objectives.

In addition to the design principles for VRLEs, medical issues should also be considered (Zender et al., 2022), like all forms of epilepsy, pre-existing eye conditions, developmental disorders from the early childhood autism spectrum, etc. Cybersickness and motion sickness are roughly comparable to classic seasickness on a ship in motion (Kim et al., 2021) and therefore VR applications can trigger dizziness, headaches, nausea and/or vomiting and occasionally lead to short-term visual impairment during or after use (Sharples et al., 2008), where women are more frequently affected by this than men (Munafo et al., 2017).

Generally, educators can consider using immersive virtual reality to create engaging and interactive learning experiences that allow students to explore complex concepts in a more hands-on way. They can also use virtual reality to simulate real-world scenarios and provide students with opportunities to practice skills in a safe and controlled environment. However, it is important to ensure that the use of virtual reality is pedagogically sound and aligned with learning objectives.

The review by Beck, Morgado, and O'Shea (2023), an extensive analysis of 47 literature surveys, identified 45 strategies and 21 practices for immersive learning environments. These practices and strategies were clustered around their conceptual proximity and relatedness, resulting in five clusters: "Active context", "Collaboration", "Engagement and Scaffolding", "Presence", and "Real and virtual multimedia learning". The article provides a descriptive framework for pedagogical interventions that can be used to bring clarity to the results and provide guidance, not prescribe actions. For example, an instructor attempting to teach their students how to solve scientific problems might seek out help from the "Real and virtual multimedia learning" cluster.

The authors suggest that the educational metaverse promises fulfilling ambitions of immersive learning, leveraging technology-based presence alongside narrative and/or challenge-based deep mental absorption. The immersive nature of the metaverse can provide students with a sense of presence and engagement that is not possible with traditional learning environments. The article also notes that the metaverse can provide opportunities for collaboration and active learning, as well as the use of real and virtual multimedia learning strategies. However, it is important to note that the effectiveness of the metaverse for education is still an area of ongoing research and development, and there are also challenges and limitations to its use in education.

Beck et al. (2024) note that there are several challenges and limitations to using immersive learning environments in education. One of the main challenges is the lack of a comparable way to describe the educational approaches that led to the learning outcomes. This makes it difficult to evaluate the effectiveness of immersive learning environments and to replicate successful approaches. Additionally, the diversity of aspects of concern for educators and researchers, such as the technological, administrative, and pedagogical aspects, can make it difficult to identify the most effective strategies for using immersive learning environments. Other challenges include the need for specialized technical skills and resources, the potential for distraction and disorientation, and the potential for unequal access to technology and resources among students. They have recently proposed a structured Immersive Learning Case Sheet as an instrument for analysing, recording, and planning in a comparable way (Beck & Morgado, in press).

According to the various authors, there are several potential approaches for using immersive virtual reality for learning, including:

- Multi-layered representation in virtual space
- Interaction with 3D models
- Building self-confidence and familiarity
- Fun of learning
- Self-directed exploration

- Emotional and cultural experiences
- Improved logistics of simulations and laboratories
- Perspective switching between different contexts or roles
- Seeking positive effects on subjective measurements such as commitment, enjoyment, usefulness, and learner motivation

However, there are also some potential drawbacks to consider, such as:

- High cost of equipment and development
- Technical difficulties and limitations
- Potential for motion sickness or other negative physical effects
- Limited social interaction and collaboration
- Limited transferability of skills to real-world contexts
- Limited situation awareness of instructors employing VR in classes
- Feasibility of conducting grounded assessment

It is important for educators to carefully consider these factors when deciding whether to incorporate immersive virtual reality into their teaching practices.

### 2.2. Learning outcomes of integrating VRLEs in educational contexts

By leveraging VR to facilitate learning experiences, educators can create dynamic and interactive learning environments that go beyond traditional textbooks and lectures, by employing approaches such as those outlined in the previous section. The ability to simulate real-world situations, provide practical application opportunities, and engage multiple senses with VR, intuitively seems to point towards it being a valuable tool for enhancing learning outcomes in various disciplines. But establishing clear outcomes has been challenging, due to the complex nature of immersive learning: a complex phenomenon (immersion) intertwined with another (learning), which represents an hypercomplex context, mutable and intricate (Beck et al., 2024). Indeed, through VR experiences, students can explore historical events, practice situated problem-solving and decision-making, and engage in scientific simulations, among other things. By engaging in these experiences, students are expected to develop a deeper understanding of the subject matter and improve their critical thinking, creativity, and problem-solving skills. And indeed, several surveys have been pointing out that such outcomes are common (Mystakidis et. al., 2021).

Moreover, learning through experience in VR can be particularly beneficial for students who prefer learning through hands-on experiences rather than traditional classroom lectures. VR can provide these students with an opportunity to engage with the subject matter in a more tangible way to develop an understanding of complex concepts. Learning through experience is a crucial aspect of education, and VR has the potential to enhance this aspect by providing students with immersive and interactive experiences. Also, by engaging in VR simulations, students can develop their skills and knowledge in a safe and controlled environment, and ultimately improve their learning outcomes (Chernikova et al., 2020).

Virtual reality usage in higher education has experienced significant growth in recent years. According to a 2020 survey by the EDUCAUSE Center for Analysis and Research, 23% of higher education institutions in the United States reported using VR or augmented reality (AR) technologies, with an additional 15% planning to implement them within the next two years (EDUCAUSE, 2020).

VR is being utilized across diverse disciplines in higher education, with various educational benefits being reported. For instance, in medical education, VR simulations are used to train medical students in surgical procedures and anatomy (Mergen et al., 2023); in engineering and architecture programs, VR allows students to interact with virtual prototypes and simulations, enhancing their design skills and spatial understanding (Han 2023); moreover, VR is being employed for historical and cultural explorations, enabling students to virtually visit significant sites and engage with immersive learning experiences (Hu et al., 2019).

