VRTEACHER Handbook Good Practices for VR-based Approaches in Teacher Education

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VRTEACHER

Virtual Reality-based Training to improvE digitAl Competences of teacHERs

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VRTEACHER handbook

Good practices for VR-based approaches in teacher education

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Dear reader,

Welcome to the VRTEACHER handbook of best practices. This handbook of best practices aims to present the VRTEACHER project and its results that have been implemented and evaluated in the five partner countries, demonstrating its effectiveness in the field of teacher education. This handbook aims to share the two-year experience of the project, which focused on leveraging Virtual Reality (VR) technology to enhance teacher training and promote the development of key skills among educators.

In today's rapidly evolving educational landscape, teachers play a crucial role in shaping the future of education and fostering the development of the next generation. However, teachers face unprecedented challenges, including the increasing complexity of classrooms, the multicultural diversity of students, and the ever-growing influence of digital technologies. Additionally, the emergence of the global COVID-19 pandemic has brought about an urgent need for innovative approaches to teaching and learning, with teachers having to quickly adapt to remote and hybrid instructional models. The sudden shift to online education posed significant challenges for both teachers and students, particularly in terms of digital skills and effective teaching practices. Recognizing the critical importance of equipping teachers with the necessary skills and knowledge to navigate these challenges, the VRTEACHER project was initiated. The project sought to harness the potential of Virtual Reality (VR) as a powerful tool in teacher training, specifically focusing on crisis management within the educational context, such as the challenges posed by a pandemic.

This handbook serves as a guide to the VRTEACHER project's findings, methodologies, and outcomes. In this handbook, you will discover how VR can enhance teacher training, fostering a more engaging and immersive learning experience for both in-service and pre-service teachers. We delve into the importance of promoting the modernisation and digital transformation of teacher education and provide practical guidance on how to integrate novel VR-based training tools effectively within teacher education. VR-based training has emerged as an exciting and promising approach in the field of teacher education. This innovative technology has the potential to revolutionize the way teachers are trained, offering immersive and experiential learning experiences. Through VR-based training, teachers can be placed in virtual classrooms and experience challenging scenarios where they can practice their teaching skills, make decisions, and engage with virtual students. This hands-on experience allows teachers to develop their pedagogical strategies, and classroom management techniques, and adapt their teaching approaches to different student needs.

We invite you to explore the best practices shared within this handbook. From the initial implementation to the evaluation of results, you will gain valuable insights into the potential of VR-based approaches in teacher education. Whether you are an educator, a researcher,

or an education stakeholder, this handbook offers practical guidance and inspiration to incorporate VR technologies as novel and modern teaching practices.

We invite teachers, teacher trainers, policymakers, and stakeholders in the field of teacher education to explore this handbook, extract valuable insights, and embrace the opportunities that VR-based training can offer. Together, let us embark on a journey towards empowering teachers and shaping the future of teacher education.

We extend our gratitude to you for joining us on this journey of exploring the transformative power of VR in teacher education. We hope that the information and experiences shared in this handbook will inspire you to embrace innovative approaches, enhance your teaching methodologies, and ultimately contribute to the development of future-ready educators.

Thank you for your interest in the VRTEACHER project, and we wish you an insightful and inspiring journey ahead.

Sincerely,

The VRTEACHER Consortium

List of Abbreviations

IO	Intellectual Output
VR	Virtual Reality
HMD	Head-mounted display
OECD	Organisation for Economic Co-operation and Development

Contents

1. Introduction

Teachers play a crucial role in driving educational excellence and sustainable development, making them a powerful and influential force in the field of education. The "Education and Training 2020" strategy in Europe has underscored the importance of teachers, emphasizing their initial education and continuous professional development. In today's dynamic educational landscape, teachers face unprecedented challenges as classrooms become more complex, multicultural, and digitalized. Moreover, the outbreak of the COVID-19 pandemic has further intensified the impact on education, presenting educators with adaptive and transformative challenges for which there are no predefined guidelines for appropriate responses (OECD, 2020). The implementation of innovative training approaches to equip educators with lifelong skills to effectively manage classrooms during crisis situations, such as a pandemic becomes increasingly imperative.

In this context, the VRTEACHER project seeks to empower teacher education by introducing a novel Virtual Reality (VR)-based approach specifically designed to respond to in-class crisis situations, such as a pandemic. By utilizing VR for teacher training, the project aims to promote educators' adaptability, preparedness, and ability to respond to and handle crisis scenarios. The integration of VR in teacher training holds significant potential as it provides a safe and controlled virtual space for experiential learning and practical training. Through engaging and immersive experiences, VR can replicate real-life situations and challenges, enabling teachers to gain first-hand perspectives and develop empathy skills. The VRTEACHER project seeks to develop a VR methodology and tool dedicated to crisis management, empowering teachers with adaptive responses and effective classroom management skills.

The primary target groups for the VRTEACHER project are in-service teachers and pre-service higher education students, PhD candidates, etc., who are the next generation of teachers. The proposed VR tool that was developed under the project aims to provide a comprehensive understanding of the teaching profession, clarifying educators' roles within the school environment and facilitating their personal and professional growth. The project places particular emphasis on inclusivity and multicultural classroom environments, aligning with the European Commission's recognition of multicultural teaching as a crucial competence for the 21st-century educator.

The vision of the VRTEACHER project is to offer innovative VR-based teaching and learning strategies that foster the personal and professional development of teachers through systematic practical and experiential training. By enhancing teachers' knowledge, skills, and adaptability during crisis situations in education, the project aims to contribute to the advancement of the field. The project takes a transnational approach, involving institutions from Cyprus, Greece, Spain, Malta and Ireland, as it addresses cross-border challenges. By involving institutions from multiple countries, the project aims to capture diverse

perspectives, experiences, and expertise in teacher education, while also allowing the exchange of knowledge, best practices, and innovative ideas among different educational systems and contexts. Each participating country brings its unique history, professionalism, and approach to teacher education, which enriches the project's outcomes and ensures a comprehensive understanding of the subject matter.

This report provides a comprehensive overview of the VRTEACHER project, along with key elements related to VR and relevant terminology. Section 2 presents a detailed overview of the project, highlighting its objectives, target audience, and implementation timeline. Section 3 introduces the concept of VR and presents essential terminology to ensure a common understanding among readers. Section 4 delves into the project's methodology, focusing on the systematic approach used to identify teachers' needs and establish the Competence Framework for VR-based teacher training. Section 5 focuses on the evaluation framework, discussing how the impact of VR-based training was measured and providing guidelines for future initiatives and tool utilization. Additionally, this handbook presents five case studies (Section 6), documenting the lessons learned during the two-year project in all partner countries. The conclusions and final thoughts section provides a summary of the findings and their implications. Finally, the handbook concludes with a reference section, citing the sources and references used throughout the document.

2. The VRTEACHER project: scope and aims

The VRTEACHER project is an Erasmus+ KA2 project (Grant Agreement: 2020-1-CY01-KA226-SCH-082707) that started in May 2021 and ended in May 2023. The project involves six partners, Cyprus University of Technology (Cyprus / Coordinator), University of the Aegean (Greece), Universidad Carlos III de Madrid (Spain), Fundación Siglo22 (Spain), Future In Perspective Limited (Ireland), Commonwealth Centre for Connected Learning (Malta). The project is coordinated by the Social Computing Research Center, through the Visual Media Computing Research Laboratory of the Department of Multimedia and Graphic Arts, Cyprus University of Technology. More information about the project can be found on the official website of the project https://www.vrteacher.eu/. The work conducted within the project builds upon the prior research conducted by Dr. Stavroulia (Stavroulia et al., 2019; Stavroulia & Lanitis, 2023) in her Ph.D. studies, which explored the use of VR application technologies in teacher training. This project represents a continuation and expansion of her previous research, aiming to further investigate and harness the potential of VR in enhancing teacher training methodologies. By leveraging the insights and expertise gained from Dr. Stavroulia's doctoral research, the project seeks to advance the field of VR-based teacher training and contribute to the development of innovative and effective approaches in this domain.

2.1. From idea to reality

The VRTEACHER project is an innovative initiative that aims to strengthen teacher education through the integration of Virtual Reality (VR) technology. The project was conceived as a response to the COVID-19 pandemic, which presented an unprecedented crisis in the field of education. The pandemic forced schools and Universities to close their physical doors and transition to remote learning, causing disruptions and challenges for both teachers and students. In this context, the VRTEACHER project sought to provide a solution to the crisis by harnessing the power of VR technology. By leveraging VR, the project aims to support teachers in adapting to the new educational landscape and equip them with the necessary skills to effectively navigate crisis situations, including the challenges posed by the pandemic. The project recognized that traditional methods of teacher training and professional development were insufficient in addressing the unique demands of the pandemic. The limitations of online platforms and video conferencing highlighted the need for more immersive and engaging training approaches that could simulate real-life classroom scenarios.

Equally important is that the VRTEACHER project was also developed as a response to the recognized need for practical training and hands-on experiences in teacher education. Traditional teacher training programs often focus on theoretical knowledge and pedagogical strategies, leaving teachers ill-prepared for the practical challenges they encounter in real classrooms. Additionally, the pandemic had a profound impact on the practical training of

teachers as it necessitated social distancing measures and the closure of educational institutions resulting in the suspension or limitation of in-person practical training for teachers. Traditional methods of observing and participating in classroom activities, conducting teaching practice, and receiving feedback from experienced educators were disrupted, leading to a significant gap in hands-on training opportunities. The VRTEACHER project aimed to bridge this gap by providing teachers with a virtual training tool that offers immersive and realistic simulations of classroom scenarios. By using VR technology, teachers can engage in interactive and experiential learning, gaining valuable practical experience in a safe and controlled environment. This hands-on approach allows teachers to develop their skills, build confidence, and refine their teaching techniques.

Furthermore, the VRTEACHER project recognizes the importance of preparing teachers for the unexpected. In the ever-changing landscape of education, teachers often encounter unexpected situations and emergencies that require quick thinking, adaptability, and problem-solving skills. Preparing teachers for the unexpected is a crucial aspect of their professional development, and VR offers a promising solution in this regard.

To conclude, the pandemic highlighted the need for teachers to be prepared for unexpected situations, including crisis management and rapid adaptation to changing circumstances. The limitations in practical training during the pandemic further underscored the importance of providing teachers with the necessary skills and resources to navigate unforeseen challenges effectively. Addressing these challenges requires innovative solutions, such as the VRTEACHER project, that aims to bridge the gap and ensure that teachers are well-prepared to face future uncertainties in education.

2.2. The objectives of the VRTEACHER project

The objectives of the VRTEACHER project demonstrate a comprehensive approach to addressing the challenges faced by teachers and enhancing their professional development through VR training. The main objectives of the project were:

- Advance the state of the art in the relatively new area of VR-based teacher training.
- Develop a Virtual Reality (VR) training framework specifically designed for teachers.
- Identify and address the specific needs and challenges faced by teachers during the pandemic.
- Design and develop VR training scenarios that meet the specific requirements and interests of teachers.
- Enhance teachers' practical skills and preparedness for unexpected situations through VR simulations and scenarios.
- Improve teachers' ability to adapt and make effective decisions in challenging classroom environments.

- Foster empathy and perspective-taking skills among teachers through immersive VR experiences.
- Support teachers' continuous professional development and lifelong learning.
- Evaluate the effectiveness of VR-based teacher training.
- Establish a transnational network and share best practices in VR-based teacher training with partner countries.
- Contribute to the advancement of VR technology in education and its integration into teacher training programs.
- Enhance the quality of education by equipping teachers with innovative tools and strategies to address unforeseen circumstances.

The intellectual outputs (IOs) of the project played a crucial role in fulfilling the project's objectives and ensuring its successful implementation. These outputs were carefully designed to address specific needs and contribute to the overall goals of the project. The project consisted of four intellectual outputs that are presented in figure 2-1.

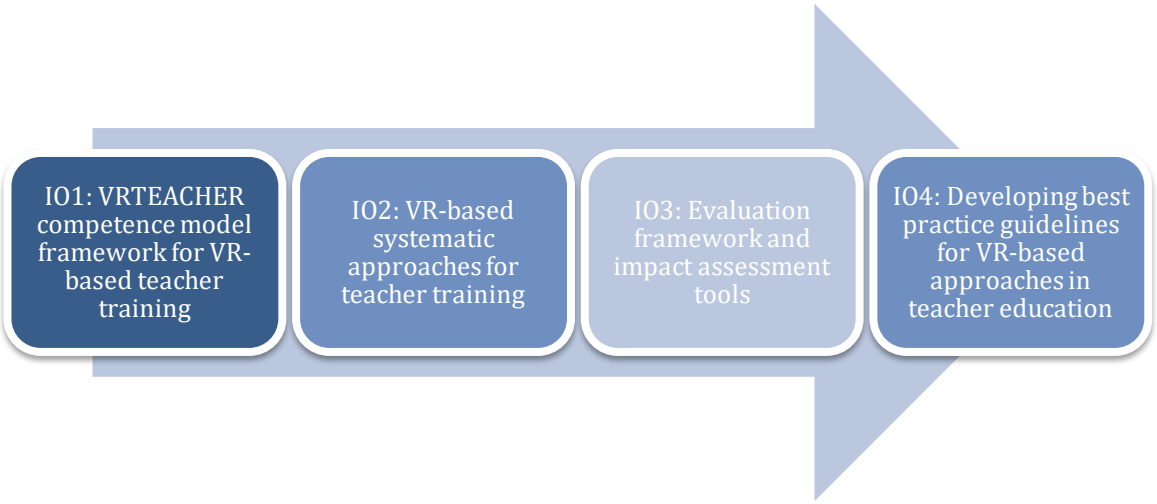

Figure 2-1. VRTEACHER project intellectual outputs

➢ **IO1: VRTEACHER competence model framework for VR-based teacher training**

Intellectual Output 1, focused on analysing existing competence frameworks and served as a foundation for identifying teachers' needs during the COVID-19 pandemic and defining the key competences to be addressed within the VR training framework. By developing a comprehensive competence model, the project aimed to ensure that the VR training aligns with the specific needs and requirements of teachers.

➢ **IO2: VR-based systematic approaches for teacher training**

This output involved the design and development of the VR training tool and the development of the VRTEACHER online platform[1]. The platform is connected to the VR application, provides useful training resources and aims to support teachers and facilitate the exchange of good practices during and also after the end of the project.

➢ **IO3: Evaluation framework and impact assessment tools**

This output focused on evaluating the effectiveness and impact of the implementation of the VR training tool. The partnership identified appropriate evaluation methodologies, quantitative and qualitative tools, and indicators to assess the impact of the VR tool on the competences, skills, knowledge and attitudes of in-service and pre-service teachers. The results from this evaluation helped the partnership measure the impact of VR-based training and provided significant insights that will guide further improvements related to the VR application.

➢ **IO4: Developing best practice guidelines for VR-based approaches in teacher education**

This intellectual output, the handbook of 'Good practices for VR-based approaches in teacher education' summarizes the methodology and provides practical recommendations for promoting the use of innovative VR-based approaches in teacher education. This handbook will serve as a valuable resource for educators, policymakers, and institutions looking to incorporate VR into their teacher training programs.

All four intellectual outputs demonstrate the project's systematic and comprehensive approach to VR-based teacher training.

2.3. Innovation of the VRTEACHER project

The VRTEACHER project brings significant innovation to the field of teacher education through its utilization of VR technology. This innovative approach revolutionizes traditional teacher education methods by providing a dynamic and immersive learning experience for educators. One important aspect of the project is the development of a VR-based competence model framework for teacher training. By analysing existing competence frameworks and identifying teachers' real needs through a survey and focus groups, the partnership identified a set of competences that can be effectively addressed within the VR

[1] The VRTEACHER platform can be found in the following link: https://www.vrteacher.eu/login/. The VRTEACHER platform adopts an open approach, allowing access to its resources and materials to anyone. However, registration is required to fully engage with the platform and take advantage of its features and functionalities.

training framework. This innovation enables teachers to acquire essential skills and knowledge more engagingly and practically, enhancing their ability to navigate challenging classroom situations. Another significant aspect of the project is the creation of a dedicated online platform connected to the VR tool. The VRTEACHER platform serves as a hub for teachers, offering ongoing support related to VR-based training and promoting the exchange of best practices. Furthermore, the VRTEACHER project introduces an evaluation framework and impact assessment tools to measure the effectiveness and impact of VR training activities. This innovative approach allows for the systematic analysis of the VR tool's influence on teachers' competences, skills, and knowledge. By collecting valuable data and insights, the project contributes to the ongoing improvement and refinement of VR-based approaches in teacher education.

2.4. Added value of VR-based training through the VRTEACHER application

The VRTEACHER project offers significant added value to the field of teacher education. One of the primary added values of the project is its ability to provide teachers with practical training in a safe and controlled virtual environment. Through the VR training tool, teachers can engage in interactive and realistic simulations that replicate real-life incidents and extreme scenario cases, allowing them to practice decision-making, problem-solving, crisis response techniques and classroom management in a safe and controlled environment. This hands-on experience in a risk-free setting prepares teachers for real-world challenges and enhances their ability to handle unexpected situations effectively. By experiencing various unexpected and extreme scenarios through VR, teachers can develop critical thinking skills and enhance their ability to adapt quickly to unforeseen circumstances.

Equally important is that VR offers a safe learning environment for teachers to experiment and learn from their mistakes without consequences. They can explore and experiment with different approaches and assess the outcomes of their decisions in a risk-free virtual classroom setting. This enables teachers to build confidence, refine their skills, and gain valuable experience in managing unexpected situations without the fear of negative repercussions. Additionally, the VR application provides teachers with feedback and reflection opportunities helping them to identify areas for improvement, reflect on their teaching practices, and refine their responses to unexpected situations.

The VRTEACHER project aims to have a lasting impact on teacher education and training. By developing a comprehensive evaluation framework, the project assesses the effectiveness of VR-based training and identifies areas for improvement. The insights and findings generated contribute to the refinement and replication of VR-based approaches in teacher education, benefiting educators worldwide.

