Virtual Reality and the Art of Empathetic Teaching: Enhancing Teacher Education Through Perspective-Taking

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The use of Virtual Reality (VR) in teacher education can revolutionize the way teachers are trained and developed. This paper presents the development and evaluation of a dedicated VR application that aims to enhance teachers' competences through experiential and practical training in a safe and controllable virtual environment. More than 290 teachers from five different countries evaluated the VR application. The results indicate that perspective changing allows teachers to better experience the problems faced by students, allowing the cultivation of skills such as empathy, inclusion and diversity. Equally important is that preliminary results indicate that the VR implementation had a long-term impact on teachers' perceptions and attitudes.

CCS CONCEPTS • Computing methodologies • Graphics Systems and Interfaces • Virtual Reality

Additional Keywords and Phrases: Virtual Reality, Teacher Training, Perspective-taking

1 INTRODUCTION

Virtual Reality (VR) technology has the potential to transform the teacher education sector by offering unique, immersive and interactive learning experiences that can improve retention and understanding [1][2]. VR-based training can enhance teachers' engagement, improve learning outcomes and foster their personal and professional development [3]. Additionally, VR allows teachers to experience hands-on learning opportunities in a safe and controlled environment [4]. Equally important is that VR can be used to simulate real-world scenarios and provide virtual field trips that are otherwise

difficult or impossible to access [5]. By providing immersive and interactive learning experiences, VR can help teachers to develop their skills and competences in a way that traditional teaching methods cannot.

This paper presents a VR application for teacher training that was developed within the framework of the VRTEACHER project (Virtual Reality-based Training to improvE digitAl Competences of teacHERs) offering teachers the opportunity to practice their teaching abilities in a simulated classroom environment. This innovative tool offers a range of benefits to teachers which make it a valuable asset for teacher education by providing immersive learning experiences depicting extreme and real-life-based classroom scenarios that offer valuable opportunities for reflection and professional growth. This novel training tool has the potential to revolutionize teacher education and improve its quality by transforming the way teachers are trained and develop their skills, leading to better teaching outcomes and improved student learning. Active teachers participated in all stages of the application design and development cycle, ensuring that the use of the application provides valuable opportunities for reflection and professional growth. The key feature of the application is the ability of users to experience the scenarios both through the eyes of teachers and students. The VR application was evaluated by more than 290 in-service and pre-service teachers from five countries (Cyprus, Greece, Spain, Ireland and Malta) allowing the derivation of comprehensive conclusions related to the effectiveness and impact of the application, and in particular, the impact of perspective changing. Preliminary results validate the promise of the VR application, as a highly useful tool for teacher training.

1.1 Virtual Reality in teacher training

Virtual reality (VR) is an emerging technology that has gained significant attention in recent years [6][7][8]. It is a simulated experience that can reflect real-world experiences and situations, providing new opportunities for a range of industries, including education. VR has become a popular tool in various fields, as evidenced by the growing body of literature in fields such as psychology [9], chemistry [10], language learning [11], physics [12] and many other scientific disciplines. VR has the potential to offer immersive opportunities for practical training in teacher education, enabling teachers to experience different scenarios and develop critical competences in a safe and controlled environment. The use of VR in teacher education can bridge the gap between theory and practice, allowing teachers to gain hands-on experience and develop their skills before entering a real classroom. VR technology has been identified as a medium that can induce empathy and is often referred to as an "empathy machine" [13][14]. Furthermore, VR allows users to see the world from the perspective of others, offering a unique opportunity to see what others see, hear what others hear, move how others move, and feel the emotions others feel [15]. This immersive technology enables users to gain a deep understanding of other people's experiences, such as the viewpoint of refugees or a student with a prosthetic leg after an accident [16] and can promote empathy and understanding in a way that traditional media cannot.