An important advantage of VR in higher education is its ability to create immersive and experiential learning environments. Through VR, students can engage with realistic scenarios and environments, gaining hands-on experiences that might be otherwise challenging or costly to access in real life. This active participation and experiential learning promote deeper understanding and knowledge retention (Makransky et al., 2017). For example, VR has been used to simulate complex scientific phenomena, allowing students to observe and interact with concepts that are difficult to visualize in traditional learning settings (Huang et al., 2010). Furthermore, VR may play a significant role in developing students' skills and preparing them for their future careers. By incorporating gamification elements such as challenges, rewards, and progress tracking, VR can tap into students' intrinsic motivation and desire for achievement (Rivera & Garden 2021).

Cao, Ng, and Ye (2023) present that recent research on immersive VRLEs has shown promising results in terms of improving self-efficacy, self-regulation, student engagement, and participation in curriculums and institutional communities. The review also identified several key factors related to learning performance, including the design, method, process, and evaluation of outcomes. Specifically, the review emphasized the importance of careful design and development of immersive virtual reality learning environments, including considerations of user experience, pedagogical goals, and ethical concerns. The review also highlighted the need for rigorous evaluation of learning outcomes, including measures of knowledge or skill achievement, motivation, concentration, memory, and self-efficacy. In addition, the review noted the potential impact of high immersion and enjoyment on users' concentration and learning performance and suggested that these factors should be carefully considered in the design and evaluation of immersive virtual reality learning environments. Overall, the review suggests that a holistic approach to the design, development, and evaluation of immersive virtual reality learning environments is essential for optimizing learning outcomes and engagement. Based on these findings, the authors suggest that immersive virtual reality technology has the potential to enhance student engagement and learning outcomes, but that further research is needed to fully understand its impact and potential limitations. The review also highlights the importance of careful design and evaluation of immersive virtual reality learning environments, including considerations of user experience, pedagogical goals, and ethical concerns. Overall, this systematic review provides valuable insights for educators and developers seeking to create effective and engaging immersive virtual reality learning environments.

Virtual reality (VR) technology is being used in classrooms to provide experiential learning opportunities for students (Trudeau, 2024). With VR headsets, students can virtually visit historical sites and cultural locations, allowing for a deeper understanding of history and culture. VR creates immersive learning experiences that engage students and help them connect with the content. By combining VR with the Experiential Learning Cycle, students can have a more meaningful learning experience and improve their understanding and retention of knowledge. VR also enhances presence and immersion, leading to emotional responses and transformative learning experiences. In the classroom, VR can be used for virtual field trips and to provide authentic, real-world learning experiences. Schumann, Conrad, and Kablitz (2024) are presenting a study that examines the effects of using virtual reality (VR) in vocational school education. The study finds that integrating VR into the classroom has strong effects on cognitive activation and knowledge acquisition. There is also a positive correlation between cognitive activation and the acquisition of relevant subject knowledge. The findings contribute to a better understanding of the effectiveness of VR-integrated instruction and have implications for vocational education. Overall, it is clear from the studies referred to that VRLEs can be conducive to learning if they are designed accordingly, using purposeful instructional design.

### 2.3 Theoretical concept

This leads to the question, what are the relevant factors that significantly determine learning in VRLEs? In order to find this out, instruments are needed with which attitudes, beliefs, behaviours or other characteristics of individuals or groups can be measured. Although there are already studies that have empirically investigated these factors, they have mostly worked with scales that were not validated or were limited to selected factors (e.g. Fu et al. 2009; Vorderer et al. 2004). In contrast, Fokidis (2023) has developed a validated scale that measures a variety of factors that can be considered relevant to learning in immersive virtual learning environments. To this end, the relevant literature was analysed and the factors considered significant there were taken up and combined. A total of 208 items were found, representing 15 dimensions. After analysing the dimensions several times with regard to their relevance to the topic, the dimensions were reduced to 14 and the items to 64. The scale was tested on a sample of 462 students at a university in Greece using factor analysis and internal consistency. The remaining 43 items represent the following dimensions:

1. Perceived quality of the virtual environment's graphics
2. Perceived cognitive load
3. Perceived ease of use/control of the virtual environment
4. Immersion/Presence
5. Perceived feedback and content quality
6. Perceived degree of interaction
7. Motivation to learn and use the virtual environment
8. Perceived usefulness/knowledge gains
9. Simulator sickness

10. Positive feelings
11. Negative feelings

These dimensions and the validated items formed the basis for our own research project. Specially developed virtual learning spaces were analysed in terms of their relevance to learning due to their specific design.

## 3 Methodology

Based on the reported research results on the design of VRLEs, the respective partners developed a module manual in which the most important didactic and technical design principles for the design of immersive virtual spaces are summarised (Makrides et al., 2024). This in turn was used by the partners in the REVEALING project to design an example of such a room and then implement it for use with virtual glasses. The respective rooms were accessible to all participants via VRChat. They formed the basis for a joint study in which the acceptance of these VRLEs by students was to be analysed from various perspectives. This approach was based on the study by Fokidis (2023). The aim of this study was to isolate the relevant factors that can be responsible for a learning outcome in VRLEs. Based on other studies, a scale of 27 items was developed to represent immersion effects, usability, interaction opportunities, feedback, motivation and positive impressions.

The following five research questions were developed for the study based on Fokidis' questionnaire:

1. How do students experience virtual learning spaces and how do they evaluate them?
2. How did they experience immersion in the virtual space?
3. How were they able to interact with the VRLE and how did they receive feedback?
4. Were there any problems in the virtual space?
5. What did the experience trigger in them?

Before the research design and the results are presented, the VRLEs developed in the project are introduced.