2.5. The VRTEACHER platform

The VRTEACHER platform is integrated into the project's website (https://www.vrteacher.eu/) and aims to serve as a hub for teachers to support them related to VR-based teacher training (figure 2-2). The VRTEACHER platform adopts an open approach, allowing access to its resources and materials to all. However, registration is required to fully engage with the platform and take advantage of its features and functionalities, including the VR application developed (https://www.vrteacher.eu/register/). The registration process allows teachers to create an account and gain full access to the platform's features, tools, and resources. Registered users may also share information and comments regarding the material available through the platform. The decision to implement a registration process serves multiple purposes. It helps to ensure the security and privacy of the platform's users by creating individual accounts and authenticating their identities. This helps to maintain a safe and trusted environment for participants to interact and access the platform's resources. Additionally, registration allows for better user management and tracking of participation and engagement. It enables the platform administrators to monitor user activity, track progress, and gather feedback, which can be valuable for assessing the effectiveness and impact of the VRTEACHER project. Registration ensures that participants can fully utilize the platform's resources, engage with the community, and receive the necessary support to enhance their VR-based teacher training journey.

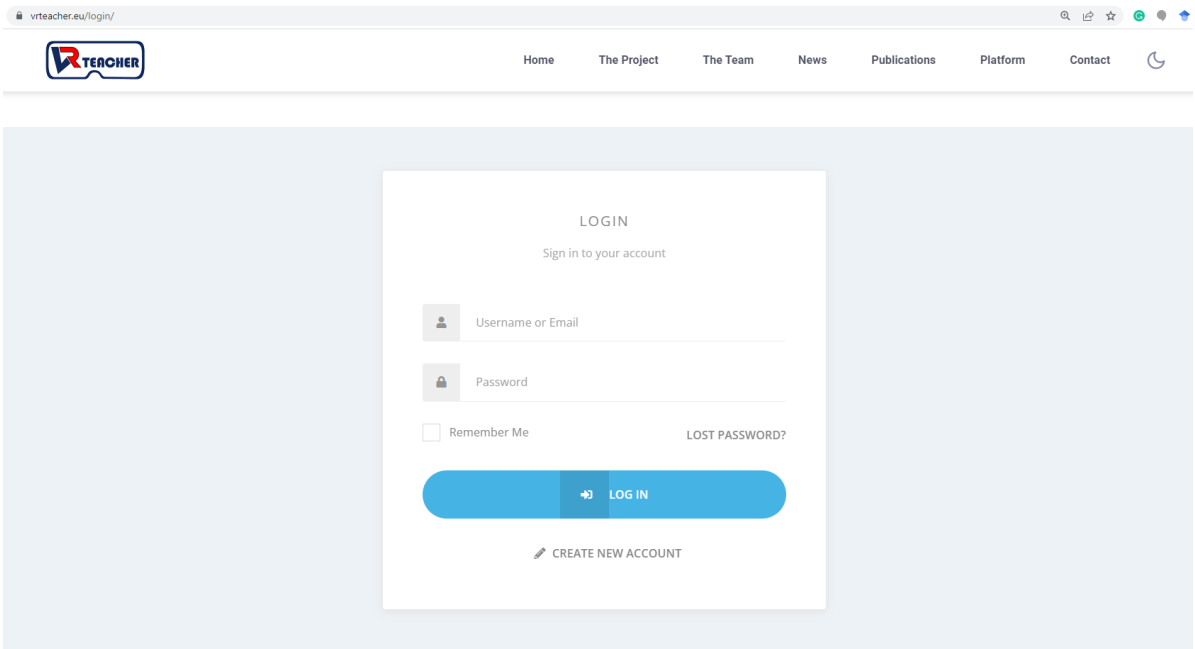

Figure 2-2. The platform environment of the VRTEACHER project

3. Introduction to Virtual Reality

3.1. Defining the terms

The definition of virtual reality lacks consensus due to its multidimensional nature and diverse set of characteristics. While 'virtual' denotes computer-generated elements, 'reality' pertains to the resemblance of objects or environments to the physical world (Cheng, 2014). Virtual Reality (VR) is defined as a '*computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors*' (Freina & Ott, 2015, p. 1). VR '*is a computer-generated 3D representation of real-life environments. A user can autonomously navigate around a VR (in the form of avatars) and interact with simulated objects and other avatars in real-time at the same pace one would experience events in the real world*' (Ke et al., 2016, p. 212). While there is a lack of consensus in defining virtual reality, there are common elements shared among various definitions. These elements highlight VR as an interactive and immersive environment, characterized by a sense of presence and autonomy (Mazuryk & Gervautz, 1996). Scholars have identified the "3I" framework, consisting of Immersion, Interaction, and Imagination (figure 3-1), as key components of virtual reality (Cheng, 2014; Li et al., 2009).

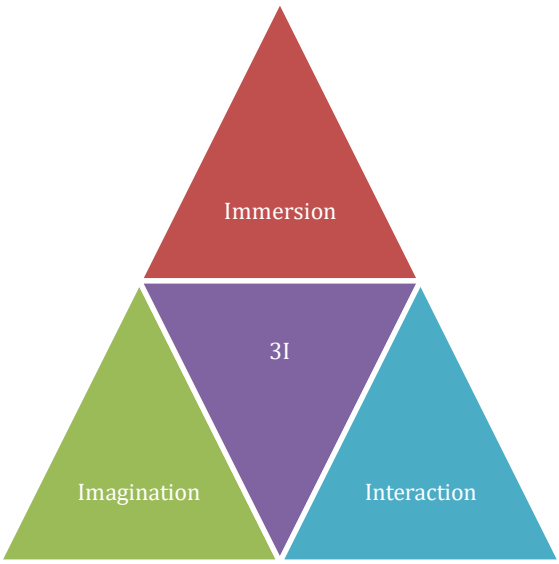

Figure 3-1. '3I'-Immersion, Interaction and Imagination

Immersion is a fundamental aspect of VR that refers to the extent to which a user feels completely engrossed and mentally absorbed within the virtual environment. It aims to create a sense of presence, where the user perceives and interacts with the virtual world as if it were real (Cheng, 2014). In VR, immersion is achieved through various techniques and technologies that stimulate the user's senses, primarily visual and auditory, but also haptic (touch) and sometimes even olfactory and gustatory sensations. Visual immersion is typically

achieved through head-mounted displays (HMDs) that provide a stereoscopic view of the virtual world, giving the illusion of depth and three-dimensionality (figure 3-2). The level of immersion in VR can vary depending on the quality of the hardware, software, and content design. Factors such as the resolution and field of view of the display, the responsiveness of the tracking system, and the realism of the virtual objects and environments all contribute to the overall sense of immersion. Additionally, the user's level of engagement, focus, and suspension of disbelief plays a crucial role in enhancing the feeling of being "present" in the virtual environment. A high level of immersion has the potential to evoke empathy and emotional responses, making it a valuable tool in fields such as healthcare, psychology, and social sciences.

Figure 3-2. Head-mounted displays (HMDs)

Interaction refers to the ability of users to actively engage and manipulate objects, elements, and environments within the virtual world (Sherman & Craig, 2003; Zhan, 2011). It encompasses the user's ability to control their actions and influence the virtual environment through various input modalities, such as hand gestures, controllers, voice commands, or body movements. Interaction plays a crucial role in creating a sense of agency and empowering users to participate and shape their virtual experiences. It enables users to manipulate virtual objects, navigate through virtual spaces, and engage in virtual activities or simulations. The level of interactivity can range from simple interactions like picking up objects or pressing buttons to more complex interactions involving gestures, locomotion, and multi-user collaboration.

The ***imagination*** element in virtual reality (VR) refers to the ability of VR technology to create and stimulate the user's imagination, allowing them to envision and experience virtual worlds and scenarios that may be beyond the constraints of physical reality (Cheng, 2014). By presenting realistic or fantastical environments, VR stimulates the user's imagination and invites them to actively engage with the virtual world in new and unexplored contexts, whether it's exploring ancient civilizations, travelling to distant planets, or teaching in a virtual classroom. One of the key aspects of the imagination element is the sense of presence. Presence refers to the feeling of "being there" in the virtual environment as if the virtual world and its elements are real and tangible (Bailenson et al., 2008, Slater, 2003). The

sense of presence is a critical aspect of VR as it enhances the user's overall experience and immersion. When users feel a strong sense of presence, they are more likely to engage actively with the virtual environment and respond emotionally and cognitively to the stimuli presented. This sense of being present in the virtual world enhances the feeling of realism and believability, making the experience more impactful and engaging.

3.2. The educational advantages of VR

In recent years, there has been a notable shift in the field of education, with a growing focus on the integration of immersive and innovative computer-based training tools to enhance knowledge and skills acquisition. While VR in education is still a relatively emerging field, research and experimentation are rapidly expanding. This shift has led to increased interest in the use of VR environments as a means to revolutionise teaching and learning through technology-based approaches (Bailenson et al., 2008). VR offers a unique and compelling educational experience by immersing learners in a simulated environment that replicates real-world scenarios. Through the use of specialised hardware, such as head-mounted displays, users can interact with and explore these virtual environments in a highly engaging and interactive manner.

One of the key advantages of VR in education is its ability to provide experiential learning opportunities that go beyond traditional classroom settings. By placing the trainees in virtual environments that mimic real-world contexts, they can actively participate in simulations, experiments, and problem-solving activities. This hands-on and immersive approach allows learners to develop practical skills, critical thinking abilities, and a deeper understanding of complex concepts. Furthermore, the utilization of this technology enables the creation of flexible educational experiences that align with key educational theories and strategies. In the following section, we will examine the primary advantages and affordances of VR technology in education.

3.2.1. Simulations

One of the earliest applications of immersive VR in education was for training purposes. VR technology enables the creation of realistic simulations, which provides trainers with a safe environment to replicate actions required in high-risk situations or in places/machinery that may be difficult to access or experience in real life. Aviation companies and defence departments were among the first to explore these possibilities for training pilots (Lee & Bussolari, 1989) and developing decision-making skills for military interventions (Lele, 2013), respectively. As technology has evolved and matured, other fields have also utilised virtual reality to create training that can be monitored, controlled, and adapted in ways that are difficult to achieve in a real-world setting (Mantovani, 2011). For instance, in the field of medicine, immersive VR systems have been used to train surgical skills. Several studies have

reported that this technology enhances skills acquisition compared to non-VR training (Atli, Selman & Ray, 2021; Bing et al., 2019; Chaudhry et al., 2020). Similarly, evidence suggests that VR outperforms conventional methods for emergency response training (Stansfield et al., 2000; Wiederhold & Wiederhold, 2008).

3.2.2. Constructivism

In any case, the benefits that VR technology can report in education are not limited to the implementation of simulations. 3D virtual spaces afford first-person exploration. Effective VR experiences remove the presence of the interface and, thus, the boundaries between the human and the machine, to pursue a non-mediated interaction that is of the "same quality" as the interactions we experience in the real world (Winn, 1993). This provides the basis to support the design of learning experiences from the perspective of the constructivist theory, that is, to afford learners to generate knowledge from meaningful direct experience with the environment (Dede, 1995). In some cases, these environments take the form of loosely structured virtual worlds, similar to sandboxes, that the learner explores and engages with freely to make sense of them. For instance, *Anatomy Builder VR* (Seo et al., 2021) enables students to learn anatomy by walking around, examining, and manipulating anatomical models. Virtual laboratories that simulate hands-on laboratory experiences in universities (Lamb et al, 2020) are another example of educational experiences designed using this approach, where students can engage in various problem-based learning activities similarly as they would in a real-world laboratory setting.

3.2.3. Situated/Experiential learning

The Situated Learner Pedagogy, proposed by Lave (1988), suggests that learning is closely connected to the activity, context, and culture in which it takes place. Consequently, much of what is learned is specific to the situation and place in which it occurs (Greeno et al., 1993). Learning activities that are designed based on these principles aim to create meaning from real-life activities. Examples of such activities include field trips, where learners engage with a specific environment, or internship experiences, where they participate in a work environment. Virtual Reality (VR) environments offer a high degree of realism, and the sense of presence they induce in learners can support the design of virtual learning activities that replicate real-life settings. This approach can make learning more accessible to a larger number of students and more easily monitored. One field that benefits greatly from this approach is foreign language learning, as it can be challenging for teachers to recreate authentic contexts in a traditional classroom. One study, described by (Franciosi et al., 2016), addresses this issue by using a farming simulation to assist Japanese university students in learning English vocabulary. As another example, (Schott & Marshall, 2018), the authors designed a virtual Pacific island that students can explore to learn about life on islands and the concept of sustainable development.

3.2.4. Embodied Learning

VR technology supports the embodied learning theory, which emphasises the connection between our bodily activity and the enactment of knowledge and concepts (Goldin-Meadow, 2009). A VR learning environment can effectively reinforce these principles since it allows for the creation of experiences where users interact with learning content through physical movement or tangible interfaces. An example of a system that utilises this feature is described by Chang et al. (2017), where movement tracking and tangible objects are combined to enhance spatial skills through puzzle-solving activities. In their study, the authors (Fuhrman et al., 2020**)** examined the impact of body movement in a VR setting on foreign language learning. The findings indicate that learners who engaged with virtual objects while learning an unfamiliar word demonstrated better comprehension rates than those who simply repeated the word or performed irrelevant gestures.

3.2.5. Motivation

Education can also benefit from the benefits that VR technology reports in terms of the motivation of the learner (Bricken, 1991). The virtual 3D environment possesses intrinsic qualities that can stimulate key motivational factors for learning, such as sensory curiosity, imagination, and control (Lepper and Malone, 2021). Nurturing motivation and cognitive engagement in learning activities are crucial factors in education, as they enhance attention and concentration, promoting the development of higher-order thinking skills (Stoney & Oliver, 1999).

3.2.6. Collaborative activities/Distant Learning

When users explore and interact with a virtual environment together, they can experience a sense of "being there together" even if they are geographically dispersed. This feeling is known as the social presence or co-presence (Dalgarno & Lee, 2010). By making use of avatar representations, not only can users recognize the location of other users within the environment, but they can also observe their actions and directly engage with them. This feature can be used to support distance learning and collaborative activities in a more efficient way than when utilising 2D environments or teleconferencing software. Immersive VR lecture halls, as described by (Marky et al, 2019; Souchet et al, 2020), not only enable distance learners to attend virtual lectures in a similar way to teleconferencing but also help to maintain student attention on the teacher's presentation by immersing them in the virtual environment and minimising distractions. While these experiences are still mostly confined to the realm of research, it is expected that in the near future, the metaverse will fulfil its promise of enabling remote attendance at virtual lessons in virtual replicas of educational centres. Additionally, the social presence feature facilitates the design of collaborative VR learning environments, where multiple learners can interact simultaneously, reinforcing their comprehension and understanding. Two examples of systems that implement this

educational approach are presented in (Chheang et al., 2019) and (Greenwald et al., 2017), one for surgery training and the other for helping to develop social communication skills among people with autism, respectively.

3.3. Exploring VR in teacher training

In recent times, there has been a significant shift in the field of education towards adopting more immersive and innovative ICT-based training tools. One particular approach that has captured the interest of the scientific community is VR. VR-based approaches are seen as a promising way to improve the delivery of education. However, research on the use of VR in education is still in its early stages, with a limited yet growing body of evidence highlighting its potential.

The development and implementation of VR applications specifically designed for teacher training are currently limited. Some attempts have been made to create virtual classrooms for experimentation using large-screen displays instead of VR equipment like head-mounted displays (HMD glasses). Examples of such attempts can be found in studies by Andreasen and Haciomeroglu (2009), Dieker et al. (2007, 2008, 2015), and Ke et al. (2016). However, it is important to note that these studies do not involve the use of VR equipment, such as head-mounted displays (HMDs), to provide a fully immersive VR experience. Instead, they focus on creating virtual classroom environments that can be accessed and interacted with through traditional screens.

Early explorations using VR technology and equipment have shown promise in the field of teacher education. For example, Bailenson et al. (2008) explored the impact of social behaviours and visual cues on learning in a VR-based teaching scenario. Their findings indicated that participants tended to ignore peripheral virtual students and a notification system helped distribute their attention more evenly. Lugrin et al. (2016) developed an immersive VR system to enhance teachers' classroom management skills, specifically targeting disruptive behaviour. The results suggested that the VR system was beneficial for teacher training, although the virtual environment and simulated student behaviours created stressful situations for the trainees. Additionally, Manouchou et al. (2016) developed a prototype VR classroom training environment that allowed teachers to experience students' vision disorders, offering them a firsthand perspective of being visually impaired. Stavroulia et al. (2016) focused on training teachers in identifying and distinguishing bullying incidents, utilizing VR to simulate bullying scenarios and teach appropriate responses. These early attempts demonstrate the potential of VR in teacher education by providing immersive experiences, realistic simulations, and opportunities for skill development. However, further research and advancements are necessary to refine and expand the applications of VR in this domain, addressing challenges such as stress-inducing situations and optimizing user attention and engagement.

3.4. Conclusions

The integration of VR technology in education shows significant potential and benefits. However, there are still several barriers that need to be addressed for the widespread adoption of VR-based approaches in daily teaching practice. One prominent aspect is the need to provide teachers with proper guidance to effectively harness the specific features of this technology to support education in their respective areas of knowledge, envisioned teaching activities, and underlying learning strategies. It is essential for educators to understand the potential advantages that VR technology offers and learn how to effectively incorporate it to maximize those benefits. By overcoming these barriers and empowering educators with the necessary knowledge and skills, we can unlock the full potential of VR in enhancing the educational experience. Continued research, development, and training efforts are crucial to realize the transformative impact of VR in education.

VR has emerged as a promising technology with numerous benefits for teacher training. By simulating realistic classroom environments and real-life based scenarios, VR provides a unique and immersive learning experience for teachers. The use of VR in teacher training offers several notable benefits including practical training and hands-on experiences in a risk-free setting enabling teachers to build their teaching confidence and improve classroom management competences. VR-based training facilitates experiential learning by enabling teachers to step into the shoes of their students. Through immersive simulations, educators can gain first-hand insights into the perspectives and challenges faced by students, fostering empathy and understanding. This experiential approach enhances their ability to address diverse learning needs, adapt teaching strategies, and create inclusive classroom environments. What is more, VR-based teacher training offers an engaging and interactive learning environment promoting active learning, stimulating creativity, and encouraging experimentation with innovative ICT-based training tools. Research also suggests that VR-based training enhances long-term skill retention compared to traditional methods. The immersive nature of VR, coupled with its ability to evoke emotions and create memorable experiences, reinforces learning outcomes and improves knowledge transfer. Teachers are more likely to retain and apply the acquired skills and competences in their real-world classroom settings, positively impacting student learning outcomes. The use of VR in teacher training brings numerous benefits, including enhanced practical training, experiential learning, engaging instruction, cost-effectiveness, and improved skill retention. As VR continues to advance, its integration into teacher education holds immense potential for transforming teaching practices and ultimately improving the quality of education. The VRTEACHER project aims to enhance the understanding of the practical applications of VR technology within a specific educational domain, particularly in the context of teacher training.