Several initial studies have shown promising results for the use of VR in teacher education. One VR prototype created a classroom environment that simulated students with vision disorders, allowing teachers to experience the perspective of visually impaired students [17]. Another study aimed to train teachers in identifying and distinguishing bullying incidents from teasing cases [18]. Lugrin et al. [19] developed an immersive VR system that enhanced teachers' classroom management skills by training them to manage disruptive behavior in the classroom. Furthermore, Bujdosó [20] explored the potential of using VR-based approaches to enhance student teachers' presentation skills.

The use of VR in teacher training has the potential to add significant value to traditional methods of education by simulating scenarios that are difficult to replicate in real life, such as emergency situations and uncommon classroom situations. VR can provide a safe and controlled environment for trainees to practice and develop their skills without the risk of harm or negative consequences. Equally important is the ability of VR to enhance empathy and perspective-taking

skills, allowing teacher trainees to experience the world through the eyes of their students gaining a deeper understanding of their experiences and challenges. This can lead to more inclusive and culturally responsive teaching practices. Furthermore, VR can offer highly engaging and interactive learning experiences, by immersing trainees in a virtual environment, promoting their active participation in the learning process, rather than just passively consuming information. The benefits that VR-based training can lead to better-prepared and more effective teachers while also increasing the quality of education through immersive, experiential, and practical learning experiences.

2 METHODOLOGICAL FRAMEWORK

The methodological framework used during the application development process was carefully designed to ensure that the delivered application was relevant and effective in meeting the real needs of teachers. The use of participatory design ensured that the VR application was user-friendly and met the needs of teachers in different educational contexts. During the design process, an online survey was conducted to identify the specific needs of teachers, providing valuable insights into the challenges they face, the impact of the pandemic on their daily work, and the types of training and support that they need. This information was used to inform the design of the scenarios for the VR training tool. Focus groups were also conducted providing an opportunity to explore teachers' expectations of the VR tool and to gather feedback on its potential usefulness. By engaging teachers in this way, the project team was able to identify any potential barriers to adoption and address these in the design and development of the VR application. Figure 1 presents the block diagram of the methodological design process.

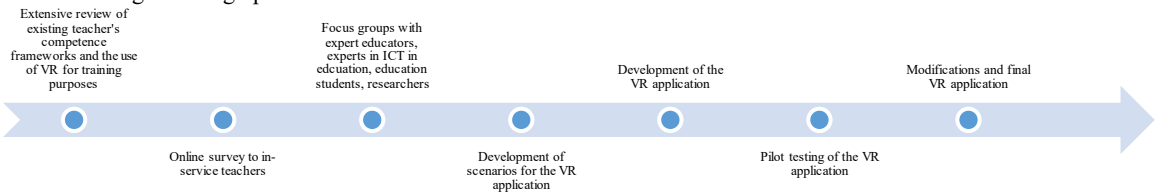

Figure 1: Block diagram of the methodological design and development process

2.1 Defining the competences for VR teacher training

To determine the essential competences for effective VR-based teacher training, the first step was to conduct a comprehensive review of existing frameworks, such as the European Key Competences Framework, DigCompEdu, and ICT Competency Framework for Teachers. This was followed by a survey designed to identify the needs and key skills required by teachers. In total, 340 in-service and pre-service teachers participated in the online survey. The results revealed a need for soft skills empowerment and a demand for training programs that can help educators to gain more experience with VR-based techniques. The survey aimed also to gather input related to three areas: 1) Digital 2) Personal and 3) Civic Competences. Related to ‘Digital Competences’ the survey results identified the most important competences the active engagement of the learners, problem-solving, collaborative learning, and ICT in education. The participants rated "Stress resistance", "Emotional control", and "Self-control" as the most important personal competences. In terms of civic competences "Valuing of diversity," "Trust," "Co-operation," "Social responsibility and engagement," "Sociability," and "Assertiveness received the highest scores. After the survey focus groups were conducted consisting of expert educators, university students, ICT experts and researchers. These focus groups aimed to provide an in-depth exploration of teachers' needs, and expectations of a VR training tool, ensuring that the resulting VR tool was tailored to meet the specific needs and expectations of the target audience.