### 3.1 Description of the developed VRLEs

Five different VRLEs have been developed. Each of the partners involved in the EU project had the task of developing a scene in a virtual space in which the instructional design principles were implemented (Makrides et.al., 2024; Modul 3). Early sketches were then transformed into virtual scenarios using Blender and Unity, and uploaded to the VRchat online platform, rendering them accessible through VR headsets or a PC. What VRLEs have in common is that they all enable user interactivity, that objects can be used and utilised for tasks. Users actively engage with tasks and receive feedback for their solutions.

## a. Ancient Greek Technology

The Ancient Greek Technology VRLE allows students to learn about the technological advances of the Ancient Greeks. The first is a primitive steam engine called the Aeolian Sphere (Figure 1). First, under the guidance of a teacher, students can take a torch and light the wood placed under the sphere. This will heat the water at the bottom of the sphere, causing it to rotate because of the steam exhaust. In the same VRLE, the students can also observe the parts of the Aeolian sphere placed on a table nearby, while the teacher explains how they work. The teacher can then use a simple slideshow presentation controller to give the students a presentation on Phryctoriae, a communication system used by the ancient Greeks. The system consisted of torches placed in specific positions on a tower or wall. Their arrangement could be deciphered to represent a particular letter, based on a pre-defined table of letters, thus allowing remote individuals to communicate with each other. Students can watch the presentation on a large display near the slideshow presentation control. They then approach a virtual Phryctoria system, where they can study the pre-defined letter table and create their own letters by placing torches in certain spaces on a wall. Finally, the VRLE contains two Phryctoria systems placed at a distance so that students can try to communicate with each other.

Figure 1: Aeolian Sphere

## b. Sea Urchin Measurement

In the Sea Urchin Measurement Expedition, students are amidst an underwater environment, where they can use rulers to measure sea urchins in two different time periods, first in the year 2023 and then after travelling through a portal to the year 2100. They annotate those measurements on virtual wooden panels using aqua pens and erasers (Figure 2). The instructor then records their measurements by using the VRChat virtual camera to take a picture. Finally, the students attend a virtual classroom where the instructor explains the statistical analysis process to analyse the underwater expedition results. They then perform this statistical analysis in the physical world based on the measurements collected in the virtual world.


Figure 2: Sea Urchin Measurement

The year and panel numbers help the instructor and students later identify which captured picture relates to each student group and activity period. This streamlines the task of carrying out statistical analysis in the physical world using specialized software to associate urchin size differences and ocean acidity. It also demonstrates how instructional design needs to consider the details.

### c. Linear Algebra

The Linear Algebra VRLE refers to the use of virtual light construction platforms that allow students to familiarise themselves with its concepts. Students are instructed by the teacher to interact with the buttons in front of the light bulbs (Figure 3). Each button affects the state of the bulb in front of it, as well as the state of the bulbs to its right and left. Therefore, students must use linear algebra to create combinations of light bulbs based on the teacher's instructions. Linear Algebra VRLE contains two different types of platforms. The first contains light bulbs with two states (on and off) and the second contains light bulbs with three states (red, green and blue), increasing the difficulty for students.

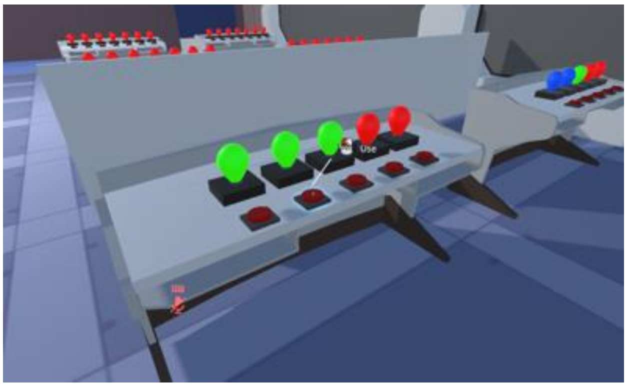

Figure 3: Linear Algebra

### d. Chimborazo Expedition

This VRLE teaches students about the process of Alexander von Humboldt's expedition to Chimborazo. The VRLE is in a wooden cabin at the foot of Chimborazo Mountain. First, the VRLE allows students to observe the tools used during the expedition in the form of signs and discuss their functionality with the teacher. Students can interact with the signs within the virtual world. Interacting with the signs causes them to rotate, revealing the true functionality of each expedition tool at the back (Figure 4). Students can also read about the rest of the expedition equipment and interact with its parts by picking them up and observing them in real time. After discussing the equipment, students need to visit a virtual globe placed in a room of the cabin. Students must discuss the location of Ecuador and find a hidden button on the globe. Interacting with the button will bring up the map of Ecuador, allowing students to further discuss the location of Chimborazo Mountain with the teacher. Next, students need to leave the hut by interacting with its main entrance of the hut. This action will teleport them to the bottom of the mountain where students can discuss the plantation. Students will be asked to pick up specific plant species and place them on progressively higher platforms that represent the different plantation zones of the mountain. The students can then use the portal next to the platforms to teleport to the top of the mountain. At the top of the mountain, students will find a final sign describing additional expedition equipment. Finally, students can use a portal to return to the cabin if they wish.

Figure 4: Chimborazo Expedition

#### e. Gallery Visit

Figure 5: Gallery Visit

The final Revealing VRLE is a visit to the Gallery. The gallery is an exact replica of the Teriade Museum in Mytilene, Lesvos, Greece, with paintings by world famous artists (Figure 5). In this VRLE, the teacher begins by presenting paintings by Pablo Picasso. Next, the students are invited to observe and discuss the paintings of Marc Chagall. Finally, the visit to the gallery is completed with a visit to another room where paintings by the famous painter Miro are displayed.