4. Defining training needs for in-service and pre-service teachers

4.1. Overview of the methodology

To create a VR application that would meet the needs of both in-service and pre-service teachers as closely as possible, three actions were carried out before its development. The first consisted of an analysis of existing competence frameworks to help establish the new project framework. The analysis served to identify the possible key competences to be addressed with the VRTEACHER tool. The second action consisted of a survey aimed at defining, based on the competences selected in the new framework, the key needs, and skills of teachers in the post-COVID era. The third and final action consisted of a focus group per country. The focus groups brought together university students and researchers to discuss the use of VR as a tool to train teachers, both active and in training, in the needs and expectations selected in the first two actions.

4.1.1. Framework analysis

To establish a new competency framework for VRTEACHER, the two main axes of the project were taken into account: digital skills and transversal skills training. For this purpose, the following competency frameworks were analysed:

- European Key Competences Framework (Parlamento y Consejo Europeo, 2006);
- DigCompEdu (EU, 2017);
- ICT Competency Framework for Teachers (Unesco, 2011);
- New Values, Skills and Knowledge Module (NIE, 2009);
- Selected social and emotional skills for inclusion in the SSES (Chernyshenko, Kankaraš, & Drasgow, 2018).

Based on the analysis, those competences closest to the objectives of the project were selected. This filter of competences helped to focus attention on those that were related to the training of key skills using Virtual Reality, grouped, in turn, into three categories: Digital Competences, Personal Competences and Civic Competences.

4.1.2. Survey

To fine-tune the necessary training of users in the VRTEACHER tool, a questionnaire was created for teachers and students of education degrees for two purposes. On the one hand, to detect the needs and shortcomings experienced in the teaching sector during the COVID-19 pandemic. On the other hand, to assess the competences selected in the VRTEACHER framework.

A questionnaire was created in Survey Monkey with 24 questions divided into 4 sections. The first section, consisting of 3 questions, collected the demographic data of the participants. This section was common to both teachers and students.

The second section, however, distinguished between the profile of the person, differentiating between teachers and students. This section was composed of 18 questions and aimed to capture the challenges faced by both profiles during the pandemic and in virtual classrooms.

The third section, common for all profiles, was called "VRTEACHER Project Framework". Here the questions related to the competences selected in the project framework were collected and grouped in the 3 blocks previously mentioned: Digital Competences, Personal Competences and Civic Competences. Participants were asked to rate the relevance of each of the competences on a scale of 1 to 6.

The fourth section, "Other competences", presented competences that are not directly related to the project and therefore not selected for the VRTEACHER framework, but which the consortium considered interesting for future research.

A total of 340 responses were obtained from all participating countries. These responses allowed a final selection to be made of the key competences to work on with the VRTEACHER Virtual Reality tool. This selection was made considering both the participants' ratings of the competences and the assessment of the strengths and limitations of the VR technology and the low-cost equipment they decided to use during the preparation phase of the project proposal.

4.1.3. Focus groups

Once the selection of competences was finalised, focus groups were held in each of the partner countries. These groups aimed to get a realistic idea of how to work on the chosen competences in the classroom and to find out the participants' prior knowledge and expectations about VR.

Each country had to gather at least 4 persons, including a teacher, a student, an ICT expert and a fourth member from any of the previous groups. To collect participants' personal information, a registration form was created in Survey Monkey.

The focus groups were conducted in December 2021 with a total of 25 participants, 13 women and 12 men between 18 and 70 years of age. Cyprus, Greece, Ireland, and Malta conducted the focus group online, while Spain conducted the focus group in a hybrid format.

The questions that were used to guide the conversation aimed, on the one hand, to further explore the needs of teachers and, on the other hand, to find out the expectations of future users with the future VR tool for training. These questions were as follows:

- Share an incident of crisis management that has taken place during these two years of COVID.
- How was it managed?
- How do teachers currently deal with empathy in the classroom?
- Which transversal skills (accessibility and inclusion, stress resilience, self-control, empathy, assertiveness, self-efficacy, and decision-making) would you be most interested in working on?
- Share your expectations regarding the virtual world (usefulness, design, categorisation of the scenario to training cases).
- What kind of feedback do you expect to get during the interaction with the virtual world?
- What kind of feedback do you expect to get at the end of the training?
- If you were provided with a free VR training tool as part of the training methodology, would you use it?

The results obtained from the three actions carried out during the first outcome of the project helped to define the VRTEACHER competences framework, to select the competences to work with the tool and, consequently, to elaborate the appropriate training scenarios reflecting the reality and address the real needs of the teachers.

4.2. Survey and results

As mentioned above, the questionnaire was developed based on the first selection of competences made during the analysis of existing frameworks. The questionnaire aimed to find out the needs of the project's target groups, thus contrasting the importance of working on the selected competences in the classroom.

A total of 340 people answered the questions in the questionnaire, including 154 from Greece, 20 from Cyprus, 23 from Malta, 31 from Ireland, 108 from Spain and 4 from other countries (2 from Morocco, 1 from China and 1 from America). Most of the participants were women (70.88%) and almost 60% were students in higher education. After collecting and analysing the results, the final selection of key competences to work with the Virtual Reality tool developed by the project partners was made. This selection was made, on the one hand, considering the evaluations of the participants and, on the other hand, the possibilities and limitations of the VR tool itself.

Based on the competences with the highest scores, the project partners discussed the possible scenarios to be developed in the tool and the possibilities offered by each of them to create the training. The discussion served to focus on those core aspects that would achieve the project's objectives and finally opted not to select all the highest-scoring competences. The final selection was based on those competences that fit best with the development and assessment possibilities of the VRTEACHER scenarios, as presented in figure 4-1:

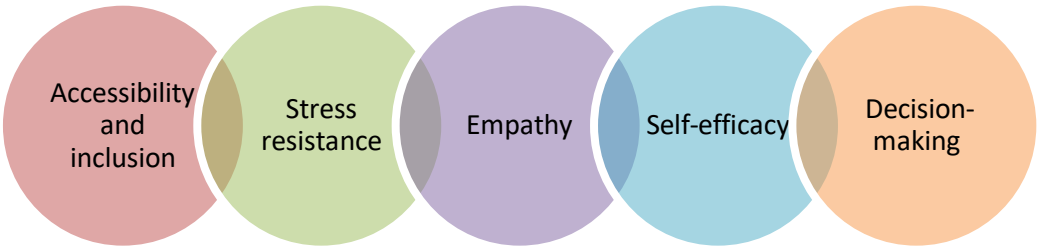

Figure 4-1. VRTEACHER Competence Framework

The full results are available at the following link: https://es.surveymonkey.com/results/SM-RB7RSQ7J9/ .

4.3. Focus groups and results

As a crucial step before the establishment and development of the training scenarios within the VRTEACHER tool, each partner country conducted a comprehensive focus group session, focusing on three primary objectives. The first was to deepen the experiences of the project's target group in the key competences selected in the previous step. The second was to learn about their experiences in crisis situations such as the COVID-19 pandemic. Thirdly, to find out more about their previous knowledge of Virtual Reality and their expectations regarding this type of tool in the educational environment. In this way, the scenarios would be adjusted as much as possible to the needs of teachers, both active and in training, and the methodology with which to develop the training within the VR tool would be specified.

In total, 5 focus groups were held in December 2021, bringing together 25 participants. Among them, there were 13 women and 12 men between 18 and 70 years old with different profiles: university and high school teachers, university students pursuing a degree in education, PhD students and ICT experts. Regarding the format of the groups, Cyprus, Greece, Ireland, and Malta conducted the focus group online, while Spain conducted the focus group in a hybrid format.

During the COVID-19 pandemic lockdowns, when asked about their crisis experiences, the majority of participants highlighted the difficulty in adapting face-to-face classes to the online environment. Among the main concerns were the disconnection from physical reality

and the distance from the students due to the cameras being switched off. This barrier prevented teachers from knowing how engaged their students were in the lessons, as they did not know the attitude of the students behind their devices at home. In addition to cameras, focus group participants highlighted some incidents with computer microphones. Some of the students used the microphones to disrupt the class, while on other occasions the microphones had inadvertently brought the class closer to the reality of some of the students at home. The microphones, while remaining active during the lesson, allowed conversations to be overheard which gave a glimpse into the way some families dealt with and communicated with the students.

Regarding the question about empathy in the classroom, empathy was defined as the ability of a person to understand and put themselves in the shoes of another person. Ways in which empathy was worked on in the classrooms of the different project countries were discussed, such as the use of theatre and literature as resources to put oneself in the shoes of different characters. In addition, it was discussed how technology can hinder the closeness between teachers and students, thus preventing a close relationship and, therefore, a good understanding between the two parties. However, some possibilities for bridging this gap were highlighted, such as lower ratios and the use of portfolios.

When it comes to soft skills, all the participants agreed on the importance of training in these skills to be able to address them with the students in a cross-cutting manner. About the project's proposals, the participants valued all the competences as indispensable, proposing some activities and clarifications to be considered. In the case of inclusion, for example, the need was expressed not to focus only on the inclusion of students with some kind of disability, but on all those who have problems in participating in group dynamics or communication. In the case of stress, they suggested listening to audio or watching videos to help them stay calm.

In addition, the participants added that inclusion, decision-making, stress resistance and self-efficacy were interrelated competences. They stressed the importance of working on these competences through continuous training and the need to adapt and update this training to the reality of the students. The implementation of new tools in the classroom, such as Virtual Reality, was highly valued to motivate and engage students in their own learning process.

During the discussions on the design of the VR tool's virtual environment, focus group participants expressed a strong preference for creating a realistic classroom setting. Regarding the interactions with the environment, they commented on the possibility of posing questions that would make them reflect on their actions in the crisis situation, contrasting them with final feedback to find out if their selected answers coincided with the real protocol of action in these situations.

4.4. Conclusions

Based on the analysis and results obtained from the progress of the project's initial activities, a VR training tool has been developed that effectively addresses the needs of both the project and the target group. Incorporating the insights gathered from the focus groups and considering the selected skills identified by the project, three immersive scenarios with a carefully crafted digital design have been developed. These scenarios effectively address the targeted skills while incorporating the valuable contributions collected during the focus group sessions. The tool has been designed to effectively address the identified needs and selected skills in the following manner:

- The VR tool is composed of three scenarios that expose crisis situations that can occur in classrooms on a daily basis.
- The scenarios are composed of visuals very similar to those of a real classroom, with elements that simulate a realistic classroom in a school.
- To address empathy, the tool allows users to change their virtual bodies and perspective within the same scenario. In this way, the user obtains a global vision of the situation, experiencing different points of view, both from the teacher's profile and from the student's profile.
- Accessibility and inclusion are dealt with in different ways. On the one hand, the scenarios present situations that have to do with hybrid training, the handling of a person with social phobia and the reception of a person from a country at war with no knowledge of the language. In addition, the avatars created to bring the people in the VR environment to life are designed according to the principles of diversity. The tool gives the possibility to choose the type of character the user wants to represent during the experience, having as options characters that do not follow stereotypes in terms of race, gender, and disability.
- In terms of decision-making, the scenarios pose different questions for users to think about and reconsider their idea of how to handle the situation. Each question offers the user possible solutions, none of which is correct. The solutions are intended to raise doubts in the participants' minds, so there is no obvious answer.
- Self-efficacy, on the other hand, is worked on in a cross-cutting manner, as users who use the VR tool will aim to resolve the situation and solve the problem they are faced with in the best possible way.
- At the end of each scenario, the tool offers a "Feedback" section in which the real protocol of action for each of the cases is presented. In this way, users will be able to self-evaluate the responses selected during their experience and learn how to deal with the problem in a real classroom.

5. The VRTEACHER application

The VR application features three different scenarios, each focusing on a different topic that teachers may encounter in their work, including distance education and domestic verbal abuse, phobias related to COVID-19 and panic attacks, and classes with refugee students who do not speak the language of instruction of a given institution. The main feature of the application is the ability to view crisis situations as seen from the eyes of the teacher, and the eyes of the students involved in the events, while a follow-up session with a virtual tutor provides feedback and guidelines for the teacher.

The VR application developed as part of the project is accessible to users through the project's website (https://www.vrteacher.eu/). It is available in the platform section, where users can register to gain access to the VR application and other project resources. Notably, the VR application is provided to users free of charge, allowing teachers to benefit from its immersive training experiences without any financial barriers. By registering on the platform, users can explore and utilize the VR application to enhance their teaching practices and expand their skills in a virtual environment. Additionally, the platform offers access to various project resources, further supporting professional development and promoting the effective use of virtual reality in education.

5.1. Technical specifications

The application runs on any Android mobile device with Android version 7.0 (API level 24) or newer and requires 604 MB of device storage. The application was developed using UNITY (version 2020.3.22). Apart from UNITY, Autodesk Maya, Adobe Photoshop, Autodesk Character Generator, mixamo.com, the SALSA plug-in for Unity, and the Google Cardboard XR plugin for Unity were used for creating the virtual environment, the assets, the animated humans, and the interaction.

By starting the application for the first time, the user is asked to select basic settings such as language, username, and country (figure 5-1). In the main menu, the user can navigate through different menus, and select one of the three VR scenarios (see section 3.2 for a description of the scenarios). When the user launches a VR Scenario, a message appears on the screen indicating that the device must be placed in a VR headset. After a few seconds, the virtual environment appears, and the scenario starts (figure 5-2). The user can explore the virtual environment using gaze movements and interact with the 3D user interface using a gaze-controlled cursor. As the scenarios progress, various questions appear which must be answered by the user to continue the scenario (figure 5-3). It should be noted that the questions can be disabled/activated from the settings menu. After the scenario completes, the user is prompted to remove the headset and taken back to the "Scenarios'' menu. At this stage, the user's answers to the questions are stored in an online data set. An important aspect to highlight is that the VRTEACHER project ensures the privacy and protection of

users' personal data. The VR application does not store any personal data that could potentially identify individual users. This commitment to data privacy is crucial in maintaining user confidentiality and safeguarding their information. The answers to these questions can be used for assessing the impact of the VR tool with respect to participant's privacy and anonymity. User's who do not wish to have their answers recorded, may disable the questions from the settings menu.

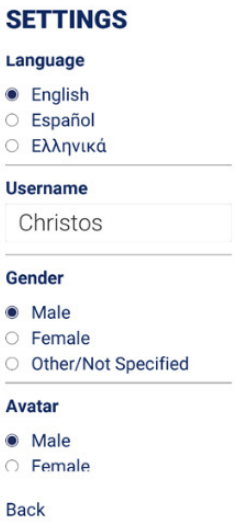

Figure 5-1. The settings menu of the VRTEACHER application

Figure 5-2. Starting button in the main scene

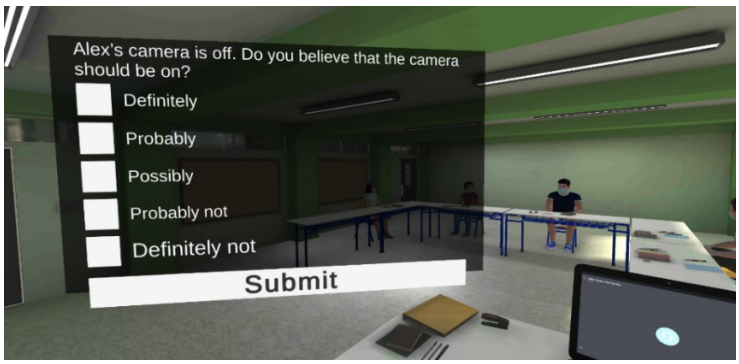

Figure 5-3. Questions window during the scenario

5.2. Eye gaze interaction in the virtual world

Eye gaze interaction in virtual environments refers to the ability of users to interact with the virtual world using their eye movements. It involves tracking and analysing the direction of a user's gaze and using that information to manipulate objects, navigate through the environment, or trigger specific actions within the virtual space. This interaction technique holds significant potential for enhancing immersion, interactivity, and naturalness in virtual reality experiences. One of the key advantages of using eye-gaze interaction is its intuitive nature. Humans naturally use eye movements to direct attention and communicate in real-world scenarios. By incorporating eye gaze as an input modality VRTEACHER application, allowed users to interact with the virtual world more seamlessly and naturally. It eliminated the need for complex controllers or input devices, enabling a more immersive and hands-free experience. Eye gaze interaction also enabled finer control and precision. Users could perform actions by simply looking at them (for example choosing the answers to the questions), providing a more accurate and efficient means of interaction.

5.3. VR headsets

The project required the purchase of VR headsets compatible with Android phones. The project aimed to purchase low-cost equipment to ensure easy accessibility for teachers, teacher education departments, and schools. Low-cost equipment was chosen to align with the limited budgets of teachers, teacher education departments, and schools. By opting for cost-effective solutions, the project aimed to make the equipment accessible to a larger number of stakeholders within the education system. The objective was to train a mass of students and teachers, which required equipment that could be obtained in larger quantities without exceeding the project's financial resources. Low-cost equipment allowed for wider distribution, enabling more teachers and students to benefit from the training program. Additionally, by selecting low-cost equipment, the project aimed to ensure inclusivity in teacher education. It recognized that not all schools or teachers may have access to high-end, expensive technology. The use of affordable equipment ensured that even schools with limited resources could participate in the training program. Furthermore, low-cost equipment was seen as a practical choice for widespread implementation. It allowed teachers to utilize their own devices, such as Android phones, which are commonly available and familiar to many educators. This practicality facilitated the integration of the training program into teachers' existing workflows and minimized the need for additional hardware investments.

By prioritizing low-cost equipment, the project aimed to ensure that teacher training and educational resources were accessible, inclusive, practical, and scalable. It recognized the importance of cost-effectiveness in enabling a wider audience to benefit from the program, ultimately enhancing the quality of education and professional development in the education system.