For the definition of the VRTEACHER competence framework, the partnership had to take into consideration, apart from the competences that scored the highest scores in the survey and the outcomes of the focus groups, the scenarios of the VR application along with the limitations of VR technology and equipment. For this reason, the selection of the project's core competences was not made based only on the competences that scored higher in the survey but also based on the competences that could be addressed and reflected through the VR tool and scenario. The competence framework for VR-based teacher training that was developed can be summarized in Figure 2.

Figure 2: Competence framework for the development of the VR application

3 VR 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 don't speak the language of instruction of the class. 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 is publicly available to educators through the VRTEACHER website (https://www.vrteacher.eu/).

3.1 Technical setup

The application runs on smartphones and 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, and the interaction.

By starting the application for the first time, the user is prompted to select basic settings such as language settings, username, and country. In the main menu, the user can navigate through different menus, and select one of the three VR scenarios (see section 3.3 for a description of the scenarios). 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.

The decision to use low-cost cardboard VR headsets for Android phones in the VRTEACHER project is a practical and cost-effective approach that aligns well with the project's objectives. By opting for a more affordable option, the project makes it easier for schools and teachers to access the necessary equipment. This ensures a wider reach and adoption of the VRTEACHER application, especially in educational settings where budgets for technology might be limited. Furthermore, the simplicity of these cardboard headsets facilitates the setup and reduces potential technical barriers for users. Scenarios, perspective change and eye gaze interaction

In the current version, the VR application offers three scenarios that simulate real-life classroom scenarios, each with its own set of challenges and learning outcomes.

- *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 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 Students:* The third scenario focuses on the challenges that teachers may encounter when working with refugee students who do not speak the language of instruction. This scenario allows teachers to develop their understanding of the unique challenges in multicultural classes.

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. Typical screenshots from the scenarios are presented in Figure 3.

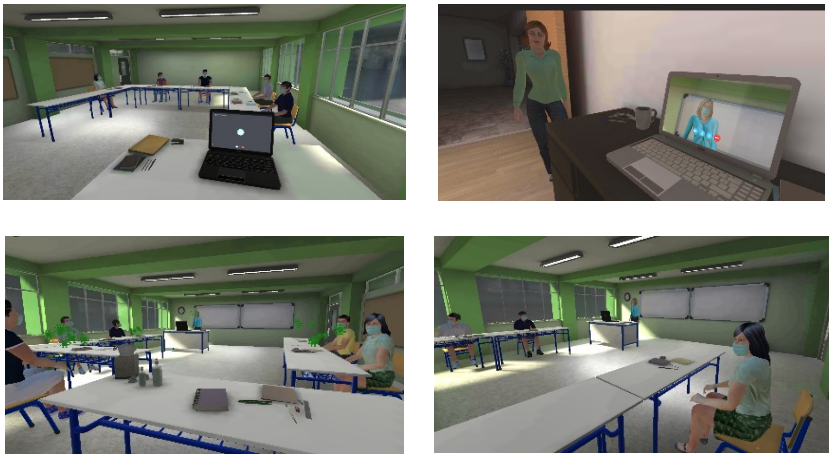

Figure 3: Typical screenshots from the VR application showing the teacher perspective (top left), and the student perspectives for scenarios 1 (top right), 2 (bottom left), and 3 (bottom right)

3.2 Research questions, Implementation and evaluation process

The research questions that the VR intervention aimed to answer were the following:

1. Did the integration of VR-based training, as facilitated by the VRTEACHER project, enhanced teachers' competences?
2. To what extent did perspective change feature lead to improved teacher empathy and understanding of student experiences?
3. Over an extended period, what lasting effects does the VRTEACHER project have on teachers' personal and professional development?