### 3.2 Realisation

The research design stipulated that students were given a brief technical usage introduction and, if necessary, on the topic of the virtual room before entering it. In each case, two to three students were allowed into the room together to complete the tasks. A researcher conducting the experiment accompanied them, to be able to answer doubts and to encourage discussions between participants on the respective content. There were also external observers who monitored the interactions and engagement of the participants on a desktop PC and recorded them on an observation sheet. After the session, everyone received a standardized questionnaire.

### 3.3. Sample

A total of 158 students took part in the empirical study, of which 27% were men and 73% women. However, only 147 questionnaires could be evaluated, as some were not completed in full and therefore could not be used. The participants were divided between the different locations (Table 1).

**Table 1**: Participations per location

| Location | No. |
|---|---|
| University of Aegean, Greece | 44 |
| Universidade Aberta, Portugal | 31 |
| University of the National Education Commission, Krakow, (UKEN), Poland | 49 |
| University of Mainz, Germany | 23 |
| **Sum** | **147** |

### 3.4 Data collection

A questionnaire was deployed to gather data on the participants' learning experience. It was based on a modified version of the MLES scale, developed for capturing users' experiences across diverse Metaverse applications, including in VR (Fokides, 2023). It consisted of 23 items examining seven factors: immersion (four items), ease of use (three items), perceived quality of the learning material (three items), perceived degree of interaction (three items), simulator sickness (three items), positive emotions toward the application (four items), and motivation (three items). Five additional items were included for recording demographic details of the participants, namely their gender, age, the university in which they study, prior experience in using VR, and prior experience in playing games. The questionnaire was provided online using LimeSurvey (Appendix 1).

## 4 Results

Cronbach's *α* was used to examine the questionnaires' internal consistency both for the whole data set and for each university separately (Table 2). As, in all but one case, the *α* was above the recommended minimum value of 0.70 (Taber, 2018), thus the internal consistency was considered satisfactory. Following that, seven new variables were calculated, representing the average score per factor, per participant and the data were imported to SPSS 29 for statistical analyses. Tables 2 to 6 present the descriptive statistics for the pilots' variables.

**Table 2.** The questionnaires' internal consistency

| Source | Cronbach's *α* |
|---|---|
| All data | .736 |
| University of the Aegean | .732 |
| UKEN | .768 |
| Universidade Aberta | .771 |
| University of Mainz | .384 |

As Table 2 shows, the overall consistency of the items of the scale used is relatively high, but with one exception. According to this, the use of the questionnaire at the University of Mainz is characterised by inconsistency. Since the scale at the other universities is consistent, the deviation is probably due to a scale that has been translated into German. In addition, problems with data entry would have been possible, although these were checked.

Table 3 provides a complete overview of the mean values of the respective dimensions of the scale, according to which all values on the 5-point Likert scale are at a high level of agreement (with the exception of the dimension ‘Simulator sickness’, which, however, must be seen in reverse). Positive emotions, motivation and the quality of the learning material were rated particularly highly.

**Table 3.** Descriptive statistics (all participants)

| Variable | | |
|---|---|---|
| Men/Women/Other | 36, 91, 1 | |
| Age (16-19, 20-24, 25-20, >30) | 33, 68, 7, 20 | |
| Prior VR use (never, once, experienced) | 75, 30, 2 | |
| Play games (no, occasionally, regularly) | 50, 41, 16 | |
| | *M* | *SD* |
| Ease of use | 3.89 | 0.75 |
| Immersion | 3.86 | 0.82 |
| Perceived quality of the learning material | 4.23 | 0.71 |
| Interaction | 3.91 | 0.74 |
| Motivation | 4.27 | 0.66 |
| Simulator sickness | 2.43 | 1.14 |
| Positive emotions | 4.39 | 0.66 |

In addition, the results were analysed separately for each partner of the participating universities and their virtual learning spaces. The results of the descriptive statistics, i.e. the mean values and the standard deviation on the individual dimensions, are in the high range for the VRLEs of the University of Aegean (Table 4), the University of Krakow (Table 5) and the Universidade Aberta (Table 6), and slightly below the overall average for the University of Mainz (Table 7). Overall, however, the individual data also show that the learning material, motivation and positive emotions receive the highest approval. The 'simulator sickness' dimension is viewed most critically by the participants compared to the other universities. This means that the proportion of those who had difficulties with the VR goggles and experienced nausea or dizziness, for example, was highest among the participants from Mainz. This could also have an impact on the overall evaluation of the VRLE 'Chimborazo Expedition', as the separate evaluation shows.

**Table 4.** Descriptive statistics (University of the Aegean)

| **Variable** | | |
|---|---|---|
| Men/Women/Other | 0, 5, 17, 0 | |
| Age (16-19, 20-24, 25-20, >30) | 14, 2, 6 | |
| Prior VR use (never, once, experienced) | 3, 18, 1 | |
| Play games (no, occasionally, regularly) | 11, 9, 2 | |
| | ***M*** | ***SD*** |
| Ease of use | 4.06 | 0.53 |
| Immersion | 3.80 | 0.98 |
| Perceived quality of the learning material | 4.48 | 0.57 |
| Interaction | 4.00 | 0.65 |
| Motivation | 4.50 | 0.59 |
| Simulator sickness | 2.26 | 1.00 |
| Positive emotions | 4.67 | 0.46 |

**Table 5.** Descriptive statistics (UKEN)

| **Variable** | | |
|---|---|---|
| Men/Women/Other | 8, 42, 0 | |
| Age (16-19, 20-24, 25-20, >30) | 33, 15, 1, 1 | |
| Prior VR use (never, once, experienced) | 36, 6 | |
| Play games (no, occasionally, regularly) | 20, 14, 8 | |
| | ***M*** | ***SD*** |
| Ease of use | 4.05 | 0.73 |
| Immersion | 3.80 | 0.81 |
| Perceived quality of the learning material | 4.33 | 0.53 |
| Interaction | 3.89 | 0.72 |
| Motivation | 4.09 | 0.75 |
| Simulator sickness | 2.65 | 1.21 |
| Positive emotions | 4.36 | 0.68 |