For the needs of the VRTEACHER project DESTEK VR Headset V5 for Mobile Phones, HD VR Glasses, 110° FOV Virtual Reality Headset with Touch Button for iPhone, Samsung, Android, 3D Glasses for 4.7 - 6.8 Inches / 11.9 - 17.2 cm have been purchased by all partner countries (figure 5-4).

Figure 5-4. VR Headset used during the trainings

5.4. Training scenarios

The VRTEACHER application offers three scenarios that simulate real-world classroom scenarios, each with its own set of challenges and learning outcomes. Figure 5-5 presents the three scenarios and a short description of them.

Scenario 1 **Distance education and domestic verbal abuse**	This scenario simulates a situation in which a teacher is conducting a lesson during which a student is connected online. During the lesson, the student is experiencing domestic verbal abuse by his mother.
Scenario 2 **Phobias related to COVID-19 and panic attacks**	This scenario simulates a situation in which a teacher confronts a student who is experiencing a panic attack and anxiety related to COVID-19.
Scenario 3 **Refugee Student**	The third scenario focuses on the challenges that teachers may encounter when working with refugee students who don't speak the language of instruction. This scenario provides teachers with an opportunity to practise their skills in communicating with students from different cultural backgrounds and to develop their understanding of the unique challenges in multicultural classes.

Figure 5-5. The three scenarios developed in the VR application

5.5. Virtual avatars and perspective taking

The users were provided with the opportunity to choose their avatar's gender which is an important feature that can significantly impact their experiences. Offering this option recognizes the importance of personal identity and self-expression within virtual spaces. It allows individuals to align their virtual representation with their preferred gender identity, promoting a sense of autonomy and inclusivity. One of the key reasons the consortium decided to offer the ability to choose the avatar's gender was to enable users to feel more connected and comfortable in the virtual environment. Previous research by the development team of the application has highlighted that individuals tend to choose an avatar that matches their gender identity. Women tend to choose female avatars more frequently, while men tend to choose male avatars. This can be attributed to various factors, including gender identity, social norms, and personal preferences. Also, during the focus groups, the participants expressed their opinion to be able to choose the desired avatar of the teacher. This sense of embodiment and familiarity can enhance the overall immersive experience and engagement with the virtual world. Hence, allowing users to choose their avatar's gender aligns with these preferences and provides a more personalized and enjoyable experience. Figures 5-6 to 5-10 present the avatars of the teachers and the students.

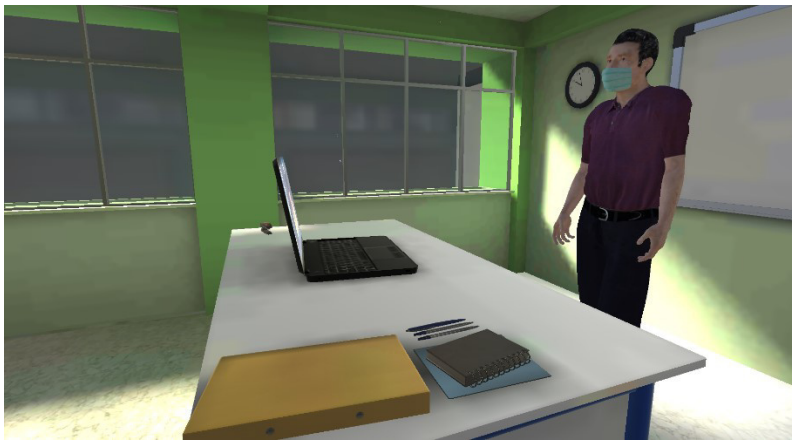

Figure 5-6. Male avatar of the teacher

Figure 5-7. Female avatar of the teacher

Figure 5-8. Student avatar from scenario 1

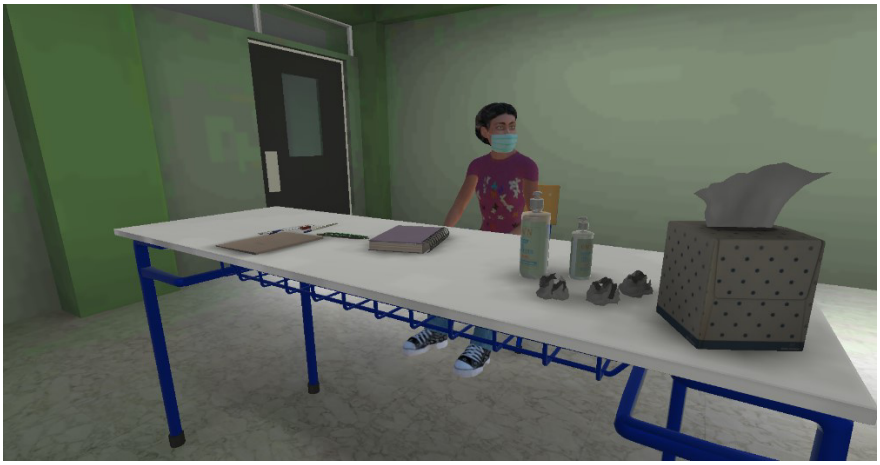

Figure 5-9. Student avatar from scenario 2

Figure 5-10. Student avatar from scenario 3

For all three scenarios, the VR tool offers teachers the ability to experience the scenario both from the perspective of the teacher, but also from the perspective of the virtual student involved in the incident. This feature aims to provide teachers with a deeper understanding of the student's experiences and challenges and to experience the impact of their teaching methods from the student's point of view. Furthermore, perspective change aims for the development of a more empathetic and student-centred approach to teaching, which can lead to better student engagement and learning outcomes.

Perspective-taking in virtual reality refers to the ability of users to adopt and experience the viewpoint of another person or entity within a virtual environment. It allows individuals to perceive and understand a situation from a different perspective, enabling them to gain empathy, insight, and a deeper understanding of various viewpoints and experiences. The main benefit of perspective-taking lies in promoting empathy by allowing users to step into the shoes of their students and experience the world from their perspective. By experiencing different perspectives, users can develop a more empathetic and understanding mindset, fostering tolerance and open-mindedness. Figure 5-11, presents the view of the classroom through the eyes of the teacher and figure 5-12, presents the perspective of the student in his bedroom participating in the lesson remotely.

*Figure 5-11. T*hrough the eyes of the teacher

Figure 5-12. Through the eyes of the student

5.6. VRTEACHER application: a multilingual tool

The VRTEACHER application was designed as a multilingual tool to cater to the diverse language needs of teachers. The application is available in English, Greek and Spanish languages to serve the needs of the partner countries. By offering the VRTEACHER application in multiple languages, the project aimed to ensure that teachers from various linguistic backgrounds could engage with the training content effectively. This accessibility promoted inclusivity and eliminated language barriers that might hinder comprehension and participation. The inclusion of multiple languages in the VRTEACHER application aimed to create a user-friendly experience. Users could navigate the interface, instructions, and educational materials more comfortably in their preferred language, promoting seamless interaction and engagement with the training program. It is worth mentioning that for the Greek and Spanish versions of the VRTEACHER application, the audio recordings were not computerized; instead, actors were employed to provide the voiceovers. This decision was made to ensure a more authentic and natural audio experience for users in these languages. By using real actors, the project aimed to capture the nuances of intonation, emotion, and expression that can be crucial for effective training and immersion in virtual reality scenarios.

5.7. User manual

Creating a manual for the VR application was crucial for the consortium in providing users with clear guidance and instructions on how to effectively utilize the VRTEACHER application (figure 5-13). The user manual was developed to ensure that users can easily navigate and utilize the VR application. It provides step-by-step instructions, enabling them to make the most of the available features and resources. The user manual is open and accessible to all users through the project's website and platform.

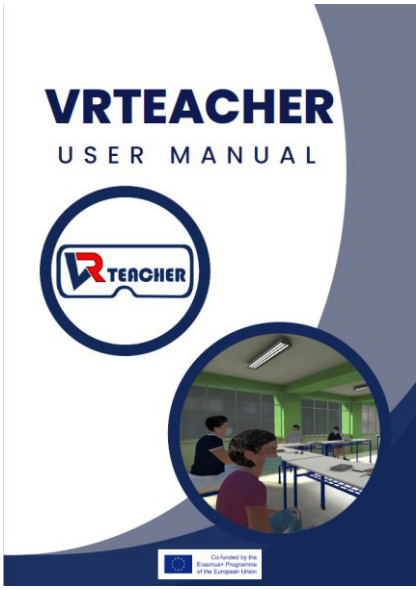

Figure 5-13. User manual handbook

5.8. Conclusions

The VR application presented in this section offers a promising tool for immersive and engaging educational experiences. The application provides users with the ability to choose their avatar, allowing for a personalized and inclusive experience. The inclusion of male and female avatar options recognizes the importance of representation and enables users to connect with the virtual environment in a way that aligns with their own identity.

The application features various scenarios that address relevant topics in education, such as distance learning, phobias related to COVID-19, and teaching refugee students. These scenarios aim to provide teachers with realistic and challenging situations that foster empathy, perspective-taking, and problem-solving skills.

The implementation of eye gaze interaction within the VR environment adds a layer of authenticity and interactivity. It enables users to communicate non-verbally and engage with the virtual environment more naturally and intuitively.

To ensure the successful adoption and utilization of the VR application, a comprehensive user manual has been developed. This manual serves as a valuable resource, providing clear instructions, guidance, and troubleshooting information.

6. Designing an evaluation framework for VR-based teacher training

6.1. Introduction

VR technology has experienced a growing presence in education, particularly in teacher training. Its immersive and captivating nature holds the potential to enhance learning and skill development. One area where VR applications show great promise is in promoting the development of essential skills, such as empathy, which are crucial for effective teaching and learning in today's diverse and inclusive classrooms. Empathy, which is the ability to understand and share the feelings of others, plays a vital role in building meaningful relationships with students and fostering a safe and supportive learning environment. Teachers who possess high levels of empathy are more inclined to recognize and respond to the unique needs of their students. Consequently, this empathetic approach leads to improved academic outcomes and higher levels of student engagement.

The VRTEACHER project consortium recognizes the potential of VR technology to revolutionize teacher training by offering a unique and impactful tool for promoting teachers' personal and professional development. Through the integration of VR in teacher education programs, educators can cultivate a more empathetic and inclusive teaching approach, resulting in improved educational outcomes and a more positive learning environment for students. As part of the VRTEACHER project, we conducted a thorough review of the processes involved in developing and implementing the project framework. This evaluation highlighted the significance of assessing the effectiveness of VR applications in cultivating essential skills, such as empathy skills, among pre-service and in-service teachers. The purpose of this evaluation was to ensure that the VR application aligned with its intended learning outcomes and achieved the desired impact on teachers.

To facilitate this evaluation process, the consortium designed and implemented an evaluation framework. This framework served as a guiding tool for assessing the influence of our VR application and scenarios on teachers' skills and competences, as defined in the project's Competence Framework. Through the utilization of this framework, we were able to measure the impact of the VR application accurately. A comprehensive summary report containing all partners' findings is accessible on our project website. In this section of the best practice guidelines, we provide an in-depth review of the evaluation process we undertook. This detailed account aims to assist interested educators and researchers who wish to employ similar evaluation tools and approaches in their own educational practices or research projects. By sharing our experiences and insights, we hope to contribute to the advancement of VR technology in the field of education and empower others to conduct thorough evaluations of their own VR applications.

Evaluation is a crucial step in measuring the effectiveness of a VR application in building skills, competences, and knowledge. Through the evaluation process, valuable feedback is

obtained regarding learning outcomes, user experience, and overall effectiveness of the application. This feedback is essential for educators and researchers to assess the impact of VR technology on skill development and identify areas for improvement in future iterations of the application. Evaluation provides evidence-based data that helps to determine the efficacy of VR in achieving the desired learning outcomes and guides adjustments or modifications to optimize the application's effectiveness. User feedback plays a significant role in the evaluation process. It can be collected through various methods such as surveys, focus groups, or individual interviews. User feedback provides insights into the user experience of the VR application, including aspects of usability, accessibility, and engagement. It helps to identify strengths and weaknesses of the application and highlights areas for enhancement, such as scenario design or graphic quality.

Within the VRTEACHER project's evaluation framework, all project partners conducted testing of the VR application with both pre-service and in-service teachers in their respective regions. This testing allowed the consortium to assess the impact of the developed VR training tool. Surveys served as our primary research tool; however, we also incorporated open-ended questions within the surveys to enable teachers to provide feedback and share their experiences of using the VR application. These testimonials were valuable in gathering qualitative insights. Following the testing phase, each partner compiled national evaluation reports summarizing and presenting their findings regarding the development, testing, and evaluation of the VR application. This chapter aims to provide an overview of the process we devised and implemented to collect data and testimonials. By sharing this process, we hope to offer guidance for the application or adaptation of similar approaches in your own educational or research projects. You can utilize the same tools and methodology employed in evaluating the effectiveness and impact of the VRTEACHER application and scenarios. By adopting and customizing our evaluation approach, you can gather relevant data and testimonials to assess the impact of VR interventions in your specific context. This will aid in understanding the effectiveness of VR applications in fostering skill development and inform further improvements in the design and implementation of such tools. The shared tools and methodology provide a foundation for conducting rigorous evaluations that contribute to evidence-based decision-making in the field of VR-based education.

6.2. Overview of the methodology

VR has emerged as a highly regarded technology for augmenting educators' skills and competences, particularly in areas like empathy. To evaluate the effectiveness of a VR application a comprehensive methodology was designed. This methodology encompassed the creation and execution of pre-training and post-training surveys, accompanied by a follow-up survey conducted four weeks after the training. The inclusion of a long-term assessment aimed to gauge the lasting impact of the VR application on teachers' skill development and competences.

The initial step in our methodology involved administering a pre-training survey to evaluate the current skill levels of participating teachers. This survey encompassed validated measures that assessed various dimensions of teachers' skills and competences. Additionally, the pre-training survey included questions about the teachers' prior experience with VR technology and their expectations regarding the effectiveness of the VR application in fostering their personal and professional development. Moreover, within the pre-training survey, we included inquiries about specific attitudes related to remote and blended teaching (scenario 1), inclusive education (scenario 2), and cultural intelligence in teaching (scenario 3). These questions were designed to establish a baseline for each teacher, against which the impact of the VR application on their attitudes could be measured and assessed. To maintain the integrity of the data collected, teachers were not informed in advance that these attitudes would be re-evaluated or addressed within the three scenarios presented in the VR application. This approach ensured the reliability of the self-reported data obtained through the pre-training surveys, as it mitigated potential bias or attempts to show progress in specific areas of assessment. By employing a comprehensive pre-training survey, we were able to gather essential information about teachers' initial skill levels, experiences, expectations, and attitudes. This baseline data served as a reference point for evaluating the impact and effectiveness of the VR application in subsequently influencing and transforming these dimensions of teacher development.

Following the pre-training survey, the participating teachers underwent training utilizing the VR application, which involved experiencing all three scenarios and responding to specific questions within the VR environment. The training was conducted within a controlled environment to ensure the teachers' safety while providing unrestricted access to the VR application. This aspect is crucial for external educators or researchers interested in implementing the VRTEACHER application in their own practices. During the training sessions, the teachers received instructions on how to navigate and utilize the VR application effectively. They were given sufficient time to explore the virtual environment and engage with the three scenarios presented. This hands-on experience allowed the teachers to actively participate in the VR application and gain a comprehensive understanding of its functionalities and educational potential.

After the training, a post-training survey was conducted to evaluate the influence of the VR application on the teachers' skills, competences and attitudes. The survey encompassed the same measures as the pre-training survey, providing a basis for comparison. However, the post-training survey also included additional assessments to examine the teachers' experience of embodiment and presence within the virtual environment. Measuring embodiment pertains to assessing the extent to which the teachers felt physically present or inhabiting a virtual body within the virtual environment. When users experience a strong sense of embodiment in VR, they may feel as though their virtual body is an extension of their own physical body. On the other hand, measuring presence captures the level of psychological immersion within the virtual environment experienced by the teachers despite

knowing that it is a simulated or artificial experience. It is the sensation of "being there" in the virtual world as if the user's mind and attention have been transported to the virtual environment. These measures are crucial indicators of the VR application's efficacy. The sense of embodiment can have profound effects on user experiences, including influencing emotional responses, social interactions, and skill development, while the sense of presence is an important aspect of VR experiences, as it contributes to the overall user engagement and the ability of VR applications to evoke authentic and meaningful interactions within the virtual environment.

To evaluate the enduring effects of the VR -based training on the skills and attitudes of the participants, a follow-up survey was conducted four weeks after the training. The follow-up survey utilized the same scales as the pre- and post-training surveys, allowing for a comprehensive comparison of results and the examination of any sustained changes over time. It is important to note that the follow-up survey did not include questions specifically addressing embodiment and presence. These aspects were excluded from the follow-up survey because they are most accurately assessed immediately following the VR application usage when the experience is still fresh and vivid. Therefore, the focus of the follow-up survey was on assessing the long-term impact of the VR application on participants' skills and attitudes, without directly addressing the subjective experiences of embodiment and presence. This follow-up assessment allowed the partnership to understand the durability of any observed improvements and to gauge the enduring impact of the VR application on the ongoing development of teachers' skills and attitudes.

6.3. Development of the questionnaires

The aim of developing the evaluation framework for the VRTEACHER project was to provide support to project partners in the development and implementation of the project. The primary purpose was to conduct an impact assessment and evaluate the effectiveness of the training activities, specifically focusing on the impact of the VR application on teacher training and the enhancement of teachers' skills. During the initial stages of developing the evaluation framework, it was determined that the most appropriate means of conducting such an impact assessment would be through pre-training and post-training surveys. This approach was chosen because pre-training and post-training surveys have proved to be effective tools for assessing the impact of educational interventions, particularly interventions that utilize VR technology to induce attitude change among participants.