The project initiated a comprehensive sequence of workshops, both online and face-to-face, meticulously tailored to equip teachers with essential competences and insights for VR technology integration. The initial online session aimed to acquaint educators with VR technology, elucidate its potential advantages, and offer a practical guide on the utilization of the VR application. This was followed by a face-to-face training workshop where educators received hands-on training with the VR application. Finally, through a follow-up online workshop participants reflected on the VR-based training practices. During the face-to-face training activities, the participants were required to complete one questionnaire before and one after the VR intervention. Additionally, a third questionnaire was administered four weeks after the VR intervention serving to assess the enduring impact of the intervention. Pre, post and follow-up questionnaires were the

same consisting of the Interpersonal Reactivity Index (IRI) (sub-scales Empathic concern, Perspective taking, and Personal distress), and three scales each one related to each scenario that were developed under the VRTEACHER project.

4 RESULTS

The evaluation of the VR application encompassed a cohort of 299 in-service and pre-service teachers hailing from five different countries. Throughout the training process, participants were afforded approximately 30 minutes per scenario to interact with the application. During this immersive experience, they were prompted to respond to inquiries embedded within the virtual environment, considering both the teacher's and student's perspectives within each scenario. It should be noted that in addition to data gathered during the VR intervention, data was also collected through pre, post and follow-up questionnaires. The results discussed in this paper refer to the data collected from the VR application, as the analysis of the pre, post and follow-up questionnaires is still ongoing. However, some initial findings are also included.

In total 223 participants evaluated Scenario 1, 184 participants evaluated Scenario 2, and 185 participants evaluated Scenario 3. Across all three scenarios, participants were asked to assess whether their experience in the virtual environment was consistent with a real-world experience rating this consistency on a scale ranging from 1 (indicating the highest level of congruence) to 5 (representing the lowest level of consistency). In the context of scenario 1, the research findings suggest that in both teacher and student perspectives, most participants reported a consistent real-world-like experience. Statistical analysis revealed no significant discrepancy between these two viewpoints ($t=1.62$, $p>0.01$). The outcomes further indicate that the experience felt immersive and authentic in both viewpoints ($M=1.35$, $SD=0.48$ as a teacher and $M=1.27$, $SD=0.44$ as a student). Additionally, the data disclosed a statistically significant contrast in the ability of participants to genuinely place themselves in the position of the student attending the class with teleconferencing ($t=3.708$, $p<0.01$). This finding signifies that the virtual embodiment of the student perspective allowed end-users to authentically experience the learning environment from a student's viewpoint, underlining the effectiveness of this feature in fostering a faithful and engaging educational experience. Regarding scenario 2, the findings underscore a notable convergence of experiences among participants from both the teacher and student perspectives, with most reporting an immersive, real-world-like encounter. Importantly, no statistically significant difference emerged between these two viewpoints. As revealed by the data, participants engaged with scenario 2 as active participants rather than mere observers, as indicated in both perspectives' responses ($M=1.37$, $SD=0.48$ as a teacher and $M=1.27$, $SD=0.46$ as a student). Notably, the results unveiled a statistically significant divergence concerning whether participants could genuinely immerse themselves in the position of the student during a COVID-19-related panic attack ($t=-16.98$, $p<0.01$). This outcome underscores that the virtual embodiment of the student's perspective facilitated a heightened understanding of the student's predicament, further emphasizing the effectiveness of this feature in cultivating empathy and providing a comprehensive experience for end-users. The outcomes for scenario 3 similarly demonstrate that a majority of participants perceived the experience as remarkably consistent with a real-world encounter. Significantly, no statistically significant distinction was observed between the viewpoints of teachers and students in this regard. Furthermore, participants fully engaged with scenario 3, embodying the role of active participants rather than passive observers, as reflected in both perspectives ($M=1.39$, $SD=0.49$ as a teacher and $M=1.17$, $SD=0.47$ as a student). Notably, the results disclosed a statistically significant divergence in participants' ability to empathetically immerse themselves in the position of a student refugee ($t=-10.13$, $p<0.01$). This finding highlights the potent effect of embodying the virtual identity of the student, enabling end-users to genuinely experience the challenges faced by students who are not proficient in the language of instruction within a classroom. This outcome further underscores the valuable contribution of the VRTEACHER application in fostering cross-cultural understanding and empathy among educators.