**Table 6.** Descriptive statistics (Universidade Aberta)

| **Variable** | |
|---|---|
| Men/Women/Other | 13, 20, 0 |
| Age (16-19, 20-24, 25-20, >30) | 0, 19, 2, 12 |
| Prior VR use (never, once, experienced) | 16, 3, 1 |
| Play games (no, occasionally, regularly) | 5, 10, 5 |

| | *M* | *SD* |
|---|---|---|
| Ease of use | 4.04 | 0.75 |
| Immersion | 3.98 | 0.87 |
| Perceived quality of the learning material | 4.47 | 0.67 |
| Interaction | 4.18 | 0.77 |
| Motivation | 4.48 | 0.58 |
| Simulator sickness | 1.78 | 0.90 |
| Positive emotions | 4.52 | 0664 |

**Table 7.** Descriptive statistics (University of Mainz)

| **Variable** | | |
|---|---|---|
| Men/Women/Other | 10, 12, 1 | |
| Age (16-19, 20-24, 25-20, >30) | 0, 20, 2, 1 | |
| Prior VR use (never, once, experienced) | 20, 3, 0 | |
| Play games (no, occasionally, regularly) | 14, 8, 1 | |
| | *M* | *SD* |
| Ease of use | 3.14 | 0.50 |
| Immersion | 3.88 | 0.63 |
| Perceived quality of the learning material | 3.41 | 0.66 |
| Interaction | 3.48 | 0.67 |
| Motivation | 4.13 | 0.42 |
| Simulator sickness | 3.04 | 0.98 |
| Positive emotions | 4.00 | 0.63 |

As linear regression was to follow for examining whether the applications had an impact on participants' motivation, the assumptions for this type of analysis were checked. The residuals were fairly normally distributed (Figure 6). The independence of residuals was checked using the Durbin-Watson (1950) statistic. As the value was 1.93 (recommended values > 1.5 and < 2.5) it was concluded that there were no issues in this assumption. There were no significant outliers, high leverage points, or highly influential points, given that the maximum Cook's distance that was observed was below the value of 1 (max = .274) (Cook, 1977). The Variance Inflation Factor (VIF) was used for checking multicollinearity: it was not an issue, as there were no cases in which the VIF was above the value of 4 (Table 7) (Miles, 2014). On the other hand, it was found that heteroscedasticity was an issue, as it was assessed using the Modified Breusch-Pagan Test for Heteroskedasticity ($p$ = .006).

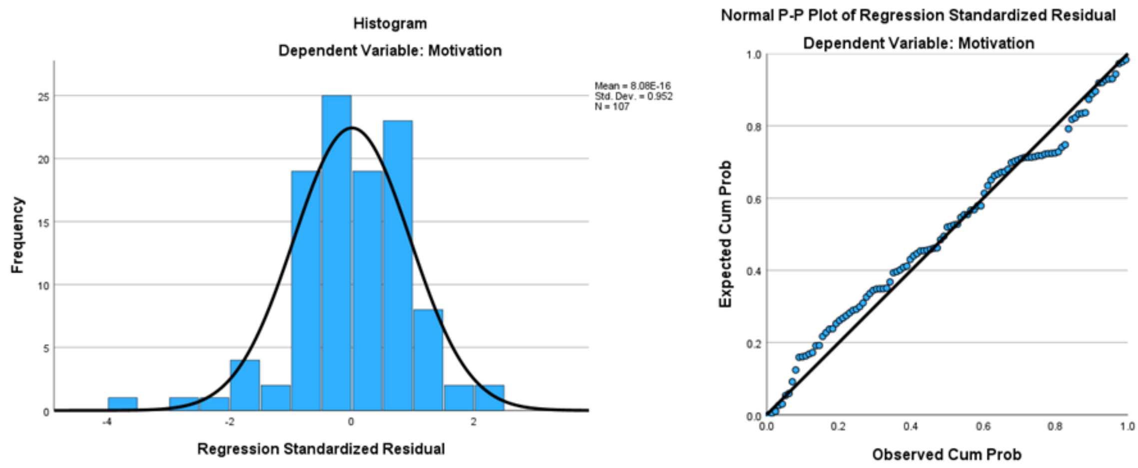


**Figure 6.** Distribution of the residuals: histogram (left) and regression plot (right)

**Table 8.** Multicollinearity statistics

| | **VIF** |
|---|---|
| Gender | 1.092 |
| Age | 1.139 |
| Ease of use | 1.420 |
| Immersion | 1.181 |
| Perceived quality of the learning material | 1.479 |
| Interaction | 1.495 |
| Simulator sickness | 1.337 |
| Positive emotions | 1.407 |
| Prior VR use | 0.126 |
| Play games | -0.038 |

Given this, we decided to run a multiple regression analysis with robust standard errors, using the HC3 method. The results of this analysis are presented in Table 8. The next step was to examine the data from each university separately. A multiple regression analysis with robust standard errors was run for the participants coming from the UKEN. For participants coming from the other universities, a regular univariate analysis was run, as there were no heteroscedasticity issues. Caution is advised for the interpretation of the results, as the sample sizes were rather small for both types of analysis. The results are presented in Tables 9 to 12.