Pre-training surveys provided a baseline measurement of participants' empathy skills and their attitudes towards the various scenarios including remote and blended teaching (scenario 1), attitudes towards inclusive education (scenario 2) and attitudes towards cultural intelligence in teaching (scenario 3). These surveys were administered before the teachers started using the VR application. The purpose of collecting this baseline data was to compare it with the results obtained from the post-training surveys, allowing for an

evaluation of the effectiveness of the VR application in enhancing teachers' skills and attitudes. By using a pre-training survey, VRTEACHER partners were able to establish a reliable starting point that could be used to assess the extent of improvement in teachers' skills after using the VR application. To assess the baseline level of empathy among participants in the VR Teacher piloting activities, the Interpersonal Reactivity Index (IRI) was used. The IRI scale was developed by Davis (1980) and consists of 28 items on a 5-point Likert scale ranging from "Does not describe me well" to "Describes me very well". IRI consists of four subscales as follows:

- *Perspective Taking*: This subscale measures participants' natural inclination to spontaneously adopt the psychological perspective of others, demonstrating their ability to understand and empathize with different viewpoints. This subscale measures participants' capacity to step into someone else's shoes and comprehend their experiences.
- *Fantasy*: The Fantasy subscale evaluates participants' tendency to immerse themselves imaginatively in the thoughts, feelings, and actions of fictional characters encountered in books, movies, and plays. This subscale aims to capture participants' ability to emotionally connect with fictional narratives.
- *Empathic Concern*: This subscale assesses participants' capacity for "other-oriented" emotions, such as sympathy and concern, towards individuals facing unfortunate circumstances. this subscale aims to capture participants' empathetic responses and genuine care for others.
- *Personal Distress*: The Personal Distress subscale measures participants' "self-oriented" feelings of personal anxiety and unease in tense interpersonal situations. It focuses on participants' emotional reactions and discomfort when confronted with distressing or challenging scenarios involving others.

In the context of the VRTEACHER project, only three sub-scales were used: Perspective-taking, Empathic concern and Personal distress. These sub-scales were employed to assess the participants' levels of empathy. Additionally, a 7-point Likert scale was used from 1=Does not describe me very well to 7= Describes very well. The specific details and format of the scale can be found in the '**VRTEACHER Evaluation Framework and Impact Assessment Tools**' document, which is openly accessible and available through the project's website (https://www.vrteacher.eu/).

The post-training surveys administered played a crucial role in assessing the impact of the VR application on the development of empathy skills among teachers. By including the same measures as the pre-training survey, focused on empathy, these surveys facilitated a comparison to determine the effectiveness of the VR application in enhancing empathy skills. This allowed the project partners to identify the specific aspects of the VR application that were most effective in fostering empathy skills and pinpoint areas for potential improvements. Furthermore, the post-training surveys were designed to capture the aspects

of embodiment and presence experienced by the teachers immediately after using the VR application. These specific questions assessing embodiment and presence were exclusively included in the post-training surveys.

Embodiment and presence are crucial factors that determine the effectiveness of a VR application in building empathy skills among teachers. Embodiment refers to the sensation of being fully present and immersed in the virtual environment, akin to a genuine real-world experience. Evaluating embodiment is crucial because it has been found to impact emotional responses and real-world behavior. When people experience a sense of embodiment in a virtual environment, they tend to establish stronger emotional connections with the virtual characters and objects. This emotional connection can lead to changes in behaviour and attitudes, such as increased empathy. To assess this aspect of the VR application in VRTEACHER, the following 7-point Likert scale (1=Strongly disagree, 2=Disagree Somewhat, 3=disagree, 4=Neither agree nor disagree, 5=Somewhat agree, 6=Agree, 7=Strongly agree) was used (table 6-1). The scale was based on the Virtual Embodiment Questionnaire (VEQ) developed by Roth and Latoschik (2020).

Table 6-1. Embodiment Scale

	1	2	3	4	5	6	7
Acceptance/Body Ownership							
It felt like the virtual body of the teacher was my body.							
It felt like the virtual body of Alex (scenario 1 / student attending the class virtually) was my body.							
It felt like the virtual body of Anna (scenario 2 / student with phobia) was my body.							
It felt like the virtual body of Celmira (scenario 3 / student refugee) was my body.							

The post-training survey also assesses the dimension of 'presence'. Presence refers to the feeling of being fully immersed and focused in the virtual environment. Presence is often achieved by creating a sense of immersion that makes the user detach from the real world and feel fully present in the virtual environment. The concept of presence is important because it helps to maintain the user's attention and engagement, which can enhance the effectiveness of the VR application in cultivating skills such as empathy. To evaluate the dimension of presence the questionnaire developed by Usoh, Catena, Arman, & Slater (2000) was used. The scale used to assess presence can be found in the 'VRTEACHER Evaluation Framework and Impact Assessment Tools' document, which is publicly accessible through the project's website (https://www.vrteacher.eu/).

By incorporating assessments of embodiment and presence in the post-training survey, the project partners were able to evaluate the degree to which the VR application was effective in creating a sense of immersion and emotional connection for participating teachers. This

evaluation provided valuable insights into the effectiveness of the VR application in creating a realistic and engaging virtual experience. By examining the levels of embodiment and presence experienced by teachers, project partners could assess the extent to which the VR training facilitated a deep and meaningful connection with the virtual environment.

The partners designed a comprehensive set of questions to evaluate the impact of each scenario on participants' knowledge, skills and attitudes. To ensure the effectiveness of the survey questions, the project partners conducted constant pilot testing of the VR scenarios. These questions were specifically crafted to assess the impact of the VR scenarios on teachers' perspectives and attitudes towards various aspects. The survey aimed to evaluate how the immersive VR experiences influenced teachers' perspectives and attitudes in the following areas:

- I&A - Inclusion and Accessibility
- DM - Decision-making
- SE - Self-efficacy
- SR - Stress resistance

A sample selection of these questions related to scenario 3 is presented in table 6-2. The full scales can be found in the '**VRTEACHER Evaluation Framework and Impact Assessment Tools**' document. This document is publicly available on the project's website, offering comprehensive information and access to the complete set of assessment tools (https://www.vrteacher.eu/).

Table 6-2. Sample questions from the VRTEACHER evaluation framework

	1	2	3	4	5	6	7
How prepared do you feel to support students from different cultural backgrounds in your classroom? (I&A)							
How conscious are you of changing your teaching style to respond to the diverse needs of students? (DM)							
How prepared are you to handle unforeseen circumstances in your teaching practice? (SE)							
How confident would you feel in coping with supporting a refugee student in your class? (SR)							

To assess the long-term impact of the VR training on teachers' skills and attitudes, the partners also decided to develop and administer a follow-up survey to all teachers who participated. This follow-up survey was conducted four weeks after the training to gather

information about the long-term impact of the VR application on enhancing skills, knowledge and competences among teachers, while also providing valuable information about the sustainability of VR application and future improvements. By comparing the results of the post-training survey with those of the follow-up survey, project partners were able to determine whether the VR application had a lasting impact on teachers' skills. The findings from this follow-up survey provided valuable insights into the effectiveness and long-term benefits of the VRTEACHER application in enhancing teachers' skills and knowledge.

6.4. Steps on how to implement the project

To replicate the process undertaken in the VRTEACHER project and deliver the VRTEACHER impact assessment and quality evaluation framework, educators and researchers should follow the steps outlined in Figure 6-1. These steps provide a systematic approach to conducting the evaluation and ensure consistency in the process. By following these steps, educators and researchers can replicate the methodology used in the VRTEACHER project and effectively assess the impact and quality of their own VR applications in the field of education.

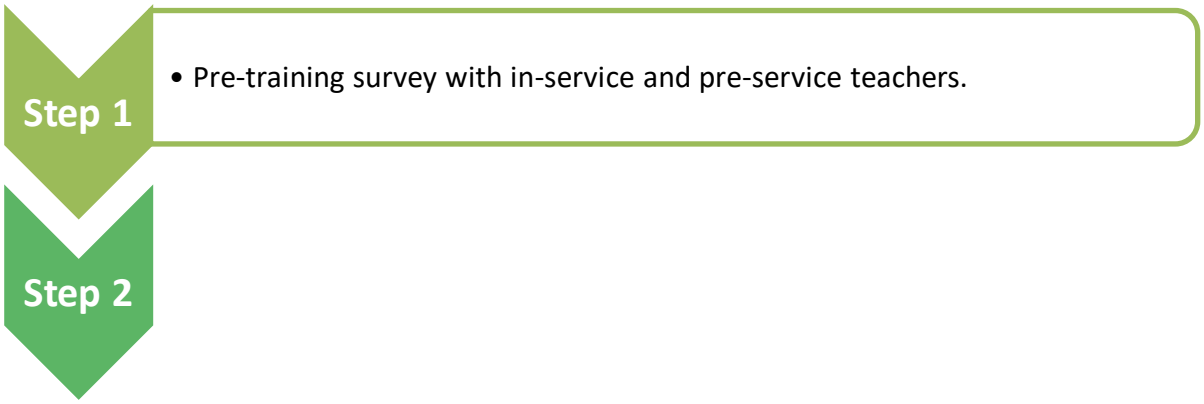

Figure 6-1. Steps to implement the VRTAECHER evaluation framework

6.5. Conclusions

Evaluating the effectiveness of a VR application in enhancing various skills and competences among teachers requires a comprehensive methodology that includes pre-training and post-training surveys, as well as a follow-up survey, typically administered four weeks after the training. The pre-training survey allowed us to establish a baseline understanding of the teacher's skills and attitudes and identify the areas for improvement. The post-training survey was used to assess the immediate impact of the VR application on the teacher's skills and attitudes, as well as aspects of embodiment and presence. The follow-up survey was used to measure the long-term effects of the VR application on the teacher's skills and attitudes.

The testing of embodiment and presence has taken place in the post-training survey only. Testing embodiment and presence is essential when evaluating the effectiveness of a VR application as they can influence emotional responses and behaviour in the real world, and by testing these factors, external researchers and educators can evaluate the effectiveness of the VR application and identify ways to improve its design. These aspects were only included in the post-training survey, as these aspects need to be assessed immediately following the use of the VR application.

By using this methodology, and applying the surveys and tools developed in the VRTEACHER project team, other educators and researchers can determine the effectiveness of the VR application in enhancing key skills and competences. This, in turn, will enable them to devise strategies for integrating this technology into their teaching practices. By following this approach, educators and researchers can gather valuable insights and evidence to support the implementation of VR applications in education, fostering the development of skills among teachers and ultimately enhancing the overall learning experience for students.

7. Lessons learned from partner countries

7.1. Cyprus

7.1.1. Overview of the process

The VRTEACHER project implemented a series of training activities aiming at enhancing in-service and pre-service teachers' skills and knowledge through VR-based training using the VRTEACHER application developed under the project.

The training took place from December 2022 to January 2023 in Cyprus at three different municipalities (Nicosia, Limassol and Larnaca) and followed a structured approach to ensure effective learning outcomes. Cyprus University of Technology (CUT) co-organized the training activities in Cyprus with the Cyprus Pedagogical Institute (CPI), which was officially an Associated Partner of the project. The contribution of CPI was extremely important because it supported the training activities by providing VR headsets and smartphones from its own resources allowing the training of a higher number of participants.

The implementation activities followed a structured approach to ensure an effective and comprehensive training experience for the participants. The activities were designed to provide a balanced combination of online and face-to-face interactions, allowing for both theoretical knowledge acquisition and practical use of the VR application.

The implementation activities followed the following structure:

- ***Introductory online workshop.*** The implementation began with an introductory online workshop, which served as a foundational session to familiarize the participants with the concepts, principles, and potential use of virtual reality in education. This workshop aimed to provide a common understanding and establish a baseline of knowledge for all participants. During this introductory workshop, the participants were also asked to register on the VRTEACHER platform through the official website of the project to be able to download the VR application and resources of the project. The introductory online workshop of the VRTEACHER project witnessed the participation of 130 individuals.
- ***Face-to-face training in groups***. Following the online workshop, the participants engaged in face-to-face training sessions conducted in groups. These sessions provided hands-on experiences with the virtual reality tool, allowing participants to explore its functionalities, experiment with the different scenarios, and gain practical skills related to classroom management. For the face-to-face training, the participants were organized into seven groups and the trainings were conducted in three municipalities, namely Nicosia, Limassol, and Larnaca, providing accessibility

and convenience for the participants from different regions. A total of 110 participants had the opportunity to undergo training using the VR application.

- ***Final online workshop.*** This final workshop served as a wrap-up and reinforcement of the key concepts covered throughout the training. It provided an opportunity for participants to reflect on their experiences, share their insights, and engage in further discussions related to virtual reality in education. The participants provided significant insights and suggestions about improvements to the VR application.

The evaluation process included the administration of three questionnaires to the participants: one before the VR implementation, one immediately after the VR training, and a follow-up questionnaire four weeks later.

The links to the three questionnaires in the Greek language are the following:

- PRE: https://es.surveymonkey.com/r/VRTEACHERS_PRETRAINING?lang=el
- POST: https://es.surveymonkey.com/r/VRTEACHERS_POST?lang=el
- FOLLOW-UP: https://es.surveymonkey.com/r/Follow-up-VR?lang=el

The training structure implemented in the VRTEACHER project proved to be effective in providing teachers with valuable learning experiences and opportunities for professional development. The combination of online workshops, face-to-face trainings, and follow-up sessions created a well-rounded and comprehensive training program.

7.1.2. The participants

During the piloting phase of the VRTEACHER project in Cyprus, a total of 110 individuals were trained with the VR application. The vast majority of participants, a total of 105 individuals were in-service teachers coming from primary (N=60), secondary (N=25) and VET level (N=12), 3 were from the Ministry of Education, Sports and Youth, 1 from Pedagogical Institute of Cyprus 3 were academics and 2 were higher education students from the Department of Fine and Applied Arts. The vast majority of the participants were not familiar with VR technology and equipment. As they embarked on the first scenario, it became apparent that they required support and guidance to navigate the virtual environment effectively. However, it was noteworthy that once they gained familiarity with the VR system and experienced the initial scenario, they quickly became autonomous in handling the VR equipment and interacting with subsequent scenarios. This observation underscores the adaptability and ease of use of the VR application, as teachers were able to swiftly grasp its functionalities and engage with the immersive learning experiences independently.

7.1.3. Results and participants' feedback

The evaluation process incorporated both quantitative and qualitative data collection methods through the administration of pre-training (PRE), post-training (POST), and follow-

up evaluation questionnaires. These questionnaires allowed for the systematic measurement of participants' perceptions and experiences before, immediately after, and four weeks after the training. On the other hand, qualitative data was gathered through open-ended questions included in the final questionnaire and reflective activities conducted during the third section of the pilot phase. This combination of quantitative and qualitative data collection provided a comprehensive understanding of the participants' perspectives, allowing for a holistic evaluation of the VR application's impact on their learning and skill development.

The participants' feedback on the impact of scenario 1 (Distance education and domestic verbal abuse) was varied. Some participants expressed positive impressions and highlighted the constructive nature of the experience, stating that it helped them gain a better understanding of the difficulties faced by students and emphasized the importance of empathy and support. Several participants mentioned that their views and perspectives had changed, leading them to be more attentive and responsive to students' needs. The scenario also prompted reflections on how to deal with similar incidents and the importance of creating a safe and supportive learning environment. However, some participants expressed scepticism about the realism of the scenario or the effectiveness of the VR experience, while others emphasized the need for external support and intervention in situations of bullying and abuse. In summary, the feedback from participants indicated a range of responses to the scenario, with some reporting positive and transformative experiences, while others expressed more cautious or reserved views.

Based on the comments provided, it is clear that scenario 2 (Phobias related to COVID and panic attacks) had a significant impact on many participants and influenced their outlook on engaging students with psychological distress and phobias related to a pandemic like COVID-19. The scenario helped participants realize the gravity of students' psychological distress and phobias and encouraged them to approach these situations with empathy, support, and specialized knowledge. It also highlighted the need for ongoing training and a sensitive, individualized approach to effectively engage students facing such challenges.

Scenario 3 (Refugee Student) had a generally positive impact on teachers' outlook towards engaging students from different cultures in their classrooms. Many participants expressed that the scenario enhanced their empathy and understanding of the difficulties faced by students from diverse cultural backgrounds. They realized the importance of providing support, adapting teaching techniques, and creating a safe and inclusive environment for these students. Some participants mentioned the need for additional training and support to effectively address the needs of students with migrant backgrounds. The scenario helped them see the situation from the student's perspective and consider alternative approaches to communication and support.

The feedback suggests that the VR training and scenarios had a positive impact on participants, helping them develop empathy, gain new perspectives, and improve their readiness as teachers. The realistic and immersive nature of the scenarios was appreciated, although some participants mentioned experiencing discomfort, such as dizziness and headaches, while using VR technology.

During the final online brainstorming meeting, participants provided valuable insights and suggestions for future improvements to the VRTEACHER project. The key points can be summarized as follows:

- The project offers new opportunities for teacher training and development, allowing educators to enhance their skills and adapt to evolving educational needs.
- The VRTEACHER tool was user-friendly and easily manageable by teachers, ensuring a smooth and seamless experience.
- Participants suggested combining virtual reality with augmented reality to create more immersive and interactive training experiences for teachers.
- Enhancements could be made to the scenarios, allowing teachers to make real-time choices that impact the scenario's development. This adaptive feature would offer a personalized training experience based on individual decisions.
- Participants emphasized the importance of receiving immediate feedback during VR training sessions. Real-time feedback would enable teachers to reflect on their actions and make adjustments to improve their teaching strategies.
- Instead of following predetermined scenarios, participants recommended giving teachers the ability to choose their own paths in VR training. This flexibility would enable teachers to explore different teaching approaches and cater to their specific needs.
- The idea of incorporating collaborative elements into VR training was suggested, allowing other participants to assume the roles of students, parents, or other stakeholders. This would provide a more realistic and interactive experience for teachers.
- Participants proposed including a new scenario focused on cyberbullying, recognizing the importance of addressing this prevalent issue in modern education.
- One of the participants stated that VR holds great potential for the future of education. Its immersive nature and ability to simulate real-world experiences make it a valuable tool for teacher training.

The brainstorming meeting provided valuable insights and ideas for the future development of the VRTEACHER project, emphasizing the need for continuous improvement, adaptability, and the integration of emerging technologies to enhance the training experience for teachers.