The results from the data gathered from the VR application indicate that in all scenarios, participants expressed a sense of immersion within the virtual world and consistently found their experience to be akin to real-life situations, irrespective of the perspective they adopted. Particularly noteworthy is the impact of perspective change; the results demonstrate that assuming the role of a student in all three scenarios had a profound effect on the participants, enabling them to perceive the scenarios from the student's viewpoint. This, in turn, fostered empathetic behavior among the participating teachers, marking a significant outcome from the experiments.

The reliability analysis performed on the questionnaires administered revealed robust consistency in the scales employed, with Cronbach's alpha coefficients demonstrating high reliability:0.73 for IRI, 0.92 for Attitudes toward Remote and Blended Teaching scale (scenario 1), 0.96 for Attitudes toward Remote and Blended Teaching scale (scenario 2) and 0.93 for Attitudes towards Cultural Intelligence in Teaching scale (scenario 3). Preliminary findings from the pre, post, and follow-up questionnaires showcased statistically significant differences before and after the use of VR for all scales. Paired-sample t-tests were conducted to explore the impact of the VR intervention on participants' empathic concern, perspective taking and personal distress after the VR intervention. The results demonstrated significant improvements. Specifically, a marked increase in participants' perspective-taking was observed. [$t(263) = -2.87$, $p<0.01$], coupled with a statistically significant decrease in personal distress [$t(263) = 2.12$, $p<0.05$] post the VR intervention. While not statistically significant, the results indicated a subtle rise in participants' empathic concerns. Further analysis focused on participants' attitudes toward remote and blended teaching revealed noteworthy enhancements. Significant improvements were observed in overall attitudes [$t(263)=-6.81$, $p<0.001$], including attitudes towards inclusive education [$t(264)=-6.52$, $p<0.001$] and cultural intelligence [$t(263)=-3.56$, $p<0.001$]. Equally important, is that preliminary findings suggest a lasting impact of the VR intervention on participants, as evidenced by a statistically significant increase in attitudes observed four weeks post-VR implementation. This sustained effect may stem from an ongoing elaboration on the experienced learning scenarios, reflective practice, and peer discussions, contributing to the amplification of the intervention's long-term impact.

5 CONCLUSIONS AND FUTURE WORK

Based on preliminary results, the VR application presented is a valuable training resource for teachers that leverages the power of VR technology to provide immersive and interactive learning experiences. By simulating real-life classroom situations, the application allows teachers to develop their skills and competences in a safe and controlled environment, while also experiencing a situation through the eyes of the student. This enables teachers to develop an empathetic and student-centred approach to teaching, which can lead to better engagement and learning outcomes for the students.

The results for all three scenarios-distance education and domestic verbal abuse, phobias related to COVID and panic attacks, and students who are refugees, highlighted the VR application's ability to provide an exceptionally realistic experience. The innovative aspect of perspective change, enabling users to immerse themselves in crisis situations from both teacher and student viewpoints, emerged as a highly promising strategy for VR-based teacher training. Of equal significance, preliminary findings from the questionnaires underscore the transformative impact of VR in teacher training. The observed changes encompassed empathic concern, perspective-taking, personal distress, attitudes toward remote and blended teaching, inclusive education, and cultural intelligence. These positive changes were evident across pre, post, and follow-up questionnaires, indicating the profound and enduring impact of the VR intervention on participants.

In the future, more comprehensive results will be presented based on extended analysis from the pre, post and follow-up questionnaires. Furthermore, the project aims to further enrich the application in collaboration with active teachers by incorporating additional scenarios, extending language options, and expanding the evaluation to include more countries.

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