**Table 9.** Multiple regression analysis with robust standard errors (all participants)

Model summary: $F = 9.49$, $p < .001$, $R^2 = .497$, $R^2_{Adj.} = .445$

| **Parameter** | ***B*** | ***Robust Std. Error*** | ***t*** | ***p*** | ***95% Confidence Interval*** | | $\eta^2_{partial}$ |
|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | |
| Gender | 0.146 | .122 | 1.200 | .233 | -.095 | .388 | .015 |
| Age | 0.083 | .067 | 1.224 | .224 | -.051 | .217 | .015 |
| Ease of use | -0.084 | .092 | -.913 | .363 | -.267 | .099 | .009 |
| Immersion | 0.085 | .075 | 1.123 | .264 | -.065 | .234 | .013 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Perceived quality of the learning material | 0.019 | .100 | .193 | .847 | -.180 | .219 | .000 |
| Interaction | 0.267 | .096 | 2.799 | .006 | .078 | .457 | .075 |
| Simulator sickness | -0.069 | .076 | -.911 | .365 | -.220 | .082 | .009 |
| Positive emotions | 0.382 | .108 | 3.519 | <.001 | .166 | .597 | .114 |
| Prior VR use | 0.160 | .093 | 1.727 | .087 | -.024 | .345 | .030 |
| Play games | -0.034 | .087 | -.387 | .699 | -.206 | .138 | .002 |

*Note*. For the interpretation of the effect sizes, the following cutoff values were used: .010-small, .059-medium, .138 or higher-large (Cohen, 2013)

**Table 10.** Univariate analysis (University of the Aegean)

Model summary: $F = 5.69$, $p = .004$, $R^2 = .838$, $R^2_{Adj.} = .691$

| **Parameter** | **Type III Sum of Squares** | **df** | **Mean Square** | ***F*** | ***p*** | $\eta^2_{partial}$ |
|---|---|---|---|---|---|---|
| Gender | 0.028 | 1 | 0.028 | 0.260 | .620 | .023 |
| Age | 0.114 | 1 | 0.114 | 1.060 | .325 | .088 |
| Ease of use | 0.007 | 1 | 0.007 | 0.069 | .797 | .006 |
| Immersion | 0.134 | 1 | 0.134 | 1.251 | .287 | .102 |
| Perceived quality of the learning material | 0.007 | 1 | 0.007 | 0.067 | .801 | .006 |
| Interaction | 2.045 | 1 | 2.045 | 19.076 | .001 | .634 |
| Simulator sickness | 0.012 | 1 | 0.012 | 0.111 | .745 | .010 |
| Positive emotions | 0.117 | 1 | 0.117 | 1.095 | .318 | .091 |
| Prior VR use | 0.386 | 1 | 0.386 | 3.597 | .084 | .246 |
| Play games | 0.262 | 1 | 0.262 | 2.442 | .146 | .182 |

**Table 11.** Multiple regression analysis with robust standard errors (UKEN)

Model summary: $F = 8.09$, $p < .001$, $R^2 = .723$, $R^2_{Adj.} = .634$

| **Parameter** | ***B*** | ***Robust Std. Error*** | ***t*** | ***p*** | ***95% Confidence Interval*** | | $\eta^2_{partial}$ |
|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | |
| Gender | 0.558 | .400 | 1.395 | .173 | -.258 | 1.373 | .059 |
| Age | 0.017 | .164 | .105 | .917 | -.317 | .351 | .000 |
| Ease of use | 0.098 | .218 | .451 | .655 | -.346 | .543 | .007 |
| Immersion | 0.127 | .141 | .902 | .374 | -.161 | .415 | .026 |
| Perceived quality of the learning material | -0.430 | .351 | -1.225 | .230 | -1.145 | .285 | .046 |
| Interaction | 0.255 | .204 | 1.248 | .221 | -.162 | .671 | .048 |
| Simulator sickness | -0.022 | .100 | -.222 | .825 | -.226 | .181 | .002 |
| Positive emotions | 0.777 | .287 | 2.708 | .011 | .192 | 1.362 | .191 |
| Prior VR use | 0.548 | .278 | 1.973 | .057 | -.018 | 1.115 | .112 |
| Play games | -0.142 | .155 | -.915 | .367 | -.457 | .174 | .026 |

**Table 12.** Univariate analysis (Universidade Aberta)

Model summary: $F$ =3.76, $p$ = .029, $R^2$ = .807, $R^2_{Adj.}$ = .592

| Parameter | Type III Sum of Squares | df | Mean Square | $F$ | $p$ | $\eta^2_{partial}$ |
|---|---|---|---|---|---|---|
| Gender | 0.038 | 1 | 0.038 | 0.426 | .530 | .045 |
| Age | 0.109 | 1 | 0.109 | 1.214 | .299 | .119 |
| Ease of use | 0.104 | 1 | 0.104 | 1.158 | .310 | .114 |
| Immersion | 0.015 | 1 | 0.015 | 0.166 | .693 | .018 |
| Perceived quality of the learning material | 0.127 | 1 | 0.127 | 1.408 | .266 | .135 |
| Interaction | 0.102 | 1 | 0.102 | 1.131 | .315 | .112 |
| Simulator sickness | 0.072 | 1 | 0.072 | 0.803 | .394 | .082 |
| Positive emotions | 0.030 | 1 | 0.030 | 0.337 | .576 | .036 |
| Prior VR use | 0.039 | 1 | 0.039 | 0.437 | .525 | .046 |
| Play games | 0.244 | 1 | 0.244 | 2.711 | .134 | .232 |

**Table 13.** Univariate analysis (University of Mainz)

Model summary: $F$ = 1.34, $p$ = .312, $R^2$ = .527, $R^2_{Adj.}$ = .133

| Parameter | Type III Sum of Squares | df | Mean Square | $F$ | $p$ | $\eta^2_{partial}$ |
|---|---|---|---|---|---|---|
| Gender | 0.402 | 1 | 0.402 | 2.588 | .134 | .177 |
| Age | 0.854 | 1 | 0.854 | 5.499 | .037 | .314 |
| Ease of use | 0.000 | 1 | 0.000 | 0.000 | .998 | .000 |
| Immersion | 0.212 | 1 | 0.212 | 1.363 | .266 | .102 |
| Perceived quality of the learning material | 0.036 | 1 | 0.036 | 0.235 | .637 | .019 |
| Interaction | 0.194 | 1 | 0.194 | 1.251 | .285 | .094 |
| Simulator sickness | 0.380 | 1 | 0.380 | 2.448 | .144 | .169 |
| Positive emotions | 0.542 | 1 | 0.542 | 3.486 | .086 | .225 |
| Prior VR use | 0.016 | 1 | 0.016 | 0.104 | .752 | .009 |
| Play games | 0.004 | 1 | 0.004 | 0.028 | .869 | .002 |