7.1.4. Conclusions

The feedback from participants suggests that VR training and scenarios have the potential to significantly impact teaching practices in Cyprus. The VR training and scenarios were effective in cultivating empathy among teachers and helping them see educational issues from the student's point of view. This is particularly valuable in a diverse educational landscape like Cyprus, where teachers interact with students from various backgrounds and experiences. Participants acknowledged that the VR training enhanced their readiness and skills as educators. They felt better prepared to handle unexpected incidents and to address the challenges faced by students, whether in distance education or traditional classroom settings. This is crucial for teachers in Cyprus, who need to adapt to different learning modalities and support students effectively. Equally important is that the participants found the VR scenarios to be realistic and impactful, allowing them to experience the emotions and challenges faced by students. This suggests that such immersive training can be highly beneficial for addressing real-life teaching situations in Cyprus, where teachers encounter diverse and complex educational scenarios.

The most important conclusions in the case of Cyprus can be summarized as follows:

- VR training had a positive impact on participants' understanding of students' perspectives and cultivation of empathy.
- The VR experience helped participants develop new skills and improve their readiness to handle unexpected incidents in both distance and traditional education settings.
- The scenarios were perceived as realistic and impactful, allowing participants to experience the emotions and challenges faced by students in different situations.
- VR training and scenarios can provide valuable insights and support for teachers in Cyprus, helping them adapt to diverse student needs and navigate complex educational scenarios.
- Participants found the VR experience to be a unique and valuable tool for effective teaching and learning, aligning with the needs of technologically advanced students.

7.2. Greece

7.2.1. Overview of the process

The program was implemented in Greece during the period from January until February 2023. It was completed in three phases.

- Phase A: Introductory online workshop. During this introductory meeting, there was a detailed presentation of the project, Virtual Reality generally and its' use in education. Registration in the platform was done as well.

- Phase B: Face-to-face Training in the VRTEACHER Scenarios with the use of VR. This phase began with filling out a pre-training questionnaire, regarding the topics of the scenarios. Afterwards, the participants engaged in Virtual World and attended the tree scenarios. For practical reasons, they were divided into groups. In the end, a post-training questionnaire was filled in.
- Phase C: Online Work Review and Evaluation. This phase included review, discussion and discourse regarding the project and the use of VR in teacher training. A questionnaire regarding the impact of the work was filled in.

Greece is a country with different landscapes. It has a large number of islands, as well as the mainland. It has large cities, such as Athens, along with towns, as in islands. The difference in the landscape generates differences in the working conditions among schools, which can have an impact on the functions, and learning outcomes, which might well relate to innovative programs such as VRTEACHER (OECD, 2021). Teachers serving in remote areas with few inhabitants do not have the opportunity to participate in the training courses that are usually held in the big cities. Apart from the issue of the cost of their participation (travel, accommodation, etc.), there is also the problem of making up for it. Consequently, their participation in in-service training programmes is prohibitive and their professional development stagnates. Programmes such as VRTEACHER provide such opportunities. There was a teacher from the island of Nisyros that could not be present, even though she expressed willingness to do so. The reason was that during winter transport from the islands is not frequent and this teacher, as she had work obligations, was not flexible to travel. In that case, she was sent the VR headsets. She received an email with detailed instructions so that she could engage with the scenarios and fill in the questionnaires.

Despite the challenges that insularity and other factors that emerge in the Greek Education context, there is a general tendency of teachers to participate overall in training. It was therefore assumed that there were fruitful grounds for the project to be implemented. This assumption was later justified. To assure a satisfactory level of accuracy and validity, it was decided that the sample of participants should be variant. For that reason, it was aimed that teachers and participants from different regions of the country should be invited and encouraged to join the training. There were two groups of trainees. The first was based in the Attica region, in the 3rd Laboratory Center of East Attica, in Rafina. The Directory of Secondary Education of Eastern Attica, which belongs Hellenic Ministry of Education and Religious Affairs assisted a lot by permitting the venue to be used and by motivating teachers to participate by sending invitations. This addressed mainly participants living in Athens and mainland Greece. The second was based on the island of Rhodes and addressed more participants living on the islands. The Directory of Elementary Education in Dodecanese Islands helped in the same way as the one of East Attica.

As planned, there were three consecutive stages. During Phase A, which was done online, 43 participants had the opportunity to become familiar with key terms of VR and its' potential, both generally and in the field of education.

During Phase B, 43 participants were invited to join the virtual world, by attending the three different educational scenarios. This training was held face-to-face.

Lastly, phase C included a review of the whole process. This was achieved through an online meeting. 48 Participants had the opportunity to reflect on what they had learned, benchmark what they believed about Virtual Reality and express ideas, on its benefits, challenges and potential for their work and teaching.

Throughout the project, the questionnaires designed were distributed appropriately, after being translated into Greek.

The links to the three questionnaires in the Greek language are the same as those of Cyprus as follows:

- PRE: https://es.surveymonkey.com/r/VRTEACHERS_PRETRAINING?lang=el
- POST: https://es.surveymonkey.com/r/VRTEACHERS_POST?lang=el
- FOLLOW-UP: https://es.surveymonkey.com/r/Follow-up-VR?lang=el

7.2.2. The participants

The participants of the project were teachers and students from different, ages, specializations and various parts of Greece. There were teachers from Athens and the surroundings, who were allocated to the training center of Rafina High School. There were also teachers from Rhodes and nearby islands, who were mostly allocated to the training center of Rhodes Island.

Among the applicants, 64 were in-service training teachers. The rest 7 were students and trainee teachers. Their specialization was different since there were elementary school teachers, nursery schoolteachers, English teachers, ICT teachers, Mathematics Teachers, Science Teachers, Special Education Teachers or Vocational Education teachers among them. There was a large age range since there were teachers in their 20s and teachers in their 50s too. As there were two different training centers, one in Attica and one in Rhodes, this helped gather teachers from various areas of the country, including Athens, Rhodes, smaller islands and mainland Greece. It can be stated that the sample of participants was representative of the Greek teacher population.

Once the announcement of the training programme was disseminated, there was a satisfactory immediate positive response. 71 participants registered via the online form and

all applications were accepted. As is usually the case, due to various impediments not all were able to complete the training.

The participation of teachers per phase was:

- Phase A – Online workshop 43 participants
- Phase B – Face-to-face training 30 participants in Rafina and 13 participants in Rhodes.
- Phase C – Final online workshop 48 participants

7.2.3. Results and participants' feedback

The results and the general feedback were generally positive. Teachers agreed the scenarios, as they were presented, reflected challenges, barriers and difficulties that teachers have to deal with regularly. They stressed that they were presented in a realistic manner too. There was agreement that VR was perhaps the best, if not the only practice to achieve so effective results.

For example, there was a teacher that explained '*I remember the scenario with the child and the mother that was behaving unproperly. It was impressive. I must say that I faced a similar case in my school recently when I had to deal with a mother who was behaving in a similar annoying way. I don't believe that I would have been able to deal with it if I hadn't attended the training*'.

There was another teacher who mentioned '*In my school, we have many children from different countries, particularly from India. So, I was really touched by the scenario about the foreign child, it was the third I think. When I was hearing the children speaking in their native language, Arabic, wasn't it? While I was in the place of the student. I was surprised because all this time that I am dealing with these children I had never realized how isolated they feel and how difficult it is form them. I kept believing that they would understand something, even a few things, someone might be helping them. I felt perhaps a small guilt, from our side [the teacher's side], bearing in mind the large number of students, and the contemporary institutions in the schools. In any case, this experience of VR was impressive because it is liking living it in certain moments*'.

The positive responses were also shown when the teachers were given the opportunity to express ideas about new scenarios that could be approached through VR. There was a teacher who commented '*In senior high school where I work, we deal with learners with learning difficulties, such as dyslexia or ADHD. It would be very interesting to use VR for these cases, so we could understand how these children feel when for example they cannot read or write properly. Certainly, there are other issues too, such as violence at schools. In any case, I congratulate you, because I felt that we had great instruction and feedback regarding*

the use of technologies, which lacked in other cases, such as when distant, online-education was imposed during the pandemic'.

There were replies which prove that teachers believe that VR can even help in the great challenges they face. A German teacher told '*I believe that, in language teaching, it would be very helpful to have scenarios that would 'transfer' children, let's say to museums, to cities, places, go to a restaurant and order, talk with locals, maybe famous Germans to learn and appreciate the language like that*'. A mathematician told '*Children might have difficulty in mathematics. They may also express ideas, concerning why we learn these topics. With VR we could possibly 'transfer' the children to places, such as the acropolis and show them how mathematics helped its' construction. Or maybe show them the applications of mathematics in medicine. In junior high school children are oriented towards preparing for the exams to enter the university. They pay no attention to other subjects and neglect the general mission of schools. By implementing activities such as those with VR, children might be more motivated to respect the school more*'.

Some comments showed appreciation of the program, such as '*I have the role of mentor in my school. I would like to see how I can prepare, something like a seminar, for my colleagues, where I will show them these scenarios and show them how they can use the class*'.

There are also comments implying that teachers feel very confident to research and even express ideas and opinions about the field of VR, as one who expressed '*VR has future. We will certainly work to have teaching material about it, and we will see [teachers from different] specializations cooperating to use it. In future, we will see that*'.

Overall, the teachers showed that this training was very helpful. It helped them not only learn about VR and technology but also motivated them to engage further in VR and investigate how to use it, to improve their work, and performance and deal with challenges that they face in their professional environment.

7.2.4. Conclusions

The outcome of the program was the best possible teachers expressed satisfaction with it. They though that the applications were easy to use and very fascinating. Thanks to the scenarios, they engaged in situations and challenges that all teachers may come across in their work. This was done in a convincing way, which gave the impression that they are actually dealing it with. They expressed that they gained benefits that can make them improve their teaching performance and achieve better education outcomes. They also stressed that VR was perhaps a unique approach to dealing with such challenges, and perhaps no other practice or application could help them at the same level.

As further recommendations, it was stressed that programmes such as the VRTEACHER need to be expanded and include even more scenarios around challenges that teachers may face

in their work. If this is achieved, then teachers can have opportunities to prepare better for actual barriers that they may deal with in their work and everyday routine, in a continuously turbulent school context. This will help them gain appropriate practical training and feasible solutions. Training that may rely only on direct instruction or theory, even though it may be useful, is still not complete and may provide impractical solutions.

The general impact showed that teachers develop positive opinions towards VR. Firstly, they constructed knowledge regarding the technology, terminology, software, hardware, applications and VR in the field of education. Secondly, they developed skills, as they used VR applications to engage in scenarios and work appropriately with them, to gain further knowledge. Lastly, they adopted positive attitudes towards VR as the expressed that it can be used without major challenges, it can help them in their work and it may be used without harming anyone. These knowledge, skills and attitudes lead to the conclusion that the teacher had significant benefit from the project and the outcome was the best possible.

7.3. Spain

7.3.1. Overview of the process

The piloting phase of the VRTEACHER project in Spain reached a total of 71 people, from the beginning of January to the end of February 2023. The main target group reached was pre-service teachers, as 64 of the total participants were university students in both the degree of kindergarten and primary education and the Physical Activity degree. The other 7 left were university teachers and experts in the area of computer science.

The pilot was divided into three main parts. An initial online session in which the project and the activities involved in the pilot were explained. To explain the VRTEACHER approach of the project a Moodle platform was created: https://vrteacher.4eclass.net. This course was the basis of the pilot, where participants could find the presentation and videos of why to use Virtual Reality in education, documents where they could find their names and their codes to be used when experimenting with the scenarios, explainer videos on how to use the VR glasses and guidelines on how to use the VR tool created for the project.

The second part was divided into 4 face-to-face sessions in which the participants used the Virtual Reality glasses and the application developed in the project. The Spanish partners had a total of 4 Meta Quest devices, with the project application programmed internally, and 11 stand-type goggles to insert Android mobile phones with the downloaded application. Participants with Android mobiles used stand-type glasses, as they had the application downloaded on their mobiles. Participants with Apple mobiles were selected to use the tool from the Meta Quest glasses. The UC3M partners were responsible for providing support to these individuals, as they were the experts in this type of device. The sessions lasted between 120 and 160 minutes and were organized as part of the practical sessions of

the participants' university courses. While some of the students were testing the application, the remaining members of the student body were working on their university assignments. To assess the impact of the VRTEACHER application, a POST questionnaire was made available in Moodle for the participants to answer after finishing their experience with the VRTEACHER glasses.

Finally, the third session was carried out online to collect the opinions of the participants and their assessment in the Follow-Up session.

To assess the impact of the application developed by the project, the Irish partner, with the help of the Cypriot organisation, created three questionnaires to be carried out throughout the pilot phase. The questionnaires are accessible in all partner languages. The pre-questionnaire is answered before using the VRTEACHER application, to assess the participants' knowledge both in competences directly related to Virtual Reality and in competences related to soft skills such as empathy and problem-solving. The post-questionnaire is intended to be a comparison with the previous questionnaire, to observe changes and modifications in the results of the participants after having used the tool and having immersed themselves in the scenarios proposed. The last questionnaire, Follow-Up, also aims to collect qualitative assessments of the participants and their feelings regarding the use of Virtual Reality as an educational tool.

Here are the links to the three questionnaires in Spanish:

- PRE: https://es.surveymonkey.com/r/VRTeachers_PreTraining?lang=es
- POST: https://es.surveymonkey.com/r/VRTEACHERS_POST?lang=es
- FOLLOW-UP: https://es.surveymonkey.com/r/Follow-up-VR?lang=es

As the main evaluation of the pilot, the participants valued Virtual Reality as a tool through which different situations can be experienced in 3D scenarios in parallel to reality, making it a truly useful activity. In the same way, the usefulness of the pilot is highlighted both as an initiation to later use this type of resources in the classroom and as a way of approaching different circumstances with technologies in an inverse way. In relation to the disadvantages, the lack of resources, both material and training, on the part of schools and teaching teams to be able to carry out this type of experience was pointed out.

7.3.2. The participants

The piloting phase involved a total of 71 participants, 64 of whom were university students, most of them with ages between 18 and 24 years old. Of these students, 11 were pursuing a degree in kindergarten education, 17 were in their fourth year of the Primary Education degree, and 36 were in their first year of the Physical Education degree.

In addition to the students, 7 university teachers with expertise in the field of computer science also participated in the piloting activities. These teachers ranged in age from 25 to 49 years old, with three teachers aged 25-29, three teachers aged 30-39, and one teacher aged 40-49. 5 of them reported already having extensive experience with virtual reality technologies. With regards to their gender, 30 of the participants were female and 21 were male.

7.3.3. Results and participants' feedback

The results are collected both quantitatively, through the pre, post and follow-up evaluation questionnaires, and qualitatively, with the open questions of the last questionnaire and the reflective activity during the third section of the pilot phase. In this section, we have collected the qualitative comments of the participants, with special emphasis on their personal assessment of the use of VR as an immersive tool to promote meaningful learning situations in schools, at all levels.

After collecting the results, it can be observed that the participants consider the experience to be very complete. From their point of view, the fact that real problems that can occur in a classroom are shown gives the experience realism. As for the images, they consider that the virtual world is perfectly constructed, thanks to the fact that what is seen has all the details that exist in a similar environment in reality. This ensures that people are immersed in the environment at all times. In addition, they say it is a great advantage that the scenes can be experienced from different perspectives, knowing the points of view of each character, thus promoting empathy and awareness that each situation has different perceptions and that to deal with it optimally it is necessary to know them all. In the same way, they add that the internal voice in the thoughts of the characters increases the realism of the situation and makes the user feel identified with the subject in each scene.

The general opinion of the participants is positive, although there are some aspects that they point out as possible points for improvement. The first of these is that, by offering different character perspectives, the scene is largely repeated in the same way as the previous one. They consider that it must be repeated, but it can sometimes become tiresome to listen to the same thing twice. In addition, they also point out as a drawback that the scenes last around 10 minutes and doing the three scenes in a row makes it more difficult to concentrate, as the continuous use of the VR goggles leads to dizziness and confusion. Finally, most of the participants expressed their concern about the lack of resources, both material and teacher training, to integrate this type of tool in the classroom.

Regarding the use of the VRTEACHER application as an educational tool, the participants reported that this training has great benefits. By going through the different scenarios, teachers put themselves in the shoes of the characters and feel as if they were part of the experience. In addition, through the questions, their opinions, and possible ways of reacting

to these problems are revealed through reflection, which is subsequently contrasted with the action protocols presented in the application after each of the scenarios. As the classroom difficulties are so realistic, the teacher is immersed in the whole experience. Therefore, the fact that teachers are involved in these experiences is very beneficial for the development of their work.

In summary, they consider it to be a very enriching experience for teachers, as it proposes realistic experiences that can take place in the classroom in a more fictitious environment. Several of the participants have reflected on their training in this type of situation and described it as poor or non-existent, some of them being in the final year of their teaching degree. This is why they fully recommend the use of the application, both for active teachers and for students with education degrees. They see it as training for what may happen, thus facilitating anticipation and training for a future approach to the situation from a more consolidated knowledge.

As for the use of VR as an educational tool, they consider it to be a resource that they would implement in the classroom with their students. Although some of the participants were sceptical at the beginning of the experience after learning about the assessment made by some experts about Virtual Reality, in the final questionnaire all the answers were positive in terms of the use they would make of it in the future. According to the experts, it is not favourable for younger students to be exposed to these technologies because they do not understand the difference between the real and the virtual world. However, the participants qualify Virtual Reality as a tool that is essential to be able to deal with different contents in the classroom in a playful way and through the use of technology. Through VR, students can get closer to unknown environments, both distant (Solar System) and those located on our planet (other countries). For all these reasons, the participants in the pilot in Spain consider that VR should form part of current education as a support to improve student learning, pointing to teacher training in the use of this type of technology as a pending issue and asking for the necessary material resources to carry it out.

7.3.4. Conclusions

As a conclusion to the pilot phase of the VRTEACHER tool implemented in Spain with both active and future teachers, the following points are highlighted.

- Virtual Reality has the ability to create inverse environments that can enhance the meaningfulness of the experience.
- Virtual Reality can be a valuable tool in education, providing access to knowledge that may otherwise be out of reach but can be programmed and accessed virtually.
- Regarding the VRTEACHER application, the shift in perspective in the scenarios promotes empathy and an understanding of the importance of considering different perspectives to effectively address a situation.

- The use of tools like VR in the classroom can grab a lot of attention from both students and teachers. It's a reality that more and more students have access to VR in their leisure time, so integrating it into education can be a great idea. However, material and training resources are required so that these experiences can be integrated into the classroom curriculum instead of being one-off external workshops.

7.4. Ireland

7.4.1. Overview of the process

The research process for evaluating the effectiveness and impact of the VRTEACHER implementation methodology involved several key steps. Firstly, Future in Perspective (FIP) organised four workshops to deliver the training programme to teachers in Ireland. Since it was difficult to accommodate all teachers in one workshop, the decision was made to conduct the training programme four times, ensuring broader participation.

These workshops were conducted in collaboration with St Mary's National School (Primary School), Loreto College Cavan (Secondary School), and St. EllenField Community College (an all-gender multi-denominational, mainstream, mixed-ability school). FIP established communication with these schools via telephone and email to coordinate the training program agenda, timeframe, and venues. The schools also played a crucial role in promoting the training program to teachers during their meetings and recruiting participants.

To facilitate the practical implementation of the VR tool, FIP acquired 10 VR Headsets. These devices were utilised during the workshops to provide hands-on experience to the participants.

Data collection for the impact assessment process in Ireland involved the use of pre, post and follow-up questionnaires. FIP issued these questionnaires to all participants, offering the choice of completing them either online or in paper format. While most participants in Ireland opted for the paper-based questionnaires, FIP staff ensured a seamless transition by transferring the responses to the online SurveyMonkey platform.

The research process undertaken by FIP demonstrates a systematic approach to evaluating the VRTEACHER implementation methodology. By conducting multiple workshops and involving a diverse range of schools, FIP ensured a comprehensive representation of teachers in Ireland. The utilisation of both online and paper-based questionnaires allowed for flexibility in data collection, catering to the preferences of the participants. Overall, this research process aimed to gather valuable insights into the effectiveness of the VR training programme and its impact on educational activities in the Irish context.

7.4.2. The participants

The training programme event was organised by FIP in collaboration with several schools in County Cavan, including:

- St Mary's National School – Primary School
- Loreto College Cavan – Secondary School
- St. EllenField Community College - A gender multi-denominational, mainstream, mixed-ability school

As such, our piloting in Ireland was completed solely with in-service teachers, i.e., teachers who already completed their formal training and qualifications to become teachers, and who were currently employed in a formal teaching position in these schools.

In total, we had over 30 participants. All teachers worked in formal education, either primary, secondary school or special needs. They were from varying backgrounds and ages. These participants had engaged with the project previously and were very interested in the VRTEACHER project.

To deliver this piloting, FIP organised four separate workshops with these teachers, where the VR Application was piloted. In each group, we had the following number of participants:

- Group 1: 7 participants
- Group 2: 7 participants
- Group 3: 8 participants
- Group 4: 9 participants

As such, each group had a small group of participants, meaning that they could each test and use the VR application at the same time – using one of the 10 headsets that FIP purchased – and also so that they could openly share their first impressions, thoughts and feelings about the VR experience.

Overall, these were very positive piloting sessions, and the participants were very enthusiastic about using the VR application to enhance their empathy skills.

7.4.3. Results and participants' feedback

The research process for the VRTEACHER Impact Assessment involved gathering feedback from participants and analysing their responses to assess the effectiveness and impact of the training event. The data collected provided insights into various aspects of the implementation and identified both positive outcomes and areas for improvement.

Participants reported that the training event was highly successful, and the feedback indicated that they believed it would benefit them in improving their interpersonal skills such as empathy, collaboration, and social skills. The VR technology allowed teachers to experience psychological distress and phobias in a safe environment, enhancing their understanding of complex concepts. The well-designed scenarios and user-friendly VRTEACHER application contributed to a positive learning experience, with no reported issues in using the application or the VR headsets.

One minor drawback mentioned by some participants was the inconvenience for those wearing eyeglasses. This feedback highlights the importance of considering the comfort and accessibility needs of all participants in future training events.

The main findings of the VRTEACHER Impact Assessment emphasised the significance of adequate resources for teachers to deliver quality education. The assessment revealed that some schools lacked sufficient funding to acquire essential online teaching and learning resources like iPads, laptops, and other equipment. This finding suggests that incorporating VR technology into teacher training programmes could address resource limitations and enhance the overall quality of education.

Additionally, the assessment identified challenges faced by teachers during the implementation. Some schools lacked the necessary resources for conducting workshops, and FIP provided all the VR headsets for the participants. It was also noted that despite providing instruction guides before the workshop, some teachers encountered difficulties downloading the VRTEACHER application. These observations highlight the importance of ensuring sufficient resources and clear instructions to support a smooth implementation process.

Overall, the research process involved collecting feedback from participants to evaluate the impact and effectiveness of the VRTEACHER application. The findings provided valuable insights into the benefits of VR technology in education, resource limitations faced by schools, and areas for improvement in the implementation process. By addressing these findings, future iterations of the training programme can be enhanced to maximise its impact on teaching and learning outcomes.

7.4.4. Conclusions

The research process for assessing the impact of the VRTEACHER implementation involved examining various aspects of the training programme and its effects on teachers' personal and professional development. The research findings shed light on the benefits of VR-based teacher training and its applicability to real-life classrooms, highlighting its potential as a viable alternative to face-to-face training activities.

One key impact of the VRTEACHER assessment process is the clarity it provides teachers regarding their role within the school reality. By experiencing teaching scenarios in a virtual environment, teachers gain a clearer understanding of their profession and can reflect on their performance. The ability to experiment without risking harm to real students empowers teachers to maximise their teaching performance and explore new instructional strategies.

The research findings also emphasise the transferability of skills and knowledge gained during VR training to the real-life classroom. This implies that VR-based teacher training can effectively equip teachers with the tools and techniques necessary for effective teaching. By bridging the gap between virtual and physical classrooms, VRTEACHER training offers a credible and impactful approach to professional development.

Furthermore, the proposed VR framework for teacher training places significant emphasis on inclusiveness and multiculturalism. This focus aims to ensure the delivery of high-quality inclusive education, even in times of crisis such as a pandemic. VRTEACHER can assist in raising awareness among teachers, promoting inclusive practices, and ensuring that every student receives equal learning opportunities.

During the implementation process, it was noted that some teachers lacked proper VR equipment, which they were unable to afford through their schools. However, the use of ICT and the Internet was popular in most schools, enabling teachers to benefit from the training. While some teachers were not well-versed in the use of ICT, the majority were able to leverage the training to enhance their educational practice.

In conclusion, the research process for assessing the impact of VRTEACHER highlighted its potential to contribute to teachers' personal and professional development. The findings underscored the transferability of skills, the importance of inclusiveness, and the need to support teachers in implementing high-quality inclusive education. By implementing VRTEACHER, educational institutions and training colleges can enhance their support for teachers and improve overall education and practice.

7.5. Malta

7.5.1. Overview of the process

The VRTEACHER project training activities were implemented in Malta between December 2022 and February 2023, from the issuing of the call for participation to the post-training online workshop.

There were 59 eligible participants from 63 registrations, with 43 completing the face-to-face training. Most of the participants were in-service female educators from Maltese

primary and secondary schools (compulsory education). The face-to-face training was conducted over three sessions for logistical reasons.

While only a small percentage of participants had previous experience with VR, the overall reaction was quite positive. There were minimal technical issues in downloading, installing and experiencing the scenarios.

The objectives of the app to promote empathy and understanding have been reached. The participant educators said VR is an effective tool in education and they appreciate that as a new tool that needs a pedagogical foundation for implementation. They suggested new scenarios and expressed willingness to use them in class. However, schools new to update their policies on using smartphones in class.

7.5.2. The participants

The recruitment process started with an open call addressed to all pre-service teachers, in-service teachers, and higher-education educators in the Maltese Islands. Relevant institutions like the Malta Union of Teachers, the Secretariat for Catholic Education, the Institute of Tourism Studies and the Faculty of Education University of Malta were approached, and they agreed to disseminate the call with their members/ students. The call opened on the 8th of December 2022 and remained open until the 13th of January 2023. However, 3CL was approached and accepted very late registrations until the 19th of January 2023.

The application form was available online at: https://forms.office.com/pages/responsepage.aspx?id=iexVtZHVxUKGkVVBMfP38ZwmcQxyCxRMgh2c-e48MlNUNjVRSU9JUFNVVTNQRjhUMlFINjNTSUhDTy4u

There were 62 registrations, of which 59 eligible participants were accepted and invited to do the training. Acceptance was based on the profession of educator, whether in service (not a pensioner), or pre-service (studying for an education-related qualification at any recognised training or higher education institution) and working in Malta. Of these, 4 were pre-service teachers, 4 were educators in post-secondary or higher education, 16 were service educators in primary schools and 35 were service educators in secondary schools.

Out of the 59 registered participants, 43 attended the face-to-face training held in three separate venues. Only 1 out of 4 of the pre-service teachers attended this training.

In terms of the gender of the registered participants, 88% were female and 12% were male. Other genders were not represented in the registrations.

Only 7 of the participants or 12% had previous experience in using Virtual Reality with a head-mounted display (headset).

The face-to-face training was held at St Martin's College (Msida), at the Directorate for Digital Literacy and Transversal Skills (Ħamrun) and the Institute of Tourism Studies (Luqa).

7.5.3. Results and participants' feedback

Technical experience

- Not really interactive - it was cinematic VR where participants did not have enough control.
- The headset was uncomfortable and heavy on the head.
- In the scenarios, some users had to move the chair around / turn their heads to keep seeing in the middle.
- Downloading and installing was straightforward.
- Physiologically side effects - some felt sick - some felt nauseous straight away. Focusing on questions made some sick. Numbers are very low.
- Eye-gaze kept bouncing and could not be precise. Some participants said that in some cases controllers are better for more control. However, some said controllers could ruin the immersion and make the user aware of the outside world (hands in one world and eyes in another world).
- 15 minutes length is a good length - lost the concept of time in the scenario - did not realise the length.
- Smartphone + headset = good combination of accessible technology and created interest to experiment more with VR.
- Scenarios are easy to follow.

Experience of first-time users

- Focusing on gazing is a bit difficult.
- Decided to try it out because interested but hadn't the opportunity - the perfect chance to try it and be trained - I really felt like in another world (not with teacher but with the mother and student) - very eye-opening and enjoyed it.
- First-time user with nausea - also second time (first time was with controller and was easier to choose) - movement with head affected nausea.
- Difficult to focus - the adjustment faders - cause nausea.
- Could not find the right focus setting and had to keep prescription glasses on.
- Relaxing music and closing the eyes helped with nausea.

Teacher training with scenarios and experience

- The child and mother part was the best scenario - users just wanted to react and punch her!
- The refugee scenario was good - made teachers realise language problems in class (being in her shoes).

- Scenario from the perspective of the student felt more immersed - as a teacher participants felt like an observer. Felt more impact of mother yelling and panic attack. Maybe it is because teachers know how teachers feel.
- Scenario student at home - looking from the eyes of the teacher had similar scenarios to that - at Church school, during Covid held lessons for the whole two classes - hybrid model with one group in class and one in another class (online) - this scenario brought back all the tension creation by this model because it is very difficult to control (not in class management but connectivity, hearing, pedagogy) - This training re-lived it - very immersive.

New proposed scenarios

- Coping with exam stress
- When students refuse to participate
- Jokes in front of class
- Bullying scenarios
- Dyslexia and dyscalculia
- Understanding autism
- Disruptive behaviour in the classroom
- Scenarios to use with students.

What would educators change or improve to redo it?

- The voices in the scenario were robotic in English.
- Some questions on the surveys were not clear enough and there was a lot of repetition from one to another (pre to post).
- Change in the class in the scenarios - different classes and students in scenarios.

7.5.4. Conclusions and Recommendations

The pilot phase of the VRTEACHER tool implemented in Malta yielded the following noteworthy conclusions:

- VR is an effective tool in education and educators appreciate that as a new tool that needs a pedagogical foundation for implementation.
- Educators want more training, the required equipment, and the opportunity to influence the development of such resources.
- The objectives of the app to promote empathy and understanding have been reached.
- Most participants did not have previous experience with VR, and they were positively surprised.

- The app filled a void – very much appreciated by most educators. They want more such resources and training on how to use them effectively.
- Participants are ready to adopt it and some even want to learn how to develop VR experiences.
- Policies on the use of smartphones in schools need to change if these are to be used as a pedagogical tool.
- The app should be available for the Apple iPhone platform too.
- The app is easy to download and install, technically reliable and works on almost all Android smartphones, which means the technical barrier is minimal.
- More scenarios should be developed but these should not be longer than 12-15 minutes.
- Wider dissemination with educators' post-project is needed for a snowball effect.

8. Conclusions

The VRTEACHER project is an innovative initiative aimed at revolutionizing teacher training through the use of VR technology. The project has emerged as a groundbreaking initiative that harnesses the power of virtual reality to revolutionize teacher training and respond to the needs highlighted by the COVID-19 pandemic by addressing the following key aspects:

- *Distance Learning Adaptation*: With the sudden shift to remote learning during the pandemic, teachers faced significant challenges in adapting their teaching methods to an online environment without previous pedagogical preparation (Aristovnik et al, 2023). It was not a simple question of moving traditional pedagogies online, as online teaching and learning needed new instructional designs that would exploit the affordances of technology (Debattista, 2018). VRTEACHER provides virtual training scenarios that specifically focus on distance learning challenges, helping teachers develop strategies and skills to effectively engage students in a virtual setting.
- *Teacher Preparedness for Technology Integration*: The pandemic highlighted the importance of technology integration in education. VRTEACHER equips teachers with the necessary digital skills and familiarity with VR technology, enabling them to confidently incorporate digital tools and platforms into their teaching practices.
- *Hands-on practical experience*: VRTEACHER addresses the need for hands-on practical experience in teacher training. While traditional teacher training programs often lack opportunities for real-life, practical application of knowledge, VRTEACHER fills this gap by offering virtual scenarios that simulate realistic teaching situations. Through the use of virtual reality technology, teachers can engage in interactive and immersive experiences that replicate classroom environments. They can practice their teaching techniques, experiment with different instructional strategies, and make decisions in a risk-free virtual setting. This hands-on practical experience allows teachers to develop their skills, gain confidence, and refine their teaching approaches.
- *Emotional and Well-being Support*: The pandemic brought about increased emotional and well-being concerns among students. VRTEACHER includes scenarios that address these issues, allowing teachers to develop a better understanding of student emotions and how to provide appropriate support and guidance during challenging times.
- *Flexibility and Adaptability in Teaching*: COVID-19 created a constantly evolving educational landscape, requiring teachers to be flexible and adaptable in their approaches. VRTEACHER offers a range of virtual scenarios that simulate various teaching situations, enabling teachers to practice and refine their adaptability skills, decision-making, and problem-solving abilities.
- *Professional Development Opportunities*: The pandemic highlighted the need for ongoing professional development to support teachers in keeping up with the

changing educational landscape. VRTEACHER provides a comprehensive and accessible professional development tool that allows teachers to continue enhancing their skills, even in remote or restricted learning environments.

VRTEACHER project supports teachers in effectively navigating the challenges brought about by the COVID-19 pandemic. It is designed to provide teachers with VR-based immersive learning experiences that enhance their skills and competences such as empathy and understanding of various classroom scenarios. The VR application developed under the project offers a multilingual experience to cater to diverse language contexts. For instance, in the Greek and Spanish versions, audio recordings were performed by actors to provide an authentic and realistic experience. This multilingual capability enables teachers from different linguistic backgrounds to benefit from the immersive training provided by the tool.

Through the VRTEACHER tool, teachers engage in virtual scenarios that simulate real-world classroom situations. By assuming the role of both teacher and student, they gain valuable insights into the challenges, emotions, and experiences that students face. This experience fosters empathy and perspective-taking, enabling teachers to better understand their student's needs and tailor their instructional approaches accordingly.

One of the key features of the VRTEACHER project is its focus on accessibility. Recognizing the importance of making the tool widely available, the project team opted for low-cost equipment, such as VR headsets for Android phones. This decision has ensured that a larger number of teachers, teacher education departments, and schools can easily access and utilize the VRTEACHER tool in the future. What is worth mentioning is that during the VRTEACHER project, one of the participants hailed from an island called Nisiros, located far from major cities. The project partner UAegean provided her with VR headsets, enabling her to participate in and complete the training remotely using the VR application. This experience highlighted the significance of remote VR-based teacher training and opened new doors for teachers in remote or geographically isolated areas. The ability to engage in VR training remotely overcame the barriers of physical distance and lack of access to traditional in-person training programs. By leveraging VR technology, participants from remote or isolated areas can access high-quality training programs that were previously limited to those located in urban areas. The ability to participate remotely eliminates the need for extensive travel or relocation, making professional development opportunities more accessible and inclusive.

This remote VR-based training experience has several important implications. Firstly, it promotes inclusivity by providing equal opportunities for teachers, regardless of their geographical location. It ensures that teachers from remote areas can access high-quality training resources and benefit from professional development opportunities that were previously limited to those in urban or well-connected regions. Additionally, remote VR-based training offers flexibility and convenience. Participants can engage in training sessions

at their own pace and from the comfort of their own surroundings. This flexibility enables teachers to balance their professional commitments with other responsibilities, making it easier for them to engage in continuous learning and skills enhancement. Furthermore, remote VR-based training reduces costs associated with travel, accommodation, and logistical arrangements for both participants and training providers.

The VRTEACHER project has received positive feedback from participants. Teachers have expressed appreciation for the realistic and impactful nature of the virtual scenarios, which have helped them develop new skills, improve their decision-making abilities, and think critically about their teaching practices. The project's emphasis on realism and immersion has significantly enhanced the effectiveness of the training experience. The VR tool has effectively influenced teachers' perspectives on engaging remote learners and addressing the challenges of bullying and abuse at home (scenario 1). The tool sheds light on various forms of abuse that students may face at home, making educators more aware of these realities. It emphasises the importance of taking immediate action, reporting incidents, seeking help, and adhering to safeguarding rules. Additionally, the scenario has made teachers aware of potential disruptions and distractions students may encounter at home, leading to considerations such as turning off cameras in certain situations.