In summary, for the whole data set, it seems that the participants' positive feelings toward the applications, as well as their perceived degree of interaction had a positive association with their motivation. For the application of the University of the Aegean, the participants perceived degree of interaction had a positive association with their motivation. For the application of the UKEN, the participants' positive feelings toward the application had a positive association with their motivation. As for the application of the Universidade Aberta, as well as for the application of the University of Mainz, there were no factors associated with the participants' motivation.

## 5 Discussion

Taking the study by Beck, Morgado and O'Shea (2023) as a reference point for the evaluation of the VRLEs developed, the following five dimensions should be considered: ‘Active context’, ‘Collaboration’, ‘Engagement and scaffolding’, ‘Presence’ and ‘Real and virtual multimedia learning’. All VRLEs had an ‘active context’, i.e. the users should and had to engage with tasks. One exception is ‘Gallery Visit’, which enables a virtual museum visit but only offers a few activities. Collaboration' is given by the fact that several users are always present in all virtual rooms at the same time and are given tasks to discuss and solve together. This aspect is most pronounced in the applications ‘Ancient Greek Technology’, ‘Sea Urchin Measurement’ and ‘Chimborazo Expedition’, and somewhat weaker in ‘Linear Algebra’, where users mostly sit alone in front of their devices. ‘Engagement and Scaffolding' is more difficult to assess as it requires observation of interactions between users in the rooms. Although this was recorded, it was not analysed in this report. ‘Presence’ which refers to the sense of being physically present or immersed in a virtual environment, creating a feeling of engagement and interaction within that space, is given in all VRLEs, because they were very real constructed. The fact that ‘real and virtual multimedia learning’ can be found in the virtual rooms is present in all VRLEs. All applications relate to scientific problems that are either of historical interest - how did ancient Greece communicate over long distances or under what conditions did Alexander von Humboldt carry out measurements on a high volcano - or deal with the challenges of climate change like ’Sea Urchins Measurement'. In the ‘Linear Algebra’ application, you also have to deal with the demands of maths. The results of the survey of VRLE users can be interpreted more stringently on the basis of this evaluation of their didactic design requirements.

In the study, a validated scale was used to assess the acceptance and evaluation of the VRLEs presented, which were developed by the four partner universities. The five related research questions can be answered as follows on the basis of the results presented. The students surveyed experienced the virtual spaces with positive emotions and rated the experience in the VRLEs as very positive overall (research question 1) This is certainly due to the fact that the virtual spaces enable a variety of interactions and activities. The fact that the applications deal with interesting scientific problem areas may also have been decisive for this point. The users felt strongly involved in the immersive worlds and had often forgotten the outside world (research question 2). The learning environments provided plenty of opportunity for interaction, i.e. users could touch and move the virtual objects and perform actions with them. This is the case with all VRLEs. The feedback was also rated positively (research question 3). This was provided in the applications by the instructors involved, who were also present in the virtual rooms, or by boards that could be used to provide hints for the correct solution.

However, some students also experienced problems when they entered the virtual rooms. Some experienced nausea or dizziness. However, only a small proportion experienced this (research question 4). Motivation achieved a very high score on the scale, i.e. the participants were very strongly motivated by all VRLEs to engage not only with the topics of the rooms, but also with the possibilities of such learning environments for learning. The experience in the virtual immersive spaces therefore had a very positive effect on all participants (research question 5).

What is striking about the results is that the scale used shows a low level of consistency among users at the University of Mainz. On the one hand, as already mentioned, this may be due to the translation of the scale into German, while an English version was available to all other users. On the other hand, it can also be assumed that the high proportion of users who had difficulties using the VR goggles and entering the virtual space during the ‘Chimborazo Expedition’ is one reason for the deviating data from the University of Mainz. For example, 40% of respondents stated that they felt nauseous or dizzy when using the VR goggles. This could have influenced the evaluation of the items.

Furthermore, the results show that considering only the VRLE as the intervention, different variables are associated with student motivation. Specifically, “perceived interaction” only emerged for the Aegean University VRLE (ancient Greek technology); “positive emotion” only emerged for the UKEN (Linear Algebra); and no variables for Universidade Aberta (Sea Urchin Expedition) nor for University of Mainz (German Explorers).

## 6 Conclusions

The REVEALING project, an EU-funded project that explores how virtual learning environments with VR glasses can be used in academic teaching, saw project partners from Greece, Poland, Portugal, and Germany develop different virtual learning environments with instructional design, for their didactic use, following a module handbook. The virtual learning environments focus on different learning content and objectives, based on design principles derived from the psychomotor domain, immersive learning research and multimedia learning theory. The research design of the pilot studies consisted of two research questions, and hypotheses, data collection and an evaluation method. The overall questions were on how learning environments be instructionally designed so that they can promote learning and on what learning outcomes could be demonstrated under the combined conditions of technology, context, and approach.