The VR training experience has significantly influenced teachers' outlook on engaging students with psychological distress and phobias arising from events like the COVID-19 pandemic (scenario 2). It has provided teachers with a unique opportunity to experience and comprehend the challenges these students face, which may be dangerous, difficult, or impossible to replicate in real-life situations. Teachers have recognised the importance of developing collaboration and social skills, fostering interpersonal relationships, and creating a safe environment for students. The scenario prompts teachers to reflect on diverse strategies and perspectives, highlighting the necessity of support from a team of professionals and available resources. Furthermore, it underscores the significance of validating students' feelings, seeking assistance when needed, and adopting tailored approaches to meet individual needs.

Equally important is that VR-based training has significantly impacted teachers' perspectives on engaging students from different cultural backgrounds in the classroom. Immersing teachers in a virtual environment cultivates empathy and enables them to see students from diverse vantage points. Experiencing students' perspectives allows teachers to better understand challenges related to language barriers and cultural differences. The scenario emphasises the importance of diversity and inclusion, highlighting the need for teachers to be mindful and treat all students equally. The VR experience increases awareness and encourages the adoption of strategies to support students from diverse cultures, fostering a more inclusive and supportive classroom environment. The scenario also highlights the need for additional training to assist teachers in effectively integrating students from different cultural backgrounds.

Overall, VR-based training and all scenarios had a positive impact on teachers, making them more supportive, empathetic, and better equipped to address the challenges faced by their students. Using a VR-based training approach has heightened their awareness, empathy, and preparedness to handle situations involving students with psychological distress and phobias, ultimately fostering a more inclusive and supportive learning environment. The impact of all the scenarios is profound, nurturing empathy, awareness, and a commitment to inclusive education.

Another important outcome of the project deals with the long-term impact of the VR-based training which was assessed four weeks after the end of the trainings. The findings indicate that participants' attitudes toward remote and blended teaching, as well as their beliefs in inclusive education, improved significantly over the long term. This suggests that the positive changes in attitudes were sustained and not just temporary. Teachers had the opportunity to further explore and analyse the VR scenarios, encouraging critical thinking and self-reflection concerning their own teaching practices. The introduction of VR likely sparked discussions among teachers, allowing for the exchange of perspectives and experiences related to the encountered scenarios when they returned to their schools.

As the pilot phase of the VRTEACHER project concludes, valuable insights and feedback have been gathered from all partner countries to further refine and develop the tool. The identified strengths and areas for improvement will be instrumental in enhancing the tool's effectiveness and ensuring its alignment with the evolving needs of teachers.

The success of the VRTEACHER project in all partner countries indicates its potential for broader implementation and adaptation in other educational contexts. The project serves as a pioneering example of how VR can be harnessed to transform teacher training programs globally, enabling teachers to better prepare for the complex and diverse challenges of the modern classroom.

9. Final thoughts

The VRTEACHER project has demonstrated great potential in revolutionizing teacher training by incorporating VR technology. It has successfully addressed the needs highlighted by the COVID-19 pandemic, offering an innovative solution for remote learning and hands-on practical experience. The project has provided teachers with a unique opportunity to immerse themselves in virtual teaching environments, allowing them to practice and refine their skills in a safe and controlled setting. The use of realistic scenarios and interactive simulations has enhanced their ability to understand and respond to the challenges they may face in real classrooms.

Looking ahead, future updates to the VRTEACHER project could focus on expanding the library of scenarios and incorporating advanced features to further enhance the user experience. Users commonly reported discomfort, dizziness, and the need for better headset adjustment and screen calibration. Participants' suggestions also included compatibility with Apple phones, improved graphics, and the use of human voices in the English version. The image quality, audio clarity, and script quality were also identified as areas for improvement. The participants also stated the need for more interaction which could include incorporating artificial intelligence in a future version of the application for more dynamic and personalized simulations, integrating real-time feedback mechanisms, and incorporating collaborative elements to facilitate interaction and peer learning among teachers. Furthermore, ongoing research and evaluation of the project's effectiveness and impact on teacher training outcomes would be valuable. This would provide valuable insights for continuous improvement and inform future developments in the field of virtual VR-based teacher training. The VRTEACHER project has laid a solid foundation for the integration of VR technology in teacher training, and with further updates and advancements, it has the potential to shape the future of education by offering immersive, effective, and accessible training experiences for teachers worldwide.

Furthermore, the case of the remote participant demonstrates the power of VR in bridging the gap between educators and training resources. This case in Greece serves as a testament to the transformative power of VR in overcoming geographical barriers in teacher training. This experience highlights the potential for future work and research in exploring the possibilities of remote VR-based training for teachers. By leveraging VR technology, teacher training programs can reach educators in remote areas who may not have easy access to traditional training resources. This opens new doors for expanding the reach and effectiveness of teacher training, ultimately benefiting the quality of education in underserved regions. Further research and development in this area can unlock the full potential of VR as a tool for remote teacher training, creating more inclusive and accessible opportunities for educators worldwide.

In addition to the comprehensive Best Practices Handbook, readers interested in delving deeper into the VRTEACHER project can explore a wealth of information and insights through various publications associated with the project (Stavroulia et al., 2023; Stavroulia et al., 2023[1]; Stavroulia & Lanitis, 2023; Pyrini & Kavouklis, 2022; Stavroulia et al., 2021). These publications, referenced in the project materials, provide valuable and in-depth perspectives on different aspects of the VRTEACHER project, including its development, implementation, and outcomes. By referring to these publications, readers can access additional research, methodologies, and findings that contribute to a more comprehensive understanding of the project's scope and impact. The references section serves as a gateway to further explore the wealth of knowledge and expertise generated by the VRTEACHER project, allowing readers to engage with a broader scholarly discourse and stay informed about the latest advancements in the field of VR-based teacher training.

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11. References

[1] OECD (2020). Supporting the continuation of teaching and learning during the COVID-19 Pandemic. Available at: https://www.oecd.org/education/Supporting-the-continuation-ofteaching-and-learning-during-the-COVID-19-pandemic.pdf

[2] Stavroulia, K.E., Christofi, M., Baka, E., Michael Grigoriou, D., Magnenat Thalmann, N. and Lanitis, A. (2019). Assessing the emotional impact of virtual reality based teacher training. *International Journal of Information and Learning Technology*, 36(3), 192 217. https://doi.org/10.1108 /IJILT 11 2018 0127

[3] Stavroulia, K. E., & Lanitis, A. (2023). The role of perspective-taking on empowering the empathetic behavior of educators in VR-based training sessions: An experimental evaluation. *Computers & Education*, 197, 104739.

[4] Cheng, T. (2014). Application and Research of Using the Virtual Reality Technology to Realize the Remote Control. *International Journal of Control and Automation*, 7(8), 427-434.

[5] Freina, L., and Ott, M. (2015). A literature review on immersive virtual reality in education: state of the art and perspectives. *eLSE Conference*, Bucharest, April 2015. Available at: http://www.itd.cnr.it/download/eLSE%202015%20Freina%20Ott%20Paper.pdf

[6] Ke, F., Lee, S., Xu, X. (2016). Teaching training in a mixed-reality integrated learning environment. *Computers in Human Behavior*, 62, 212–220.

[7] Mazuryk, T., & Gervautz, M. (1996). Virtual Reality History, Applications, Technology and Future. Available at: https://www.cg.tuwien.ac.at/research/publications/1996/mazuryk-1996-VRH/TR-186-2-96-06Paper.pdf

[8] Li, Z., Yue, J., Jáuregui, D.A.G. (2009). A New Virtual Reality Environment Used for e-Learning. In *2009 IEEE International Symposium on IT in Medicine & Education* (Vol. 1, pp. 445-449). IEEE..

[9] Sherman, W. R. & Craig, A. B. (2003). *Understanding virtual reality. Interface, application and design*. San Francisco: Morgan Kaufmann Publishers.

[10] Zhan, Z. (2011). The Application of Virtual Reality on Distance Education. In *International Conference on Intelligent Computing and Information Science* (pp. 78-83). Springer, Berlin, Heidelberg.

[11] Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N. & Jin, M. (2008). The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teachers, Students, and Social Context. *Journal of the Learning Sciences*, 17 (1), 102-141. doi: 10.1080/10508400701793141

[12] Slater, M. (2003). A Note on Presence Terminology. Presence connect, 3(3), 1-5. Available at: http://www0.cs.ucl.ac.uk/research/vr/Projects/Presencia/ConsortiumPublications/ucl_cs_papers/presence-terminology.htm

[13] Lee, A. T., & Bussolari, S. R. (1989). Flight simulator platform motion and air transport pilot training. *Aviation, space, and environmental medicine*.

[14] Lele, A. (2013). Virtual reality and its military utility. *Journal of Ambient Intelligence and Humanized Computing*, 4(1), 17-26.

[15] Mantovani, F. (2001) 12 vr learning: Potential and challenges for the use of 3d environments in education and training, Towards cyberpsychology: mind, cognition, and society in the Internet age, 2(207).

[16] Atli, K., Selman, W., & Ray, A. (2021). A comprehensive multicomponent neurosurgical course with use of virtual reality: modernizing the medical classroom. *Journal of surgical education*, *78*(4), 1350-1356.

[17] Bing, E. G., Parham, G. P., Cuevas, A., Fisher, B., Skinner, J., Mwanahamuntu, M., & Sullivan, R. (2019). Using low-cost virtual reality simulation to build surgical capacity for cervical cancer treatment. *Journal of global oncology*, *5*, 1-7.

[18] Chaudhry, A. H., Bukhari, F., Iqbal, W., Nawaz, Z., & Malik, M. K. (2020). Laparoscopic Training Exercises Using HTC VIVE. *Intelligent Automation & Soft Computing*, *26*(1).

[19] Stansfield S, Shawver D, Sobel A, Prasad M, Tapia L (2000) Design and implementation of a virtual reality system and its application to training medical first responders. *Presence Teleoperators Virtual Environments*, 9(6), 524–556.

[20] Wiederhold BK, Wiederhold MD (2008) Virtual reality for posttraumatic stress disorder and stress inoculation training. *Journal of CyberTherapy & Rehabilitation*, 1(1), 23–35.

[21] Winn, W. (1993) A conceptual basis for educational applications of virtual reality. Technical Publication R-93-9, Human Interface Technology Laboratory of the Washington Technology Center, Seattle: University of Washington.

[22] Dede, C. (1995). The evolution of constructivist learning environments: Immersion in distributed, virtual worlds. *Educational technology*, 35(5), 46-52.

[23] Seo, J. H., Malone, E., Beams, B., & Pine, M. (2021). Toward Constructivist Approach Using Virtual Reality in Anatomy Education. In *Digital Anatomy: Applications of Virtual, Mixed and Augmented Reality* (pp. 343-366). Cham: Springer International Publishing.

[24] Lamb, R., Lin, J., & Firestone, J. B. (2020). Virtual reality laboratories: A way forward for schools?. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(6), em1856.

[25] Goldin-Meadow, S. (2009). How gesture promotes learning throughout childhood. Child Development Perspectives, 3, 106–111.

[26] Chang, J. S. K., Yeboah, G., Doucette, A., Clifton, P., Nitsche, M., Welsh, T., & Mazalek, A. (2017, June). TASC: Combining Virtual Reality with Tangible and Embodied Interactions to Support Spatial Cognition. In *proceedings of the 2017 conference on designing interactive systems* (pp. 1239-1251).

[27] Fuhrman, O., Eckerling, A., Friedmann, N., Tarrasch, R., & Raz, G. (2020). The moving learner: Object manipulation in virtual reality improves vocabulary learning. *Journal of Computer Assisted Learning*, 37, 672–683. https://doi.org/10.1111/jcal.12515

[28] Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life*. Cambridge University Press.

[29] Greeno, J. G., Moore, J. L., & Smith, D. R. (1993). Transfer of situated learning. In D. K. Detterman, & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 99–167). Westport, CT, US:Ablex Publishing.

[30] Franciosi, S. J., Yagi, J., Tomoshige, Y., & Ye, S. (2016). The effect of a simple simulation game on long-term vocabulary retention. *CALICO Journal*, 33(3), 355–379.

[31] Schott, C., & Marshall, S. (2018). Virtual reality and situated experiential education: A conceptualization and exploratory trial. *Journal of computer assisted learning*, *34*(6), 843-852.

[32] Bricken, M. (1991). Virtual reality learning environments: potentials and challenges. *Acm Siggraph Computer Graphics*, *25*(3), 178-184.

[33] Lepper, M. R. & Malone T. W. (2021) Intrinsic motivation and instructional effectiveness in computer-based education. In *Aptitude, learning, and instruction* (pp. 255-286). Routledge.

[34] Stoney, S., & Oliver, R. (1999). Can higher order thinking and cognitive engagement be enhanced with multimedia. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, *1*(2), 7.

[35] Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments?. *British journal of educational technology*, 41(1), 10-32.

[36] Marky, K., Müller, F., Funk, M., Geiß, A., Günther, S., Schmitz, M., ... & Mühlhäuser, M. (2019). Teachyverse: collaborative E-learning in virtual reality lecture halls. In *Proceedings of Mensch Und Computer 2019* (pp. 831-834).

[37] Souchet, A. D., de Cassagnac, R. G., Drapier, O., Maurice, É., Azouani, R., Zaza, E., ... & Philippe, S. (2020). Virtual classroom's quality of experience: a collaborative VR platform tested in situ. *Laval Virtual VRIC ConVRgence 2020 Proceedings*, 5.

[38] Chheang, V., Saalfeld, P., Huber, T., Huettl, F., Kneist, W., Preim, B., & Hansen, C. (2019, December). Collaborative virtual reality for laparoscopic liver surgery training. In *2019 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR)* (pp. 1-17). IEEE.

[39] Greenwald, S. W., Kulik, A., Kunert, A., Beck, S., Fröhlich, B., Cobb, S., ... & Maes, P. (2017). Technology and applications for collaborative learning in virtual reality. Philadelphia, PA: International Society of the Learning Sciences.

[40] Andreasen, J. B., & Haciomeroglu, E. S. (2009). Training teachers in multiple environments: Microteaching versus mixed-reality. *Faculty Focus*, 8(1), 7.

[41] Dieker, L., Hynes, M., Stapleton, C., & Hughes, C. (2007). Virtual classrooms: Star simulator. *New Learning Technology SALT*, 4, 1–22.

[42] Dieker, L., Hynes, M., Hughes, C., & Smith, E. (2008). Implications of mixed reality and simulation technologies on special education and teacher preparation. *Focus on Exceptional Children*, 40, 1.

[43] Dieker, L. A., Hynes, M. C., Hughes, C. E., Hardin, S., & Becht, K. (2015). TLE TeachLivE™: Using technology to provide quality professional development in rural schools. *Rural Special Education Quarterly*, 34, 11–16.

[44] Lugrin, J. L., Latoschik, M. E., Habel, M., Roth, D., Seufert, C., and Grafe, S. (2016). Breaking Bad Behaviors: A New Tool for Learning Classroom Management Using Virtual Reality. *Frontiers in ICT*, 3.

[45] Manouchou, E., Stavroulia, K. E., Ruiz-Harisiou, A., Georgiou, K., Sella, F., & Lanitis, A. (2016). April). A feasibility study on using virtual reality for understanding deficiencies of high school students (pp. 1–6). IEEE.

[46] Stavroulia, K. E., Ruiz-Harisiou, A., Manouchou, E., Georgiou, K., Sella, F., & Lanitis, A. (2016). April). A 3D virtual environment for training teachers to identify bullying (pp. 1–6). IEEE.

[47] Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology*, 10, 85.

[48] Usoh, M., Catena, E., Arman, S., & Slater, M. (2000). Using presence questionnaires in reality. *Presence*, 9(5), 497-503.

[49] Roth, D., & Latoschik, M. E. (2020). Construction of the virtual embodiment questionnaire (VEQ). IEEE Transactions on Visualization and Computer Graphics, 26(12), 3546-3556.

[50] Aristovnik, A., Ravšelj, D., Umek, L. & Karampelas K.. (2023). Research Trends of Online Learning in Postsecondary Education During the Covid-19 Pandemic: A Bibliometric Analysis. In E. Varonis and A. Pyrini (Eds.), *The International Conference on Information Communication Technologies in Education (ICICTE 2022) Proceedings*, pp. 7-20. ICICTE.

[51] OECD (2021), Education at a Glance 2021: OECD Indicators, OECD Publishing, Paris, https://dx.doi.org/10.1787/69096873-en.

[52] Debattista, M. (2018). A comprehensive rubric for instructional design in e-learning. *International Journal of Information and Learning Technology*, 35 (2), 93-104. https://doi.org/10.1108/IJILT-09-2017-0092.

[53] Stavroulia, K., Pyrini, A., Álvarez Testillano, I., Keegan, S., Debattista, M., Zarraonandia Ayo, T., Roussias, C., Sanz Prieto, M., Díaz Pérez, P. and Lanitis, A. (2023). VRTEACHER project: A Revolutionary Approach to Teacher Education Using

Virtual Reality. To be presented at the ICICTE 2022 International Conference on Information Communications Technologies in Education, 6-8 July 2023, Lesvos, Greece.

[54] Stavroulia, K. E., Testillano, I. Á., Pyrini, A., Debattista, M., Ayo, T. Z., Prieto, M. S., ... & Lanitis, A. (2023). On the development of a virtual reality teacher training application: inspired by educators, designed for educators. In INTED2023 Proceedings (pp. 4666-4672). IATED. https://library.iated.org/view/STAVROULIA2023OND

[55] Stavroulia, K. E., & Lanitis, A. (2023). The role of perspective-taking on empowering the empathetic behavior of educators in VR-based training sessions: An experimental evaluation. Computers & Education, 197, 104739. https://www.sciencedirect.com/science/article/abs/pii/S0360131523000167

[56] Pyrini, A. & Kavouklis, G. (2022). VRTEACHERS: Virtual Reality-Based Training to Improve Digital Competences of Teachers. Proceedings of ICICTE 2021 International Conference on Information Communications Technologies in Education (2022), Rhodes, Greece, pp. 139, http://icicte.org/assets/icicte21-proceedings.pdf

[57] Stavroulia, K. E., Aedo, I., Díaz, P., & Lanitis, A. (2021, September). Virtual-Reality Based Crisis Management Training for Teachers: An Overview of the VRTEACHER Project. In 2021 International Symposium on Computers in Education (SIIE) (pp. 1-4). IEEE, https://ieeexplore.ieee.org/abstract/document/9583628


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