The first question was answered by synthesizing the literature into an instructional design manual for the VRLEs, which was tested and refined by creating the various VRLEs, interactively identifying shortcomings in the manual content and refining it, then observing issues and shortcomings in the operational use of the VRLEs, and also use it to refine the manual, resulting in its final version (Makrides et al., 2024). The second question was answered by testing hypotheses: that the virtual learning environments would have a positive influence on learners' motivation, engagement, interaction and emotions. Data was collected through an online questionnaire that captured the learners' experiences. The evaluation method was a multiple regression analysis that examined the influence of the various factors on learner motivation. The results of the pilot studies showed that the positive emotions and the perceived interaction of the learners had a positive association with their motivation. For the Aegean University application, perceived interaction also had a positive association with motivation. For the UKEN application, positive emotion also had a positive association with motivation. For the Universidade Aberta and University of Mainz applications, there were no factors associated with learner motivation.

This corroborates the literature (e.g., Beck et al., 2024) that points out that the technology (VR) or the technological environment by itself is not determinant of outcomes. Thus one should seek to study associations with the combined factors of technological environment (the VRLE), the context (participating students, subject), and pedagogy (aspects of the instructional design and its deployment).

This analysis requires an identification of guidelines to hold that three-partite comparison. Namely, methods to select variables for those dimensions in a systematic manner. A pathway towards it may be Beck & Morgado (in press) proposed Immersive

Learning Case Sheet, which provides a method to identify specific categories of educational practices and strategies in immersive learning activities, and to identify quantitative and qualitative factors of immersion in those activities.

Hopefully, establishing such guidelines may enable identifying associations that provide expectable outcomes prior to the realization of actual learning activities, hence contributing to more robust methods of instructional design for immersive environments.

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Appendix 1: REVEALING Questionnaire

# Revealing Questionnaire

Thank you for taking part in the following survey after experimenting with the Oculus Quest 2 VR glasses and visiting the virtual learning environment. Apart from a small amount of social data, no other personal data will be collected. No IP address or other data will be recorded during the processing of the questionnaire. Everything is anonymous and the data is analyzed in aggregated form.

The REVEALING team

There are 14 questions in this survey.

# Use/control of the virtual environment

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **I used/controlled the VRChat application with ease** | ○ | ○ | ○ | ○ | ○ |
| **I was uncomfortable controlling my actions my actions in the virtual world** | ○ | ○ | ○ | ○ | ○ |
| **While using the apllication, I encountered issues performing tasks** | ○ | ○ | ○ | ○ | ○ |

# Spatial Immersion/Presence

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **I felt I was inside the virtual world** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **I forgot/ignored what was going on the physical room around me while I was in the virtual world** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **I lost track of time while I was in the virtual world** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **I felt like I was in a different place and time** | ◯ | ◯ | ◯ | ◯ | ◯ |

# Quality of feedback and content

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **Overall, the learning content was well presented** | ○ | ○ | ○ | ○ | ○ |
| **I received sufficient guidance on what to do in the virtual world tasks** | ○ | ○ | ○ | ○ | ○ |
| **I received sufficient feedback on my performance in the virtual tasks** | ○ | ○ | ○ | ○ | ○ |

# Degree of interaction

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **It was possible to have good interactions with the virtual world** | ○ | ○ | ○ | ○ | ○ |
| **The virtual world responded adequately to my actions** | ○ | ○ | ○ | ○ | ○ |
| **The interactions with the virtual objects were similar to interactions in the physical world** | ○ | ○ | ○ | ○ | ○ |

# Motivation to learn and use the virtual environment

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **The content had elements that piqued my curiosity** | ○ | ○ | ○ | ○ | ○ |
| **I feel motivated to continue using VR** | ○ | ○ | ○ | ○ | ○ |
| **I wanted to explore VR further** | ○ | ○ | ○ | ○ | ○ |

# Simulator Sickness/Discomfort

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **I experienced some sickness using Oculus Quest 2 (ex. nausea, heavy-headness, vertigo)** | ○ | ○ | ○ | ○ | ○ |
| **I felt physically tired while using Oculus Quest 2** | ○ | ○ | ○ | ○ | ○ |
| **I felt unease or some other light physical discomfort** | ○ | ○ | ○ | ○ | ○ |

# Feelings and Sensations While Using the Simulator

Please choose the appropriate response for each item:

| | strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|
| **I felt happy/excited when using Oculus Quest 2** | ○ | ○ | ○ | ○ | ○ |
| **I felt I was wasting my time in the tool during the session** | ○ | ○ | ○ | ○ | ○ |
| **I felt the virtual reality session was boring or irritating** | ○ | ○ | ○ | ○ | ○ |
| **I felt the virtual reality session was something unique and different, in a positive way** | ○ | ○ | ○ | ○ | ○ |

# General Questions

# From which University are you participating?

Please choose **only one** of the following:

- ◯ University of Aegean
- ◯ Universidade Aberta
- ◯ University of Cracow
- ◯ University of Mainz
- ◯ other (please insert in comment):

Make a comment on your choice here:

# Which gender do you belong to?

Please choose **only one** of the following:

- ◯ Male
- ◯ Female
- ◯ Diverse

## How old are you?

Please choose **only one** of the following:

- ◯ 15 to 19 years
- ◯ 20 to 24 years
- ◯ 25 to 29 years
- ◯ 30 years and older

## What level of studies are you currently studying?

Please choose **only one** of the following:

- ◯ Bachelor
- ◯ Master
- ◯ Doctoral Thesis
- ◯ other

## What is your major field of study?

Comment only when you choose an answer.
Please choose all that apply and provide a comment:

- [ ] Teacher Education
- [ ] Science
- [ ] Humanities
- [ ] Arts
- [ ] Sports
- [ ] other

## Have you used VR goggles for gaming or learning?

Please choose **only one** of the following:

- ( ) No, never
- ( ) Yes, I have already tried them once
- ( ) Yes, I am experienced in this

## Do you play computer games on a desktopPC or console?

Please choose **only one** of the following:

- ◯ no
- ◯ now and then
- ◯ regularly

Thank you for completing the questionnaire!

Submit your survey.
Thank you for completing this survey.